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ROLE OF HERBS ON DIABETES FOR A HEALTHY PERSON— A LITERATURE REVIEW

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ABSTRACT

Introduction: Diabetes mellitus also referred as hyperglycaemia is a complex metabolic disorder resulting from the insulin deficiency or insulin dysfunction. Currently, the main and effective treatment for diabetes is the use of insulin and hypoglycaemic drugs, but these compounds also have many adverse side effects. Medicinal plants have a long history of usage and today, they are being extensively used for various diseases.

Objective: To describe the therapeutic effects of various herbs and their role in treatment of, diabetes.

Methodology: Review of evidences for the therapeutic effects of various herbs in treatment of, diabetes from the various published articles.

Results: Evidences have shown that there is a valuable and proven benefit of various herbs mainly insulin plant in treatment of diabetes.

Conclusion: Evidences suggests that various herbs mainly insulin plant can have a positive therapeutic effect on the blood glucose levels thus relieving the adverse effects of, diabetes and controlling it. The Physicians should advice their patients about the importance of herbs and their benefits in the diabetes.

Key words: *insulin plant, herbs, diabetes, insulin.*

INTRODUCTION

Diabetes mellitus also referred as hyperglycaemia is a complex metabolic disorder resulting from the insulin deficiency or insulin dysfunction. It affects the people in both developing and developed countries. According to statistics, 2.8% of the world's population suffer from this disease and it is expected to increase to more than 5.4% by 2025 (Mukesh R, Namita, 2013). It changes the metabolism of lipids, carbohydrates, and proteins, having long term effects on eye, kidney, cardiovascular, and neurological systems.

Destruction of beta-cells of the islets of Langerhans in the pancreas and consequently development of insulin-dependent diabetes will also results in impairments of the regulation of the immune system and pancreatitis. (6).

Treatment includes diet, exercise, and medication. Currently, the main and effective treatment for diabetes is the use of insulin and hypoglycaemic drugs, but these compounds also have many adverse side effects. (12). Medicinal plants have a long history of usage and today, they are being extensively used for various

diseases. There are several reasons for increasing the use of medicinal plants, one of the most common is less or no adverse reactions on long term use and are cheaply available (9).

Corsolic acid obtained from insulin plants is reported to have anti-diabetic properties (*C. igneus*, *C. pictus*, *C. speciosus*, *C. acuminata*, *C. pinnatifida*, *C. roseus*, *E. japonica*, *L. angustifolia*, *L. polyphylla*, *T. vulgaris* and *U. molinae*). *Costus igneus* commonly known as insulin plant in India belongs to the family costaceae. it is believed that consumption of these leaves helps in decreasing the blood glucose levels, and diabetics who consumed the leaves of this plant report a fall in their blood glucose levels. The leaves are usually consumed by shade dried, finely powdered, weighed, ground in water. In a study by (4), effect of insulin plant leaves on dexamethasone-induced hyperglycemia, concluded that the leaves of insulin plant reduced the fasting and post-prandial blood sugar levels, bringing them normal, in dexamethasone induced hyperglycaemia rats.

This article shall summarize the various herbs used in treating Diabetes emphasizing on their potential effects on controlling the blood glucose levels.

Various Herbs used in Diabetes :

Acacia arabica : (Babhl) It is found all over India mainly in the wild habitat. The plant extract acts as an antidiabetic agent by acting as secretagogue to release insulin. (29).

Allium cepa: (onion) Various ether soluble fractions as well as insoluble fractions of dried onion powder show anti-hyperglycemic activity. When diabetic patients were given single oral dose of 50 g of onion juice, it significantly controlled post-prandial glucose levels (20).

Aloe vera and Aloe barbadensis : Aloe, a popular houseplant, has a long history as a multipurpose folk remedy. The plant can be separated into two basic products: gel and latex. Aloe vera and its bitter principle are through stimulation of synthesis and/or release of insulin from pancreatic beta cells. (3).

Bel : Bel fruit known as Aegle marmelose, it was observed that on oral administration of the aqueous extract derived from Aegle marmelose fruit (125 and 250 mg/kg) in streptozotocin diabetic Wistar rats twice daily for approximately 4 weeks caused a significant decrease in blood glucose, plasma thiobarbituric acid reactive substances, hydroperoxides, ceruloplasmin, alpha-tocopherol, and a considerable increase in plasma reduced glutathione, and vitamin C. The use of a 250 mg/kg dose of the extract was more effective than glibenclamide in the improvement of these parameters. In this research, results clearly show the hypoglycemic activities of Aegle marmelose extract.

Bitter Gourd : The indigenous populations of Asia, South America, India, the Caribbean and East Africa frequently use *Momordi cacharantia* (*M. charantia*), also known as bitter melon, karela, balsam pear, or bitter gourd, as a popular plant used for the treating diabetes-related conditions amongst. The main constituents of bitter melon which are responsible for the anti-diabetic effects are triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic compounds. In particular, four triterpenoids have AMP-activated protein kinase activity which is a plausible hypoglycaemic mechanism of *Momordi charantia*.

Caesalpinia bonducella : It is widely distributed throughout the coastal region of India and used ethnically by the tribal people of India for controlling blood sugar. Both the aqueous and ethanolic extracts showed potent hypoglycemic activity in chronic type II

diabetic models. These extracts also increased glycogenesis thereby increasing liver glycogen content. (7).

Chiraita : A well herb found in the Himalays known as *Swertia chirayita* (Gentianaceae), commonly known as Chiraita, is used in traditional medicine to treat numerous ailments such as liver disorders, malaria, and diabetes and is reported to have a wide spectrum of pharmacological properties. Its medicinal use is well-documented in Indian pharmaceutical codex, the British, and the American pharmacopeias and in different traditional medicine such as the Ayurveda, Unani, Siddha, and other conventional medical systems. The wide-range biological activities of *S. chirayita* are attributed to the presence of a diverse group of pharmacologically bioactive compounds belonging to different classes such as xanthenes and their derivatives, lignans, alkaloids, flavonoids, terpenoids, iridoids, secoiridoids, and other compounds such as chiratin, ophelic acid, palmitic acid, oleic acid, and stearic acid (22, 23).

Coccinia indica: Dried extracts of *Coccinia indica* (*C. indica*) (500 mg/kg body weight) when administered to diabetic patients, it was found that these extracts restored the activities of enzyme lipoprotein lipase (LPL) that was reduced and glucose-6-phosphatase and lactate dehydrogenase which were raised in untreated diabetics (14).

Ferula assafoetida : Due to the presence of antioxidant compounds, gum can reduce the amount of intracellular free radicals and stimulate the synthesis and secretion of insulin or hyperplasia of the remaining beta cells in the pancreas. Anthoczone gum may reduce blood glucose by stimulating the synthesis and secretion of insulin and hyperplasia of the remaining beta pancreatic beta cells. (8).

Giloy: Guduchi (*Tinospora cordifolia*) a highly potent Pramehahara (anti-diabetic) herb commonly used in Ayurveda and Guduchi Satva (GS), popularly known as Giloy is used to treat Paittika type of Prameha. GS prepared from the stem of *T. cordifolia* was evaluated for hypoglycaemic. and anti-hyperglycaemic activity in 18 hour fasted mice. GS was suspended in distilled water and administered to animals at the dose of 130 mg/kg that showed the marginal reduction in blood sugar level (BSL) at all the time intervals in normoglycemic mice. In anti-hyperglycaemic activity, administration of GS prior to

glucose over load failed to attenuate blood sugar levels, at all-time intervals in comparison to glucose control group. The study concludes mild hypoglycaemic insignificant anti-hyperglycaemic activities of GS. (25).

Ginseng: Ginseng has a blood glucose-lowering effect that stimulates insulin secretion, protects pancreatic islets, stimulates glucose uptake, and increases insulin sensitivity. (16).

Gurmar: A well identified anti diabetic herb used in traditional ayurveda is *Gymnema sylvestre* (Asclepiadaceae), popularly known as “gurmar” It is well known for its distinct property as sugar destroyer. The phytoconstituents responsible for sweet suppression activity includes triterpenesaponins known as gymnemic acids, gymnemasaponins, and a polypeptide, gurmardin. The herb exhibits a broad range of therapeutic effects as an effective natural remedy for diabetes; It is also being used for arthritis, diuretic, anaemia, osteoporosis, hypercholesterolemia, cardiopathy, asthma, constipation, microbial infections, indigestion, and anti-inflammatory. *G. sylvestre* has good prospects in the treatment of diabetes as it shows positive effects on blood sugar homeostasis, controls sugar cravings, and promotes regeneration of pancreas. (28).

Insulin plant (*Costus igneus*) : The corsolic acid is considered to be the best among the pentacyclic triterpene in management of diabetes. *Corsolic acid* is widely available in the leaves of insulin plant (*C. igneus*, *C. pictus*, *C. speciosus*). *Costus igneus* Nak (syn. *Costus pictus* D. Don, *Costus mexicanus* Liebm ex Petersen or *Costus congenitus* Rowle), commonly known as fiery costus, Step ladder or Spiral flag or Insulin plant, is native to South and Central America. They are usually grown in fertile, organic, moist, well-drained soils in shade. A regular consumption of 2 to 3 fresh leaves early in the morning followed by 30-35 minutes workout, the blood sugar level was maintained between 5.5 to 6.1 in HbA1C ranges. (10, 11, 24). The hypoglycaemic action can be due to release of insulin, insulin-sensitizing action or a combination of both. (27).

Jamun : Jamun scientifically known as *Syzygium cumini* commonly found in India. Its seed extract contains many phytochemicals, such as triterpenoids, anthocyanins, oleic acid, essential oils, glycosides, saponins, and several members of the flavonoids (e.g.,

rutin, quercetin, myricetin, and myricitrin). Hence, the observed anti-diabetic effects of *Syzygium cumini* seed extract may be due to a single component or a combination of these components that could have direct or indirect effects on insulin resistance and β -cell function. Jamun stimulates the secretion of pancreatic insulin. Jamun administration is reported to restore the architecture of the pancreatic β -cell in diabetic experimental animal cells. (15, 26).

Perilla : Hypoglycemia effect of *Perilla* leaf growth factor (PLE) is derived, at least in terms of reduced glucose uptake, in the small intestine. Improved tolerance to Glucose PLE may be due to direct inhibition of glucose uptake in the small intestine (5).

Tecoma : A common herb used in Mexico is *Tecomastans* aqueous extract (TAE) widely used as a traditional antidiabetic remedy; the main antidiabetic effect of TAE is due to intestinal α -glucosidase inhibition by decreasing the postprandial hyperglycaemia peak. (2).

Urtica Dioica : The aqueous UD extract plays an important role by improving the morphology and / or function of beta cells. Preventing damage to beta-cell cells, repair damaged beta cells, rebuilding new cells, and stimulating insulin secretion in functional cells is one of the mechanisms of action of the extract of this plant. (30).

Apart from the above mentioned herbs, the following herbs also have anti-diabetic effects:

Achyranthes Aspera (19) *Acosmium Panamense* (Andrade cetto A, 2004), *Allium sativum* (garlic) (17), *Andrographi spaniculata* (31), *Annona squamosal* (13), *Azadirachta indica* (18), *Coriandrum sativum* (21), *Mangifera indica* (1).

CONCLUSION

The main anti-diabetic phytochemical, corsolic acid (synonyms: colosolic acid, Corsolic acid; Glucosol; (2 α , 3 β)- 2, 3-Dihydroxyurs-12-en-28-oic acid; 2 α -hydroxyursolic acid) present in insulin plant is reported to have beneficial effects on several life threatening diseases.

Diabetes mellitus is the most common endocrine disorder, and the therapies developed along the principles of western medicine are often limited in efficacy and have various adverse effects on long term use. Despite considerable progress in the development

of synthetic drugs, the discovery of phyto-medicines as an alternative therapy requires a lot of scientific inputs. Therefore, awareness about the potential as an alternative therapy requires lot of scientific inputs. Therefore, awareness about the potential plants for the management of diabetes mellitus, their recognition, production, usage and availability of quality product are great challenges but enormous opportunities do exist. The health care professionals should now emphasize on “system approach for disease management and cure”(SADMA) to build a healthy society by adopting all practices of medicine judiciously with harmony to conquer malnutrition, food security, escalating cost of treatments, drug resistance and safe guard from all possible side effects.

Therefore, treating diabetes with plant derived compounds which are easy accessible and do not require laboratory synthesis, are to be encouraged by physicians for a better potency and healthy living of the patients with diabetes.

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ISOLATION, SCREENING AND CHARACTERIZATION OF POTENTIAL CHLORPYRIFOS UTILIZING BACTERIA FROM BUDDHA NULLAH AS WELL AS AGRICULTURAL SOILS OF RURAL LUDHIANA, KAPURTHALA AND SHAHEED BHAGAT SINGH NAGAR, PUNJAB

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ABSTRACT

The state of Punjab is one of the highest users of pesticides especially after the ushering in of green revolution. Chlorpyrifos has been used in Punjab since 1970s for the eradication of various insects in fruits, vegetables, cotton, corn, wheat and to remove ticks, termites, roundworms, and mosquitoes. The impact of this pesticide is such that the WHO has put it to adversely affect 97% of the 1,782 species listed under the endangered species act. Considering that chlorpyrifos is one of the most commonly applied insecticides for control of pests and insects especially in Punjab, the purpose of this research was to isolate and characterize chlorpyrifos utilizing bacteria able to rapidly and efficiently degrade chlorpyrifos from Ludhiana, Shaheed Bhagat Singh Nagar and nearby villages. Through repetitive enrichment and successive culturing, indigenous bacterial strains were screened and examined in detail for their morphological, cultural and biochemical characteristics. In addition to this, the study also aimed to assess their adaptation to high concentrations of chlorpyrifos and to determine their drug resistance potential.

Keywords : *Chlorpyrifos, Punjab, Enrichment, Bacterial strains, Biochemical characteristics*

INTRODUCTION

In India approximately 80,000 tonnes of pesticides are used annually, mostly in the production of cotton (45%), rice (23%), fruits and vegetables (8%), and cereals, pulses, oilseeds and millets (6–7%). Among all the states of India Haryana, Punjab and Uttar Pradesh have the largest pesticide consumption, using 45,000 tonnes of (technical grade) pesticides in 2000–01. Organophosphorus compounds (OP), a group of highly toxic agricultural chemicals are widely used for plant protection and have generated a number of environmental problems. Diazinon, malathion and chlorpyrifos as insecticides and acaricides, are the most commonly used OPs. Chlorpyrifos [O,O-diethyl O-(3,5,6-trichloro-2-pyridyl phosphorothioate)] is an important OPs insecticide, widely used against a broad spectrum of agricultural crops throughout the world at concentration of 3 to 15 kg/ha (39). It is a highly effective pesticide because it irreversibly inhibits acetylcholinesterase (AChE) enzymes leading to excess acetylcholine accumulation at nerve terminals resulting in agitation, hypersalivation, convulsion, and ultimately death of insects and mammals (22). The

extensive usage of chlorpyrifos having a half life from 10 to 120 days in soil has resulted in widespread environmental contamination affecting beneficial non-target soil microorganisms because of its entry in the food chain (6, 10, 25, 30) and undesirable health issues to humans that include developmental toxicity, liver damage, reproductive defects, endocrine disruptions, nervous system disorders, and immune system abnormalities (3, 16, 35, 45). The acute toxicity of CP has also been reported in some animals including aquatic invertebrates and fishes, arthropods, and soil microorganisms (12, 28, 32, 47). Although detoxification of contamination by OP pesticides mainly relies on chemical treatment, incineration and landfills (37), a reliable cost-effective technique for pesticide removal is biodegradation of organophosphorus compounds. There are many reports on the biotransformation of chlorpyrifos into other metabolites. One such metabolite resulting from hydrolysis is 3,5,6-trichloro-2-pyridinol (TCP) having a half life of 65–360 days (7, 11, 38). However, TCP is an antimicrobial metabolite which inhibits the proliferation of microorganisms in the soil and also prevents its own degradation by microorganisms and

chlorpyrifos degradation (33). The presence of three chloride atoms on the N-aromatic ring contributes to increased resistance of this metabolite to microbial degradation (9, 21, 40). The released chlorine atoms from TCP have antimicrobial activity that prevents the proliferation of CP-degrading bacteria (33). Owing to TCPs' greater persistence and water solubility compared to its parent compound, it leaches into the ground and surface water bodies causing widespread contamination of soils and aquatic environments, posing significant ecotoxicological risks (15, 48, 49). The Australian Pesticides and Veterinary Medicines Authority (APVMA) have identified CP and its metabolites to be assessed for spray drift risks due to human health and environmental concerns (28).

The use of microorganisms having the right metabolic pathways is one of the most viable options for the remediation of CP and TCP in soil and water (24, 44, 46). Previously, CP was reported to be resistant to degradation (27, 34), but later studies identified bacteria from the genera *Enterobacter* (41), *Pseudomonas* (8, 14, 23), *Bacillus* (13, 26), and *Klebsiella* (19) that were able to degrade CP efficiently. In other recent studies, it was further determined that some of CP-degrading bacterial strains from the genera *Bacillus* (4), *Alcaligenes* (51), *Paracoccus* (49), *Gordonia* (1), *Sphingobacterium* (2), and *Mesorhizobium* (21) could utilize CP as a sole source of carbon (C) and also degrade TCP. The first ever bacterium (*Pseudomonas sp.*) capable of processing TCP as a sole source of C and energy was reported in 1997 (15), and a recent study by (24) reported *Ralstonia sp.* to degrade concentrations of TCP as a sole source of C and energy. *Alcaligenes faecalis* (51), *Enterobacter sp.* (40), *Sphingomonas sp.* (25), and *Stenotrophomonas sp.* (50) all these are the papers which reports the diversity of microbes capable of complete mineralization of chlorpyrifos without the formation of TCP. Although a significant phylogenetic diversity of microorganisms capable of degrading OP pesticides and their metabolites have been isolated, the potential for degradation is highly influenced by biotic and abiotic environmental factors (29, 31). Therefore, it has been highlighted that the characterization of more diverse groups of biodegrading microbial isolates will increase the flexibility of the development of effective bioremediation technologies tailored to local environmental conditions (e.g., pH, nutrients, and soil moisture) (42). Use of pesticide-degrading microbial

systems for removal of pollutants from the contaminated systems requires an understanding of ecological, physiological, and biochemical requirements of degrading organisms. More broadly, it will improve our understanding of the metabolic routes through which biodegradation of these compounds can take place (43).

MATERIALS AND METHODS

Chemicals and Media

Technical grade chlorpyrifos (98%) was purchased from Sigma–Aldrich (USA). Microbial isolations were conducted in minimum salt (MSM) (pH 6.8–7.2) medium containing g/L $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$, 3.0; KH_2PO_4 , 1.0; $(\text{NH}_4)_2\text{SO}_4$, 1.0; $(\text{NH}_4)[\text{Fe}(\text{C}_6\text{H}_6\text{O}_7)_2]$, 0.01; yeast extract, 0.1; and 10 ml of $100 \times$ trace element solution. The $100 \times$ trace element solution was composed of (g L^{-1}) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 10; $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$, 2.0; $\text{MnSO}_4 \cdot \text{H}_2\text{O}$, 3.0 and $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, 0.2.

Site description and sample collection

Soil samples were collected as per the method of (36) with slight modifications. Soil was obtained from sugarcane fields of Ladhawal (Ludhiana), Mohallon (Shaheed Bhagat Singh Nagar), Bhagouran (Shaheed Bhagat Singh Nagar) Jassomajra (Kapurthala) and from rice field of Punjab Agricultural University, Ludhiana with a history of chlorpyrifos use for several years to control insect pests. Soil sample was also procured from wet banks of Buddha Nullah, Ludhiana, Punjab.

Within each site, three replicates of soil samples were collected. Each replicate was composed of three soil sub-samples taken by digging a hole about 30 cm deep. These three sub-samples were mixed together and a composite 1 kg sample was taken for each replicate. The soils were sealed and kept at 4°C in the dark until further use. Fresh soil samples were sieved through a 2 mm sieve to get fine soil particles free from vegetation and other coarse particles.

Isolation and Enrichment of chlorpyrifos utilizing strains

A commercial formulation of chlorpyrifos 500 EC (500 g/L, Dow AgroSciences) was used in this study to investigate which soil types were able to degrade chlorpyrifos. 10 g of soil from all the sites were placed in 250 ml Erlenmeyer flasks containing 100 ml Dorn's medium supplemented with a solution of chlorpyrifos

Isolation, screening and characterization of potential chlorpyrifos utilizing bacteria from Buddha Nullah as well as agricultural soils of rural Ludhiana Punjab

Table-1 : Bacterial isolates and their source of isolation.

Source of soil collection	Village/ Location	District	Total number of isolates
Buddha Nullah	Haebowal	Ludhiana	13 (B1-B13)
Sugarcane field	Ladhowal	Ludhiana	3 (L1-L3)
Sugarcane field	Mohallon (site 1)	Shaheed Bhagat Singh Nagar	11 (S1-S11)
Sugarcane field	Mohallon (site 2)	Shaheed Bhagat Singh Nagar	6 (M1-M6)
Sugarcane field	Bhagouran	Shaheed Bhagat Singh Nagar	4 (B1-B4)
Sugarcane field	Jassomajara	Kapurthala	4 (J1-J4)
Rice field	Punjab Agricultural University	Ludhiana	8 (R1-R8)

Table-2 : Morphological characterization of chlorpyrifos utilizing bacterial isolates.

Bacterial isolates	Characteristics		
	Shape	Fluorescence	Cell arrangement
B1	Small curved rods	+	Single
B2	Small curved rods	+	Single
B3	Small curved rods	+	Single
B4	Cocco-bacillus	-	Single, chains
B5	Cocco-bacillus	-	Single
B6	Small curved rods	+	Single
B7	Coccus	-	Single, chains
B8	Small curved rods	+	Single
B9	Cocco-bacillus	-	Single
B10	Small curved rods	+	Single
S1	Cocco-bacillus	-	Single
S2	Small curved rods	+	Single
S3	Cocco-bacillus	-	Single and in pair
S4	Cocco-bacillus	-	Single
S5	Cocco-bacillus	-	Single
S6	Cocco-bacillus	-	Single, chains
R1	Cocco-bacillus	-	Single
R2	Coccobacillus	-	Single
R3	Coccus	-	Single
R4	Cocco-bacillus	-	Single
<i>Pseudomonas putida</i>	Small curved rods	+	Single
<i>Flavobacterium multivorum</i>	Cocco-bacillus	-	Single

to a final concentration of 50 mg/ml. The flasks were then incubated on a rotary shaker at 250 rpm at 30°C. All the soil-pesticide combinations were sampled periodically up to 7 days to isolate potential utilizing bacterial strains on petri plates containing Dorn's medium supplemented with 50 mg/ml of chlorpyrifos. The isolated bacterial strains were then sub-cultured on Dorn's medium containing same chlorpyrifos concentration until pure isolates were obtained.

The enrichment of chlorpyrifos utilizers was done sequentially from 100 mg/ml to 1000 mg/ml of

chlorpyrifos. The cultures were incubated at higher chlorpyrifos concentrations followed by their isolation. The strains capable of growing at increased chlorpyrifos concentration were further exposed to even higher concentrations of chlorpyrifos. Finally the strains with the tolerance for the highest chlorpyrifos concentration were selected and used for further morphological and biochemical characterization. The bacterium *Pseudomonas putida* (MTCC 2445) and *Flavobacterium multivorum* (MTCC 7504) were also

Table-3 : Cultural characterization of chlorpyrifos utilizing bacterial isolates.

Bacterial isolates	Colony colour	Colony characteristics
B1	Light yellow	Circular, Convex, Entire
B2	Light yellow	Circular, Convex, Entire
B3	Light yellow	Circular, Convex, Entire
B4	Creamish-yellow	Circular, Convex, Entire
B5	Cream	Circular, Raised, Entire
B6	Creamish-yellow	Circular, Convex, Entire
B7	Cream	Circular, Raised, Entire
B8	Light yellow	Circular, Convex, Entire
B9	Cream	Circular, Raised, Entire
B10	Light yellow	Circular, Convex, Entire
S1	Cream	Circular, Raised, Entire
S2	Light yellow	Circular, Convex, Entire
S3	Cream	Circular, Raised, Entire
S4	Cream	Circular, Raised, Entire
S5	Creamish-yellow	Circular, Convex, Entire
S6	Cream	Circular, Raised, Entire
R1	Cream	Circular, Raised, Entire
R2	Creamish-yellow	Circular, Convex, Entire
R3	Creamish-yellow	Circular, Convex, Entire
R4	Creamish-yellow	Circular, Convex, Entire
<i>Pseudomonas putida</i>	Light dull yellow	Circular, Convex, Entire
<i>Flavobacterium multivorum</i>	Cream	Irregular, Raised, Wavy

Table 4 : Carbohydrate fermentation of chlorpyrifos utilizing bacterial isolates.

Bacterial isolates	Sugars								
	Glucose	Xylose	Sorbitol	Trehalose	Sucrose	Mannitol	Lactose	Arabinose	Galactose
B1	+	+	-	-	+	+	-	-	-
B2	+	+	-	+	+	+	+	-	+
B3	+	+	-	+	+	+	+	-	-
B4	+	-	-	+	+	-	-	+	-
B5	+	+	-	+	+	+	-	-	+
B6	+	+	-	+	+	+	-	+	-
B7	+	-	-	-	+	-	-	+	+
B8	+	+	-	+	+	+	+	-	+
B9	+	-	+	+	-	+	+	-	-
B10	+	+	+	+	+	+	+	-	-
S1	+	+	-	+	-	+	-	+	-
S2	+	+	-	+	+	+	-	+	+
S3	+	-	-	+	+	+	+	-	+
S4	+	-	+	+	+	+	+	-	+
S5	+	+	-	-	+	+	-	+	+
S6	+	+	-	+	+	+	-	+	-
R1	+	-	+	+	-	+	-	-	-
R2	+	-	-	+	-	+	-	+	-
R3	+	+	-	-	-	+	+	-	+
R4	+	+	-	-	+	+	+	-	-
<i>Pseudomonas putida</i>	+	+	-	-	+	+	-	-	-
<i>Flavobacterium multivorum</i>	+	+	-	-	+	+	+	+	-

+ = positive reaction

- = negative reaction

Table-5: Biochemical characterization of chlorpyrifos utilizing bacterial isolates.

Biochemical tests	Bacterial isolates															
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	S1	S2	S3	S4	S5	S6
Catalase	d	d	D	d	d	d	d	D	d	d	d	d	d	d	-	-
Indole	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Citrate utilization	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Growth on MacConkey agar	+	+	+	-	-	-	-	-	-	-	-	+	+	+	-	+
Starch hydrolysis	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	+
Esculin hydrolysis	+	+	+	-	+	-	+	+	+	+	+	+	+	+	-	+
Casein hydrolysis	-	-	-	-	-	-	+	+	-	-	-	-	-	+	-	+
Urea hydrolysis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tween-80 hydrolysis	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
Methyl red	-	-	-	-	+	-	-	-	+	-	+	-	+	+	+	-
Voges-proskauer test	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate reduction	+	+	+	+	-	+	+	+	+	+	+	+	-	-	-	+
Oxidase production	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+
H ₂ S production	+	+	-	+	+	+	+	-	+	-	-	-	+	+	-	-
Gelatin hydrolysis	+	+	+	+	-	+	-	+	-	+	-	+	-	-	+	+
Phosphatase production	-	+	+	-	-	-	+	+	+	+	+	-	-	+	-	+
TTC reduction (Nutrient broth)	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+
TTC reduction (Dorn's broth)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

d = delayed positive reaction

+

- = negative reaction

Table-6 : Sensitivity of chlorpyrifos utilizing bacteria to various antibiotics.

Antibiotics	Bacterial isolates									
	B2	B3	B4	B5	B6	B7	B10	S4	<i>P. putida</i>	<i>F. multivorum</i>
Amikacin	R	S	S	S	R	S	R	R	S	S
Imipenem	S	S	S	S	S	S	S	S	S	S
Cefotaxime	I	S	S	R	I	R	I	S	I	S
Ceftazidime	I	I	S	S	S	R	I	R	S	S
Levofloxacin	S	S	S	S	S	S	S	S	S	S
Aztreonam	R	I	S	R	I	I	S	S	S	S
Tetracyclin	S	S	S	S	I	S	I	R	I	S
Ampicillin	R	I	S	R	R	R	R	R	S	S
Chloramphenicol	R	I	R	R	R	I	R	R	R	S
Penicillin G	R	R	R	R	R	R	R	R	R	I
Streptomycin	R	R	R	R	R	R	R	R	S	R
Sulphatriad	S	S	S	R	S	S	I	S	R	R

Table-7 : MAR (multiple antibiotic resistance) of Chlorpyrifos utilizing bacterial isolates.

Bacterial isolates	a	b	*MAR index= a/b
B2	6	12	0.5
B3	2	12	0.17
B4	3	12	0.25
B5	7	12	0.58
B6	5	12	0.42
B7	5	12	0.42
B10	5	12	0.42
S4	7	12	0.58
<i>Pseudomonas putida</i>	3	12	0.25
<i>Flavobacterium multivorum</i>	2	12	0.17

R - resistant

S - sensitive

I - intermediate

a = number of antibiotics to which the isolate was resistant

b = total number of antibiotics to which the isolate was exposed

*MAR index > 0.2, means organisms originate from high-risk sources of contamination.

procured from IMTECH Chandigarh to study their chlorpyrifos degradation potential.

Morphological and cultural characterization of chlorpyrifos utilizing bacteria

Screened bacterial isolates as well as procured one were studied on the basis of their shape and arrangement of cells, Gram staining, endospore staining (13), motility (5) and detection of fluorescence on King's B medium (17).

Biochemical characterization

A detailed biochemical characterization of chlorpyrifos

utilizing bacterial strains was done on the basis of oxidase test, catalase test, citrate utilization, MaConkey's lactose bile salt agar test, nitrate reduction test, MR-VP, gelatin liquefaction, starch, casein and esculin hydrolysis, hydrogen sulfide production, urease test, indole test, hydrolysis of tween-80, phosphatase production, reduction of tetrazolium chloride and carbohydrate fermentation test.

Antibiotic sensitivity Test by Disc Diffusion method

All the bacterial isolates were tested for their sensitivity to different antibiotics by means of Kirby

–Bauer Disc diffusion method. The following antibiotics (all from Hi-media, India) were used: Amikacin (30 mcg), Azetreonam (30 mcg), Ampicillin (10 mcg), Cefotaxime (30 mcg), Ceftazidime (30 mcg), Chloramphenicol (30 mcg), Imipenem (10 mcg), Levofloxacin (5 mcg), Penicillin G (10 units), Streptomycin (10 mcg), Tetracyclin (30 mcg) and Sulphatriad (300 units).

RESULTS

During primary screening thirteen bacterial strains were isolated from Buddha Nullah soil and twenty eight chlorpyrifos utilizing bacteria were isolated from sugarcane fields. Eight chlorpyrifos tolerant bacterial strains were isolated from soil sample collected from rice field of PAU, Ludhiana (Table 1). All these forty-nine bacterial isolates were sub-cultured and purified on Dorn's agar media and preserved at 4°C for further screening.

Based on tolerance to grow at higher concentration twenty bacterial isolates were then selected which could grow at higher concentration (100mg/ml) of chlorpyrifos. Ten bacterial isolates viz. B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 were selected from Buddha Nullah soil. Six bacterial isolates viz. S1, S2, S3, S4, S5, S6 were selected from sugarcane field, village Mohallon site1 Shaheed Bhagat Singh Nagar and four isolates viz. R1, R2, R3, R4 were selected from rice field PAU, Ludhiana. Two bacterial isolates *Flavobacterium multivorum* (MTCC 7504) and *Pseudomonas putida* (MTCC 2445) were also able to grow at same higher concentration of chlorpyrifos in the media. Out of these selected bacterial isolates only eight bacterial strains (B2, B3, B4, B5, B6, B7, B10 and S4 along with *P.putida* and *F.multivorum*) were able to grow at chlorpyrifos concentration of 250 mg/ml. None of the isolated bacteria were able to grow at chlorpyrifos concentration more than 250mg/ml.

For twenty local bacterial isolates along with two procured bacteria (*F. multivorum* and *P. putida*) morphological, cultural and biochemical studies were carried out (Tables 2-7). The isolates were identified according to Bergey's Manual of Systematic Bacteriology (Vol I and II).

The antibiotic resistance and sensitivity as well as multiple antibiotic resistance (MAR) index of eight local bacterial isolates B2, B3, B4, B5, B6, B7, B10 and S4 along with *P.putida* and *F.multivorum* to

different antibiotics was recorded. It was found that all the strains were sensitive to imipenem and levofloxacin (Table 6). Ninety per cent bacterial isolates were resistant to streptomycin and penicillin G. Multiple antibiotic resistance (MAR) index was also recorded for these ten bacterial isolates. It was found that two bacterial isolates B3 and *F.multivorum* had MAR indices 0.17 whereas other isolates recorded MAR indices more than 0.2 (Table 7) suggesting that these isolates originated from high risk source of contamination.

DISCUSSION

The chlorpyrifos utilizing bacterial isolates obtained as a result of this study exhibited strong chlorpyrifos degradation potential and were able to survive in soil with chlorpyrifos concentration as high as 250mg/ml. These selected strains exhibited a wide variation in their morphological and cultural characteristics. Biochemical characterization of these isolates lead to the discovery of some important features in them like hydrolysis of urea, esculin Tween-80, gelatin and TTC reduction The positive test in TTC reduction assay was indicated by the appearance of red colour in the culture tubes due to the reduction of tetrazolium chloride (TTC) to formazon through the activity of dehydrogenase enzymes Identification of the bacterial strains was done by consulting Bergey's Manual of Systematic Bacteriology (1984) Vol- I. Accordingly seven bacterial strains B1, B2, B3, B6, B8, B10 and S2 are presumptive to be the members of the true *Pseudomonas* group (RNA group I) and might belong to *Pseudomonas fluorescens* because fluorescence was recorded for these bacterial isolates when they were observed under UV illuminator at 360 nm (17). According to Bergey's Manual of Systematic Bacteriology, members of *P. fluorescens* liquefy gelatin, do not hydrolyse starch, hydrolyse tween-80 with delayed reaction or do not hydrolyse it, do not utilize arabinose or lactose but utilize glucose, mannitol, xylose, galactose, fructose, sucrose and trehalose. The biochemical results of these seven bacterial isolates are in concordance with those given in Bergey's Manual of Systematic Bacteriology whereas remaining isolates belong to some other bacterial specie. For identification of all these bacterial isolates their molecular characterization has been further processed.

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SOIL NUTRIENT DYNAMICS AS INFLUENCED BY VARIED AGROTECHNIQUES IN *RABI* PIGEONPEA

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ABSTRACT

A two year study was conducted during *rabi* 2012-13 and 2013-14 to investigate soil and plant nutrient dynamics as influenced by times of sowing, nutrient levels and foliar applications to pigeonpea. The experiment was laid out in split-split design replicated thrice, with three replications having three times of sowing [II FN of September (T_1), I FN of October (T_2) and II FN of October (T_3)] in main plots, three nutrient doses [10-40-0 kg N, P_2O_5 and K_2O ha^{-1} (N_1), 20-50-10 kg N, P_2O_5 and K_2O ha^{-1} (N_2) and 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3)] in sub-plots and two foliar sprays [NAA (25 ppm) and DAP (2 per cent) applied at 60 DAS (F_1) and NAA (25 ppm) and DAP (2 per cent) applied at 60 and 80 DAS (F_2)] in sub-sub plots. Crop sown during II FN of September (T_1) significantly improved seed and stalk yield relative to late sowings. Application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) enhanced seed and stalk yield, during both the years. Foliar spray of NAA (25 ppm) and DAP (2 per cent) at 60 and 80 DAS (F_2) significantly improved seed and stalk yield of redgram during both the years. Crop sown during II FN of September receiving 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (T_1N_3) significantly improved seed and stalk yield. Seed yield was the highest with II FN of September sowing along with foliar spray of NAA (25 ppm) and DAP (2 per cent) at 60 and 80 DAS (T_1F_2), during both the years. The highest nutrient (nitrogen, phosphorus and potassium) uptake and lowest post harvest soil nutrient status were with the earliest sown crop during II FN of September (T_1) during both the years. Application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) resulted in the higher nutrient uptake and soil nutrient status at harvest. With regard to foliar sprays, nitrogen uptake during first year and phosphorus uptake during both the years, were the highest with NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F_2). The highest phosphorus uptake during both the years and potassium uptake during second year were with crop sown during II FN of September along with the nutrient dose of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (T_1N_3). Significant improvement in post harvest soil fertility status (nitrogen, phosphorus and potassium) after *rabi* redgram was with the crop sown during II FN of October (T_3). Among the nutrient doses, 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) resulted in the improved residual soil fertility status, during both the years.

Key words : *Rabi pigeonpea, Nutrient Uptake, Post harvest soil nutrient status.*

INTRODUCTION

Pulses form an important group of food crops for nutritional security, sustainable crop production and soil health. Pulses offer most convenient and practical means of eradicating protein hunger especially among children and nursing mothers. Pigeonpea is one of the most promising legumes but the yield potentiality of this crop is very low in India. The main reasons are non-availability of high yielding disease resistant varieties and non-adoption of proper agrotechniques for cultivation with inadequate fertilizer application. The full potential of redgram can be exploited by selecting suitable agrotechniques. Time of sowing, a non-monetary input has a considerable influence on

growth and yield of crop. It ensures the complete harmony between vegetative and reproductive phases on one hand and climatic rhythm on the other hand. Among various reasons for low productivity one finds the role of nutrient supply in pulses of paramount importance. Imbalanced nutrients use especially NPK and limited micronutrients have created concern in India as it may affect overall pulses productivity. Application of the nutrients through foliar spray at appropriate stages of growth becomes important for their efficient utilization and better performance of the crop. The advantages of foliar nutrition are that it brings about immediate improvement and in the short term it is much more effective than soil fertilization. Hence, the present study was carried out to find out the

optimum time of sowing, nutrient dose and foliar spray for higher yield, and nutrient dynamics.

MATERIALS AND METHODS

The field experiment was conducted for 2 consecutive years (2012-13 and 2013-14) during *rabi* season at the dryland farm of S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University. The soil was sandy clay loam, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium. The experiment was laid out in a split-split plot design and replicated thrice by assigning three times of sowing in main plots, viz., T₁-II FN of September, T₂-I FN of October and T₃-II FN of October, sub-plots, three nutrient levels in sub-plots viz., N₁-10-40-0 kg N, P₂O₅ and K₂O ha⁻¹, N₂-20-50-10 kg N, P₂O₅ and K₂O ha⁻¹ and N₃-30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ and 2 foliar applications, viz., F₁-NAA (25 ppm) and DAP (2 per cent) applied once at 60 DAS and F₂-NAA (25 ppm) and DAP (2 per cent) applied twice at 60 and 80 DAS in sub-sub-plots. The test variety used was LRG-41. The nutrients N, P₂O₅ and K₂O were supplied through urea, single super phosphate and muriate of potash, respectively to the respective treatments as basal. Intercultural operations and plant protection measures were taken as and when required. Foliar application of NAA and DAP was done as per the prescribed treatments *i.e.*, at 60 and 80 DAS. The net plots (leaving 2 border rows on each side) were harvested, sun-dried and were expressed as seed and stalk yield in kg ha⁻¹. Nitrogen, phosphorus and potassium contents in plants were analyzed by the standard procedure outlined by (3). The uptake of nitrogen, phosphorus and potassium at harvest by crop was calculated and expressed in kg ha⁻¹ by multiplying the nutrient content with the corresponding dry matter production. The shade dried soil sample at harvest of redgram was analyzed for available nitrogen (8), available phosphorus (6) and available potassium (3).

RESULTS AND DISCUSSION

Seed and Stalk yield

Crop sown during II FN of September (T₁) resulted in significantly higher seed and stalk yield. Cumulative effect of improvement in growth and yield attributes resulted in significantly higher yield with the earliest sown crop (7) and (4). Application of 30-60-20 kg N,

Table 1 : Effect of sowing time, nutrient levels and foliar application on seed and stalk yield rabi pigeonpea (pooled data over two years).

Treatment	Seed yield (kg ha ⁻¹)	Stalk yield (kg ha ⁻¹)
T ₁	1700	7226
T ₂	1329	4102
T ₃	1067	3253
SEm ±	36.8	52.3
CD (5%)	144	204
N ₁	1127	4611
N ₂	1379	4867
N ₃	1589	5102
SEm ±	10.3	6.7
CD (5%)	32	21
F ₁	1297	4806
F ₂	1434	4914
SEm ±	3.6	5.3
CD (5%)	11	16
T ₁ N ₁ F ₁	1371	6951
T ₁ N ₁ F ₂	1505	7054
T ₁ N ₂ F ₁	1650	7198
T ₁ N ₂ F ₂	1809	7297
T ₁ N ₃ F ₁	1863	7372
T ₁ N ₃ F ₂	2000	7485
T ₂ N ₁ F ₁	976	3769
T ₂ N ₁ F ₂	1145	3881
T ₂ N ₂ F ₁	1245	4035
T ₂ N ₂ F ₂	1407	4144
T ₂ N ₃ F ₁	1521	4308
T ₂ N ₃ F ₂	1680	4476
T ₃ N ₁ F ₁	794	2963
T ₃ N ₁ F ₂	974	3052
T ₃ N ₂ F ₁	1066	3218
T ₃ N ₂ F ₂	1097	3313
T ₃ N ₃ F ₁	1187	3445
T ₃ N ₃ F ₂	1285	3528
TxN		
SEm ±	17.8	11.6
CD (5%)	55	36
TxF		
SEm ±	6.2	9.2
CD (5%)	19	NS
NxF		
SEm ±	6.2	9.2
CD (5%)	19	NS
TxNxTx		
SEm ±	10.8	15.9
CD (5%)	32	NS

Table 2 : Nitrogen uptake at harvest (kg ha⁻¹) of *rabi* pigeonpea as influenced by varied times of sowing, nutrient levels and foliar applications

	Nitrogen Uptake	
	2012-13	2013-14
Times of sowing		
T ₁ -II Fortnight of September	191.6	190.8
T ₂ -I Fortnight of October	116.3	111.8
T ₃ -II Fortnight of October	66.2	63.8
SEm±	1.27	2.23
CD (P=0.05)	5.0	8.7
Nutrient levels		
N ₁ -10-40-0 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	107.0	105.6
N ₂ -20-50-10 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	125.4	122.2
N ₃ -30-60-20 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	141.6	138.7
SEm±	1.71	1.43
CD (P=0.05)	5.3	4.4
Foliar applications		
F ₁ -Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS	120.1	119.3
F ₂ -Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS	129.3	125.0
SEm±	1.97	2.11
CD (P=0.05)	5.9	NS

P₂O₅ and K₂O ha⁻¹ (N₃) resulted in significantly higher seed and stalk yield. Improvement in growth parameters leading to improvement in yield attributes, increased the yield at higher nutrient levels (5, 10). Foliar spray of NAA (25 ppm) and DAP (2 %) twice at 60 and 80 DAS (F₂) resulted in significantly higher seed and stalk yields (Table 2) relative to that due to the same foliar spray once at 60 DAS (F₁). It was probable that application of NAA might have induced large number of new sinks leading to greater activity of carboxylating enzymes and rate of protein synthesis. This resulted in higher photo-synthetic rate, translocation and accumulation of metabolites in the sink and eventually greater seed production (Dixit and Elamathi, 2007).

Interaction of sowing times and nutrient levels significantly increased the seed and stalk yield of pigeonpea. It appeared that, early sowing with higher nutrient dose (T₁N₃) had improved growth parameters (plant height, leaf area, dry matter production and crop growth rate) and yield attributes (number of pod bearing branches plant⁻¹, number of pods branch⁻¹, number of seeds pod⁻¹ and test weight) leading to

higher seed and stalk yield. Significantly, higher seed yield was with crop sown during II FN of September receiving two foliar sprays at 60 and 80 DAS (T₁F₂) was due to N and P₂O₅ availability from flower primordia initiation to seed maturity as DAP was applied through foliar application. Higher nutrient level along with foliar application twice (N₃F₂) resulted in higher seed yield. Earliest sown crop receiving higher nutrient dose and two foliar applications (T₁N₃F₂) resulted in the enhanced seed yield of *rabi* pigeonpea due to efficient use of natural resources and applied nutrients.

Nutrient Uptake at harvest

The higher nutrient (nitrogen, phosphorus and potassium) uptake was with the early sown crop during II FN of September (T₁) during both the years. Higher nitrogen uptake with the early sown crop was due to the longer vegetative lag phase of the crop for efficient use of growth resources leading to higher dry matter production. Application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (N₃) resulted in significantly higher nutrient uptake than with 20-50-10 kg N, P₂O₅ and K₂O ha⁻¹ (N₂) in both the years. Increase in nutrient uptake by

Table 3 : Phosphorus and potassium uptake at harvest (kg ha^{-1}) of *rabi* pigeonpea as influenced by varied times of sowing, nutrient levels and foliar applications

	Phosphorus uptake						Potassium uptake					
	2012-13			2013-14			2012-13			2013-14		
	F ₁	F ₂	Mean for T	Mean for N	F ₁	F ₂	F ₁	F ₂	Mean for T	Mean for N	F ₁	F ₂
T ₁	N ₁	23.0	24.7	30.7	14.4	21.5	12.9	87.5	92.0	109.2	55.6	87.2
	N ₂	28.6	31.5			27.5		105.3	111.1			103.5
	N ₃	37.1	39.3			33.0		127.5	131.6			117.7
T ₂	N ₁	12.0	13.8	16.5	18.6	10.6	17.0	49.2	52.5	61.9	68.3	51.8
	N ₂	16.1	16.7			13.0		61.1	62.7			58.0
	N ₃	19.5	21.1			17.7		71.4	74.7			66.0
T ₃	N ₁	6.3	6.8	9.5	23.7	5.5	21.3	24.7	27.8	35.3	82.4	26.6
	N ₂	8.7	10.2			7.6		33.7	36.1			34.9
	N ₃	11.8	13.3			10.5		42.6	46.5			44.5
Mean for F	18.1	19.7	-	-			67.0	70.5	-	-	65.6	69.1
												-

	2012-13			2013-14			2012-13			2013-14		
	SEm ±	CD (P =0.05)	SEm ±	CD (P =0.05)	SEm ±	CD (P =0.05)	SEm ±	CD (P =0.05)	SEm ±	SEm ±	CD (P = 0.05)	CD (P = 0.05)
T	0.48	1.9	0.32	1.2	1.10	4.3	1.21	4.7	1.21	1.21	4.7	4.7
N	0.55	1.7	0.32	1.0	2.56	7.9	1.30	4.0	1.30	1.30	4.0	4.0
F	0.37	1.1	0.41	1.7	1.91	NS	1.14	NS	1.14	1.14	NS	NS
TN	0.95	2.9	0.56	1.2	4.43	NS	2.25	6.9	2.25	2.25	6.9	6.9
TF	0.65	NS	0.72	NS	3.31	NS	1.98	NS	1.98	1.98	NS	NS
NF	0.65	NS	0.72	NS	3.31	NS	1.98	NS	1.98	1.98	NS	NS
TNF	1.12	NS	1.24	NS	5.73	NS	3.42	NS	3.42	3.42	NS	NS

Table 4 : Post harvest soil available nutrient status (kg ha⁻¹) after *rabi* pigeonpea as influenced by varied times of sowing, nutrient levels and foliar applications.

	Nitrogen		Phosphorus		Potassium	
	2012	2013	2012	2013	2012	2013
Times of sowing						
T ₁ -II Fortnight of September	143.9	134.8	19.3	19.8	170.3	170.3
T ₂ -I Fortnight of October	171.9	154.6	21.9	23.2	197.4	193.3
T ₃ -II Fortnight of October	197.2	176.0	24.9	25.4	226.9	208.6
SEm±	4.67	2.64	0.26	0.36	4.39	3.23
CD (P=0.05)	18.2	10.3	1.0	1.4	17.1	12.6
Nutrient levels						
N ₁ -10-40-0 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	164.7	146.3	20.2	21.4	184.8	182.7
N ₂ -20-50-10 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	170.7	154.6	22.2	22.7	199.3	191.4
N ₃ -30-60-20 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹	177.6	164.4	23.7	24.3	210.4	198.2
SEm±	1.89	1.73	0.35	0.38	2.58	1.76
CD (P=0.05)	5.8	5.3	1.1	1.2	8.0	5.4
Foliar applications						
F ₁ -Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS	170.3	155.1	22.1	22.7	198.1	190.7
F ₂ -Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS	171.7	155.1	22.0	22.8	198.2	190.8
SEm±	1.54	1.60	0.25	0.18	2.01	1.97
CD (P=0.05)	NS	NS	NS	NS	NS	NS

redgram at higher nutrient doses can be attributed to higher yield coupled with slight improvement in nutrient concentration in seed and non-seed parts. With regard to foliar sprays, nitrogen uptake during first year and phosphorus uptake during both the years, were the highest with NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F₂). These results are in accordance with Umesh and Shankar (2013). Higher nitrogen and phosphorus uptake with NAA and DAP spray was due to higher N and P content in plant parts with the spray. With regard to interaction, the highest phosphorus uptake during both the years and potassium uptake during the second year were with crop sown during II FN of September along with the nutrient dose of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (T₁N₃). Higher nutrient uptake with II FN of September sowing was due to higher biomass production with the earliest sowing.

Post harvest soil nutrient status

Higher post harvest soil available nutrients (nitrogen, phosphorus and potassium) was with the crop sown during II FN of October which was distinctly superior to that of I FN of October sowing. The latter return was significantly higher than that with II FN of September sowing. Lower residual soil nutrient after the harvest of *rabi* redgram with early sown crop was due to efficient use of soil and applied nutrients for optimum growth and final seed yield due to its longer duration compared with the latter sowings. With regard to nutrient doses tested, application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (N₃) resulted in significantly higher post harvest soil available nutrients relative to that due to 20-50-10 kg N, P₂O₅ and K₂O ha⁻¹ and 10-40-0 kg N, P₂O₅ and K₂O ha⁻¹. Improvement in N and P status of soil can be ascribed to more biomass added to the soil by redgram crop, higher dose of nitrogen applied

to the soil and longer crop duration leading to efficient use of native and applied phosphorus respectively. The results are in conformity with that of (22).

CONCLUSION

From the present investigation it can be inferred that sowing of *rabi* pigeonpea during II FN of September with nutrient dose of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ and foliar application of NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F₂) resulted in the higher seed and stalk yield. Enhanced nutrient (nitrogen, phosphorus and potassium) uptake and lowest post harvest soil nutrient status were with the earliest sown crop during II FN of September (T₁). Application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (N₃) resulted in the higher nutrient uptake and soil nutrient status at harvest. With regard to foliar sprays, nutrient uptake at harvest was higher with NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F₂) but it could not influence the post harvest soil nutrient status.

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EVAPORATION ESTIMATION USING METEOROLOGICAL PARAMETERS BY “R” SOFTWARE

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ABSTRACT

Evaporation is a process by which liquid is converted into vapor. Evaporation is important element of the hydrological cycle. Because of increasing temperature of earth surface, evaporation is also increasing. Increased evaporation cause reduces the water availability in the earth surface. In this regard, understanding of hydrological cycle play an important role to conserve the water. Evaporation is very important component of the hydrological cycle. Evaporation can occur only when water is available. It also requires that the humidity of the atmosphere is less than the evaporating surface (at 100 % relative humidity there is no more evaporation). It plays an important role for planning and management of water resources projects, necessary for scheduling of irrigation and in planning farm irrigation systems. Different methods have to be used to estimate evaporation, but for estimating the evaporation firstly we should have to knowledge about which parameters are more responsible for creating evaporation. So in this study we used different combinations of parameters to find out which combination is mostly influenced the evaporation using R software. The data set consisted daily records of four years from 2010 to 2013 and the data set consisted of these parameters, temperature, relative humidity, wind speed, sunshine hour and evaporation. In R software we used simple linear regression and multiple linear regression models to find out the most appropriate combination for estimating the evaporation. In this study different combinations of parameters with E such as Temperature (T), Sunshine hour (S), Wind speed (W), Relative humidity (R), T+R, T+S, T+W, R+S, R+W, S+W, T+R+S, T+R+W, R+S+W, T+S+W and T+R+S+W have been used. Besides all these combinations, T+S+R+W gave best results using R software. In this combination R^2 is 0.812 which is highest than other combinations with highly significant value of p. So for the best estimation of evaporation we should be used T+S+W+R combination.

Key words : Correlation coefficient, multiple linear regressions, R software, R^2 , p value

INTRODUCTION

Water is moved from the land surface into the atmosphere by evaporation and transpiration. Evaporation is the process in which water state is converted into a gaseous state. Evaporation process requires a large amount of energy. Two main factors that influence the evaporation are the latent heat of vaporization and the ability of energy to transport the vapour from the evaporating surface. Solar radiation is the main source of heat energy, which is convert the water into the vapour. The ability to move the vapour from the evaporating surface depends on the wind velocity and the specific humidity. Evaporation is the essential component of hydrological cycle. Besides all of the components, evaporation is difficult to estimate in hydrological process (2, 7). Estimation of

evaporation is very useful in planning and management of irrigation practices in many areas, where water resources are scarce (13). Understanding of evaporation is very useful in the management and planning of water resources project especially in many areas where water availability is less such as temperate region because it affects the reservoir capacity and its design, rainfall-runoff modelling, river basin yield, irrigation water management, crop water requirements and its scheduling. Accurate determination of evaporation is important for the water balance, management of water resources, irrigation, and water and soil conservation. Calculation of evaporation is necessary for water resources modelling and management studies related to agronomy, food, irrigation, hydrology, forestry and lake ecosystems (16). Empirical and semi-empirical models are based

on relationships between evapotranspiration and meteorological variables. In an area, variation in evaporation depends on the climatic conditions and the availability of surface water bodies so because of evaporation, discharge from the surface water also varies accordingly. Evaporation variation affects the planning, design, and management of water resources and irrigation systems (12, 13). In order to determine evaporation, parameters get from meteorological stations and used as the input data for different simulations and models. Meteorological parameters are wind speed, precipitation, relative humidity and sunshine hours (5, 11, 18). Use average temperature, wind speed, solar radiation, minimum air temperature, maximum air temperature, and relative humidity as input parameters for predicting evaporation. Their results show that the wind speed and temperature creates the most significant effect on evaporation prediction; and least significant effect create by relative humidity on the prediction of evaporation. Many researchers done different studies to determine evaporation from the various meteorological parameters (1, 2, 8, 9, 15) and most of their methods require data that are not easily available for estimating evaporation. The most important factors that affect evaporation are solar radiation, temperature, relative humidity, vapor pressure deficit, atmospheric pressure, and wind (6, 14). It is concluded by the most of researchers that relative humidity, solar radiation, wind speed, and temperature are the factors that mostly effect the prediction of evaporation.

The objective of present study is to estimate the evaporation using metrological data. In this study defined that which parameter or combination of parameters mostly influenced the evaporation.

MATERIAL AND METHODS

This study was conducted at Hawalbagh in Almora district of Uttarakhand, India. Geographically, it is located at 29° 36' N latitude & 79° 40' E longitudes at elevation of 1250 m from the mean sea level. The climatic condition of an area is cool temperate with annual maximum, minimum and average temperatures in the area stands at 25.77°C, 13.50°C and 19.635°C respectively. From south-west monsoon, maximum rain is received during rainy season from June to September.

The soil of the study area is good for agricultural production and contains enough moisture to produce crops. The meteorological data used to develop the models in this study were acquired from the Meteorological observatory of Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS) Almora, Uttarakhand. The meteorological data contains temperature (T), relative humidity (R), sunshine hour (S), wind velocity (W) and evaporation (E). In this study temperature, sunshine hour, wind velocity, relative humidity used as input and evaporation was used as output to developed model. The data set consisted of four years of daily records from 2010 to 2013.

R Software is a powerful tool for data management and analysis. R is Open source Software, i.e. available without any cost. It is working on Low Configured computer i.e. no advanced computing resources required. Basic data types are character, complex, logical, integer, and numeric. The R software is widely used by data miners and statisticians for data analysis and for developing statistical software. R is an easy language; users easily access it by a command line interpreter. By using R software we can easily perform different operations. In present study, for developing models only correlation coefficient and multiple linear regression operations were used in R software.

A correlation coefficient is a statistical measure, in which developed a statistical relationship between dependent and independent variables. Basically the value of correlation coefficient value lies between -1 to +1. Positive sign means, the variables are positively correlated with each other, means if one value is increased then other value is also increased. Negative sign means, the variables are negatively correlated with each other it means if one value is increased then other value is decreased.

Multiple linear regression (MLR) equation is the relationship between dependent variable and several independent variables by fitting in a linear equation.

$$Y = b_0 + b_1 X_1 + 2b_2 X_2 + \dots + b_n X_n$$

Where,

Y is the dependent variable (evaporation), b_0 , b_1 , b_2 , ..., b_n are the regression coefficient for the linear equation, and X_1 , X_2 , ..., X_n are the independent variables (relative humidity, wind velocity, sunshine hour and temperature).

RESULT AND DISCUSSION

(a) **Effect of T, R, S, W on E** – correlation coefficient models were developed for comparing the different combination of T, R, S, W on E. Graphical representations of all combinations are shown in Fig. 1 to Fig. 8. Positive correlation was achieved in all the combinations except for R on E. The result is also true according to the natural law. All the combinations were compared by correlation coefficient (Table 1).

Table 1 : Different Combinations of parameter with Correlation coefficient

Combination of parameter	Correlation coefficient
T on E	0.6138
R on E	-0.408
W on E	0.7212
S on E	0.404

(b) **Effect of T-R, T-S, T-W, R-S, S-W on E**–Multiple linear regression models were developed

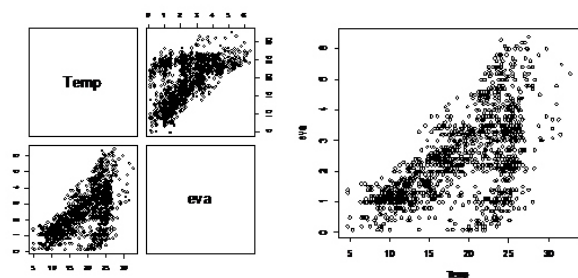


Fig. 1 and 2 : Observed correlation coefficient of

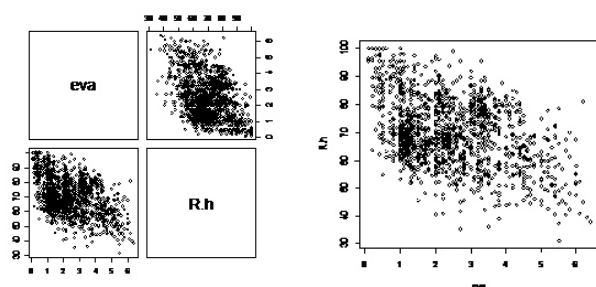


Fig. 3 and 4 : Observed correlation coefficient of Relative humidity on Evaporation

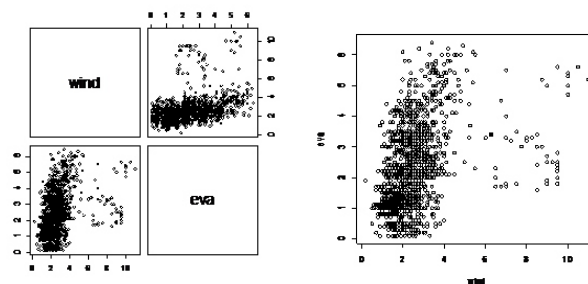


Fig. 5 and 6 : Observed correlation coefficient of Wind on Evaporation

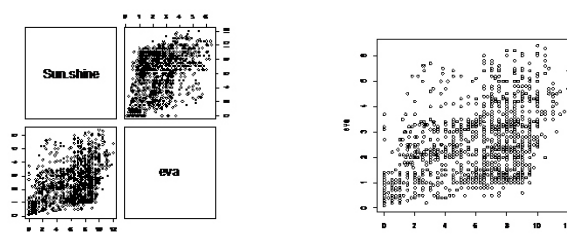


Fig. 7 and 8 : Observed correlation coefficient of Sunshine hour on Evaporation

for comparing the combination of T-R, T-S, T-W, R-S, S-W on E. Graphical representations of all combinations are shown in Fig. 9 to 14. All the combinations were compared by R² and p value (table 2). As shown from the table 2 it is concluded that p value was highly significant for all the combinations.

Table 2 : Different Combinations of parameter with R² and p value.

Combination of parameters	Correlation coefficient	p value
T+R	0.624	2e-16 ***
T+S	0.639	2e-16 ***
T+W	0.445	2e-16 ***
R+S	0.208	2e-16 ***
R+W	0.247	2e-16 ***
S+W	0.345	2e-16 ***

(c) **Effect of T-R-S, T-S-W, T-R-W, R-S-W, T-R-S-W**

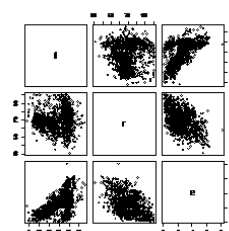


Fig. 9 : Observed correlation coefficient of Temperature, Relative humidity on Evaporation

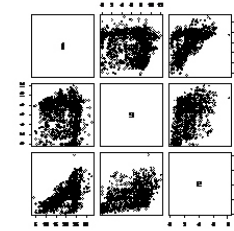


Fig. 10 : Observed correlation coefficient of Temperature, Sunshine hour on Evaporation

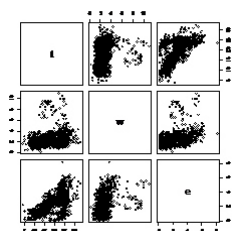


Fig. 11 : Observed correlation coefficient of Temperature, wind speed on Evaporation.

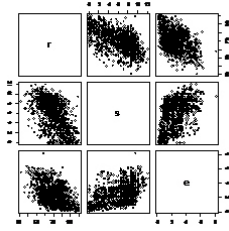


Fig. 12 : Observed correlation coefficient of Relative humidity, Sunshine hour on Evaporation

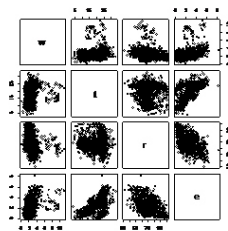


Fig. 15 : Observed correlation coefficient of Wind speed, Temperature, Relative humidity on Evaporation.

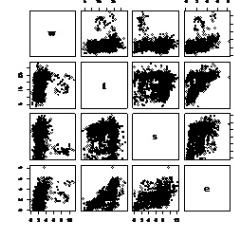


Fig. 16 : Observed correlation coefficient of Wind speed, Temperature, Sunshine hour on Evaporation.

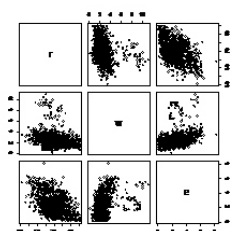


Fig. 13 : Observed correlation coefficient of Temperature, wind speed on Evaporation.

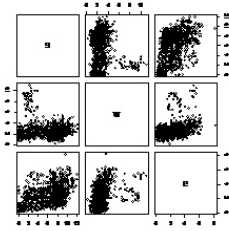


Fig. 14 : Observed correlation coefficient of Sunshine hour, Wind speed on Evaporation

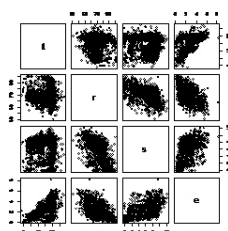


Fig. 17 : Observed correlation coefficient of Temperature, Relative humidity, Sunshine hour on Evaporation.

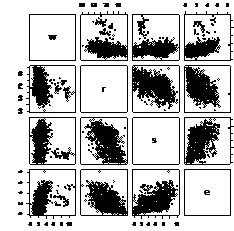


Fig. 18 : Observed correlation coefficient of Wind speed, Relative humidity, Sunshine hour on Evaporation.

on E—Multiple linear regression models were developed for comparing the combinations of T-R-S, T-S-W, T-R-W, R-S-W, T-R-S-W on E. Graphical representations of all combinations are shown in Fig. 15 to 19. All the combinations were compared by R² and p value (table 3). it is concluded that p value was highly significant for all the combinations except for the combination of R+S+W.

Table 3 : Different Combinations of parameter with R² and p value.

Combination of parameters	Correlation coefficient	P value
T+R+W	0.644	2e-16***
T+R+S	0.701	2e-16***
T+S+W	0.742	2e-16***
R+S+W	0.652	0.0199*
T+R+S+W	0.812	2e-16***

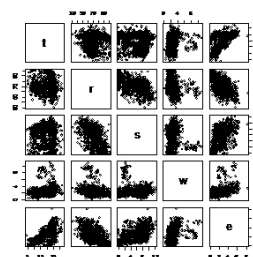


Fig. 19 : Observed correlation coefficient of Temperature, Relative humidity, Sunshine hour, Wind speed on Evaporation.

CONCLUSION

In this study, estimate the evaporation using metrological data i.e. temperate, relative humidity, wind speed, sunshine hours and evaporation. The comparative study of different combinations indicates that the combination of T-R-S-W on E gave highest R² value with high significant value of p. So for the best estimation of evaporation, T+S+W+R combination should be used in different techniques.

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GENETIC DIVERGENCE STUDIES FOR GRAIN YIELD AND OTHER QUANTITATIVE TRAITS IN DURUM WHEAT (*TRITICUM DURUM* L.)

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ABSTRACT

Genetic divergence study on durum wheat (*Triticum durum* L. Desf.) was consist twenty three genotypes of diverse sources. The experiment was conducted at IARI, Collaborative Outstation Research Center, Mandsaur in Rabi 2017-18 in Randomized Complete Block design with three replications. Thesedurum wheat genotypes included with one check were grouped into seven different clusters namely cluster I (seven genotypes), cluster II (six genotypes), cluster III (three genotypes), cluster IV(three genotypes) and cluster V (four genotypes). This indicates that the genotypes grouped with in a particular cluster are more or less genetically similar to each other and apparent wide diversity is mainly due to the remaining genotype distributed over rest of the other cluster.The highest intra cluster distance for yield traits was found in cluster II (2.467). The lowest values for intra cluster distances were recorded for cluster III (1.794).The maximum inter cluster distance (D^2 -values) was found between cluster IVand II (4.870), followed by cluster IV and cluster III (4.842). The lowest value for inter cluster distance for cluster III and I (2.915). The hybridization between the genotypes SKAF-510, HI-1605, LOC-1 (check)(group-IV) with SKAF-620, SKAF-58 and SKAF-6156(group-III) would produce heterotic hybrids and wide spectrum of variability in subsequent generations. It may be used as parents for hybridization after determining their combining abilities so as to obtain considerably batter promising segregates, recombinantspopulation in durum wheat breeding program.

Key words: Durum wheat, *Triticum durum*, Intra Cluster, Inter Cluster, Divergence and yield traits

INTRODUCTION

Wheat is believed to have originated in South Western Asia, where it has been grown for morethan 10,000 years. Bread wheat (*Triticumaestivum* L.) and durum wheat (*T. turgidum* L.) are the two principal types of wheat grown in Ethiopia. Ethiopia is considered to be one of the centers ofgenetic diversity to durum wheat while bread wheat has been introduced. In Ethiopia durum and bread reported more recently, with durum and bread wheat occupying approximately 30 and 70%, respectively (6). Durum wheat (*Triticum turgidum* var. *durum* Desf.) is an economically important crop and widely grown in most parts of the world, including India. It is in an area of 10 to 11% of the world and accounting about 8% of the total production (2). Wheat species, each occupy approximately equal proportion of the area under wheat production.

Over the past century selection of desirable parents for hybridization programme has been found as an effective operating implement in developing high

yielding crop varieties upon which, the modern agriculture can rely. The presence of genetic diversity and genetic relationships among genotypes is a prerequisite and paramount important for successful lential breeding programme. Developing hybrid wheat varieties with desirable traits require a thorough knowledge about the existing genetic variability. The more genetic diverse parents, the greater chances of obtaining higher heterotic expression in F_1 's and broad spectrum of variability in segregating population as already reported by earlier workers. Precise information on the nature and degree of genetic diversity helps the plant breeder in choosing the diverse parents for purposeful hybridization. Several genetic diversity studies have been conducted on different crop species based on quantitative and qualitative traits in order to select genetically distant parents for hybridization. (3) reported that the character contributing maximum to the divergence should be given greater emphasis for deciding the type of cluster for purpose of further selection and the choice of parents for hybridization.

Durum hardest of all wheat species and consumed the form of semolina (suji and fast pasta products). The pasta producers wheat which is hard with high yellow capable of making products with excellent quality. Breeding for varieties with high yield, disease resistance, elevated yellow pigment concentration, excellent cooking quality and other desirable end-use quality traits are the objectives of durum wheat breeding programs worldwide. Genetic improvement of any species depends primarily on the extent and magnitude of genetic variability present among available germplasm for important traits (5). Mahalanobis D^2 statistic had based on multivariate analysis and serves to be a good index of genetic diversity.

MATERIAL AND METHODS

The field studies were carried out during *Rabi* cropping seasons of 2017-18 (October to March) for two years at Indian Agricultural Research Institute - Sipani Krishi Anusandhan Farm, Collaborative Outstation Research Center, Mandsaur (M.P) India. The experimental material comprising twenty three genotypes was sown on 16th October every year under two growing conditions. Each genotype was planted in six rows of 4 m row length and row to row spacing of 30 cm in RBD in three replications. Ten observations *i.e.* days to 50% ear emergence, no. of tillers; ear length, no. of spikelets per ear, plant height, leaf length, leaf breadth, flag leaf area, days to maturity and grain yield g/m². Analysis of variance was done as per Randomized Block Design method given by Panse and Sukhatme genetic divergence was estimated based on (4) D^2 analysis generalized distance as described by (8) and distribution of genotypes into different clusters by Tocher's method.

RESULTS AND DISCUSSION

In the present study twenty three genotypes of durum wheat were subjected to D^2 analysis using ten component attributes. Out of the five clusters cluster I, II, III, IV and V had 7, 6, 3, 3 and 4 genotypes respectively (Table-1). It was concluded that in general, there was parallelism between genetic and geographic diversity this view point has been supported by (5) and (6). The highest intra cluster distance for grain yield traits was found in cluster II (2.467) and lowest for cluster III (1.794). The maximum intra cluster distance was because of wide genetic diversity among its

genotypes. The chance of developing good segregates by crossing, the genotypes of the same cluster showing low value for intra cluster distance. Therefore, it would be logical to attempt crosses between the genotypes of clusters separated by larger inter cluster distance. The little diversity and selection of parents within the cluster having higher mean for a particular character may also be useful for further developing high yielding durum wheat varieties. Cluster analysis revealed the presence of five major clusters (6) (Fig. 1).

The maximum inter cluster distance (D^2 -values) was found between cluster IV and II (4.870), followed by cluster IV and cluster III (4.842), cluster V and cluster IV (3.999) (Table-2). This clearly indicates that the genotypes included in these clusters are having broad spectrum of genetic diversity and could very well be used in hybridization programme of durum wheat for improving grain yield. Thus the crosses between the genetically diverse genotypes of cluster IV characterized by spikelets per ear, number of tillers per plant and Ear length with genotypes SKAF-510, HI-1605 and Lock-1 as a check and cluster III characterized by Ear length, No. of Tillers and No. of spikelets per ear with these genotypes like SKAF-620, SKAF-58, SKAF-6156 are expected to exhibit high heterosis and are also likely to produce new combinants with desired character to give desirable segregates with high grain yield for developing superior variety of durum wheat. The present contribution of Flag Leaf area (13.04%) followed by No. of spikelets per ear (12.39%) followed by 50% Ear emergence (11.99%) followed by Leaf length (11.64%) followed by Days to maturity (11.05%) followed by No. of Tillers (10.66%) followed by Ear length (10.51%) followed by Plant Height (7.31) and grain Yield g/plant (2.26%) contributed most towards genetic divergence. Hence parent chosen on basis of number of tillers (along with higher genetic advance) may not throw transgressive segregates for higher yield potential because it showed a very low contribution towards divergence.

The maximum inter-cluster distance was between cluster IV and cluster II, the distance implying the existence of genetic variability and the distinct nature of the durum wheat genotypes. Hence, hybridization between such genotypes having wider genetic background could result in obtaining better heterosis, segregation and recombination for enhancing grain yield and grain yield related attributes in wheat

Table-1 : Distribution of twenty three genotypes of durum wheat (*T. durum* L.).

Clusters	No of genotypes	Genotype name
I	7	SKAF-7003,SKAF-5/12,SKAF-2/19,SKAF-52,SKAF-532,HI-8777, HI-8759
II	6	SKAF-57, SKAF-59, SKAF-64, SKAF-655, SKAF-6146, SKAF-8498
III	3	SKAF-620, SKAF-58, SKAF-6156
IV	3	SKAF-510, HI-1605, LOC-1(Check)
V	4	SKAF-626, SKAF-639/1, HI-1544, SKAF-6077

Table-2 : Average intra and inter cluster (D^2 value) distance in twenty three genotypes of durum wheat.

Clusters	I	II	III	IV	V
I	1.911				
II	2.987	2.467			
III	2.915	3.068	1.794		
IV	3.815	4.870	4.842	2.297	
V	3.107	3.696	3.879	3.999	2.110

Bold values are intra cluster distances.

Table-3 : Cluster means values for ten characters in durum wheat.

Character Cluster	50% Ear emergence	No. of Tillers	Ear length (cm)	No. of spikletes per ear	Plant Height (cm)	Leaf length (cm)	Leaf breadth (cm)	Flag Leaf area (cm ²)	Days to maturity	Grain Yield g/ m ²
I	80.24	4.93	7.71	19.52	96.70	19.75	1.92	24.72	132.48	485.82
II	80.83	6.30	7.11	19.50	112.50	24.79	1.92	31.19	136.17	534.25
III	78.56	11.52	8.33	20.78	106.83	22.33	1.92	27.80	131.33	493.65
IV	87.11	5.68	9.22	21.00	97.00	20.58	1.57	20.93	136.56	390.28
V	82.08	3.50	9.92	22.08	96.50	22.00	2.09	29.90	134.83	422.58

*, ** represent minimum and maximum values, respectively.

Table-4 : Contribution of different traits in creating diversity in durum wheat based on Mahalanobis's D^2 analysis.

S. No.	Character	Contribution %
1.	50% Ear emergence	11.99
2.	No. of Tillers	10.66
3.	Ear length (cm)	10.51
4.	No. of spikletes per ear	12.39
5.	Plant Height (cm)	7.31
6.	Leaf length (cm)	11.64
7.	Leaf breadth (cm)	9.15
8.	Flag Leaf area (cm ²)	13.04
9.	Days to maturity	11.05
10.	Yield g/m ²	2.26

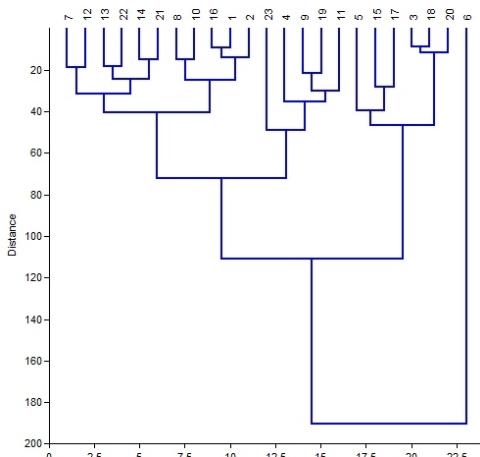


Fig. 1 : Dendrogram of 22+1 check of durum wheat genotypes used in the study

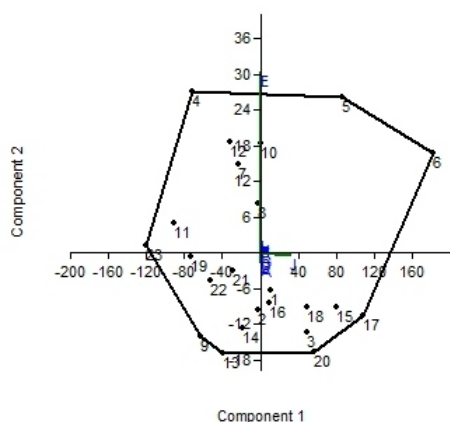


Fig. 2 : The plot of PCA is showing the genotypes and the ten studied traits. The dots represent the genotypes (n = 23) and the lines represent the traits ordination. Q stands for quadrant.

improvement program (9, 10). The minimum genetic distance in cluster three and one implying narrow genetic base of the genotypes and this could be associated with the pedigree of the genotypes and in such cases the level of obtaining outstanding lines is lesser. The clustering analysis classified the twenty three durum wheat genotypes into four distinct clusters and this implying the presence of diversity in the durum wheat genotypes and the tendency

of obtaining promising parent for crossing and for direct consumption using the mean value is also possible (11). There was no association between the clustering pattern and geographic location of the durum wheat genotypes. The local check (Lock-1) was identified divergent located in the fourth cluster and this could be the adaptive nature of the genotype to the growing environment. Similar research report was obtained by (3 and 10). Generalized divergences of genotypes are genetically related whereas diverse cultivars are classified into different clusters.

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GENETIC AND PHYSIOLOGICAL IMPROVEMENTS OF SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] BREEDING FOR DROUGHT RESISTANCE IN ETHIOPIA

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ABSTRACT

Sorghum is an essential supply of food and feed inside the tropical and sub-tropical components of the globe specifically in sub-Sahara Africa and Asia. It is stipulated that sorghum has to play such an important role within the crop area in attaining international meals in the face of climate exchange, land fragmentation and increasing water deficit stress. The latter remains being a consistently occurring international phenomena that affects sorghum production across sub-Sahara Africa and Asia where agriculture is rain dependent. In the context of current and foretold water scarceness, increasing irrigation usually not viable possibility for assuaging water deficit stress in rain-fed sorghum growing environments. Notwithstanding many studies efforts made, drought continues to be taken into consideration to be one of the most pressing factors limiting sorghum yields around the world and continues to be a venture to sorghum breeders. It is far higher to apprehend the genetics and physiological mechanisms of sorghum guiding its drought tolerance with a meant reason of breeding to reduce the detrimental outcomes of water deficit stress trouble. In this review paper, the genetic and physiological improvements of sorghum breeding for drought resistance in Ethiopia is restated by thinking about sorghum research findings in Ethiopia from the 1970s as much as recent are used. In connection to this, discussion was made on the impacts of drought, breeding for drought tolerance, physiological mechanisms of drought tolerance, achievements in sorghum breeding for drought tolerance and the principal constricting challenges and methods of handling in sorghum breeding for drought tolerance. It is realized that in Ethiopia the research still remains predominantly conventional and the methodologies are relatively old, with few recent betterments. As a result, it was viable to develop above 23 modern sorghum varieties adaptable to lowland and early maturing which are in one way or the other targeted for lowland dry regions of the country, Ethiopia. Subsequently, it is by far advised that the usage of a mixture of various tolerance traits and developing steps including morphological, physiological and biochemical as a general choice criteria would be greater profitable than a unmarried selection standards.

Key words: Water deficit stress, drought resistance, *Sorghum bicolor*, genetics, physiological mechanisms

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is a crucial source of food and feed in the tropical and sub-tropical parts of the globe. Globally, Sorghum is the fifth most vital cereal grain crop after maize, rice, wheat and barley (27). As reported by (32) nearly 90 % and 77% of the world's sorghum area under cultivation and the total output respectively contributes by developing countries. According to (70) sorghum is primarily grown as a food grain crop in the arid and semi-arid tropics of Africa and Asia whereas in the developed world it majorly produced and used for animal feed. In Ethiopia, sorghum ranks third after tef and maize in terms of area coverage and it was only second next to

maize in productivity as reported by (18). It is grown in almost all regions covering a total land area of 1.882 million ha (18). The major sorghum growing areas of the country are Oromia (39.1%), Amhara (37.6%), Tigray (11.5%) and Southern Nations and Nationalities and Peoples (SNNP) (5.7%). It has a wider agro-ecological adaptation in Ethiopia and is cultivated in the three major agro-ecological zones, which can be broadly classified into highlands >1900 meter above sea level (m. a. s. l), intermediate between 1600-1900 m. a. s. l and lowland agro-ecologies < 1600 m. a. s. l (42). The grain is used for the preparation of locally preferred food products including the most widely consumed staple injera or leavened bread that requires specific grain quality characters. The stover, which has

uses for animal feed, fuel and construction of fences, is often valued as highly as grain yield.

Sorghum is a diploid C4 cereal crop with 10 chromosomes and having approximately 800Mbp genome size (67). Regardless of the argument by many other scholars, Ethiopia has been regarded as a center of origin and diversity for sorghum because of huge variation of the crop in the region (84). In line with the Ethiopian Biodiversity Institute gene bank report, sorghum is among the top well studied cereal crops, so far there exist nearly 11,353 sorghum accessions gathered and conserved in the institute's gene bank. Besides, It was also reported by (25) that Ethiopia has huge range of sorghum genetic diversity. Fortunately, sorghum is a drought tolerant crop and capable to withstand other a biotic stresses like low soil fertility and high temperature as compared to other cereal crops (81).

It is predicted that, nearly 1.8 billion people will face absolute water shortage and around 65% of the population will dwell under water stressed environments by the year 2025 (6). Furthermore, nearly 75% Ethiopia's landmass is categorized as dryland experiencing water deficit stress during most months of the year, having between 45 and 120 days of growing period per year, and these areas are home for about one third of the country's population (44). Drought is a frequently occurring global event that affects crop production and productivity most. To this end, its timing, as early season, mid-season or terminal stage, has a great influence on how to much yield loss occurs (29). According to (85) drought continues to be a major challenge on the productivity of cereal crops and water deficit will increase in most arid and semi-arid regions under the future climate change scenario. As a result, water deficit stress impacts crop performance and yield negatively. It has been evident that in almost all lowland areas crops are prone to periodic moisture stress in one way or another because of insufficient, unevenly distributed and unpredictable rainfall (21). The impacts of agricultural drought are a reduction in crop biomass, yield, and plant growth (65). The effect of moisture stress on crop yield is dependent on the stage of plant development. As reported by (94) both anthesis and grain filling stages appear to be more vulnerable; occurrence of drought at these stages may result in reduced yield and/or complete crop failure. Although drought stress at the beginning of the growing season severely affect plant

establishment, plants tend to recover soon when the rain falls late (71).

Despite the fact that, in Ethiopia, sorghum is vastly grown more than any other crops, in the areas where water deficit stress problem prevails. It is also obvious that the situation is being exacerbated by the complex nature of drought. However, the complexity is became a driving force and prerequisite for the discrimination of drought resistance with high yield potential genotypes. In doing so, lots of efforts have been exerted to generate drought tolerant and early maturing sorghum varieties targeted for water deficit stressed sorghum production sites. Inseparably, a number of research centers in the country have optimized and recommended huge soil and moisture conservation practices including tillage operations, mulching and others to reduce the effect of drought (72). In this regard, there are some drought tolerant (adaptable to lowland dry areas) and early maturing improved sorghum varieties useful for the water deficit stress prone environments. It is a signal for purposive exploration of the existing broad genetic variability within and among sorghum germplasm for resistance to drought which would be revealing the inherent capacity to develop new sorghum cultivars that may perform well under the drought prone areas. Hence, the aim of this review paper was to restate the vital improvements and constricting challenges associated with genetic and physiological basis of sorghum breeding for drought resistance in Ethiopia.

EFFECTS OF DROUGHT ON GROWTH AND DEVELOPMENT OF SORGHUM

Inside the semi-arid tropics where dry land farming is practiced, drought is a commonplace phenomenon that occurs at special periods for the duration of the developing season (12). There may be also a high season-to-season variability of rainfall, temperature, and radiation in the tropics. Drought is a mixture of stress effects as a result of high temperatures and a lack of water. Evapo-transpiration is the principal riding force that affects the soil, plant, and atmospheric continuum of the hydrologic cycle. On the other hand, agricultural situations significantly vary in topography, soil, current agricultural practices, and different associated biotic pressure factors. In earlier research, predictions of drought were particularly based on the quantity and distribution of precipitation (10). But, in latest research soil moisture stability and

soil traits had been introduced inside the evaluation of drought. Lack of good enough soil moisture, or water deficit, influences the capacity of plant life to grow entirely and everyday life cycle. Drought may have foremost impacts on growth, development and yield of crops by affecting numerous physiological, morphological and biochemical processes. It is the essential cause of negative crop performance and low yields, and sometimes it causes general crop failure. In the tropics, the chance of drought is highest on the start and the cease of the growing season. Drought can occur at both seedling, pre-flowering and post-flowering development stages, and has the most damaging effect on yield (41). Drought stress on the seedling stage of development will drastically have an effect on the plant establishment status. If it takes place at flowering, or in the grain filling stages, it may motive reduced yields, or entire crop failure (12). Researchers have categorized drought as both pre- or post-flowering stress. Pre-anthesis moisture stress has consequences on yield additives which includes stand count, tillering capacity, quantity of heads and number of seeds per head, even as post-anthesis moisture stress influences transpiration efficiency, CO₂ fixation and carbohydrate translocation. The latter factors, in flip, consequences in low yields and untimely plant senescence (89).

PHYSIOLOGICAL MECHANISMS OF DROUGHT RESISTANCE IN SORGHUM

Water deficit stress resistance can be defined as mechanisms of drought avoidance, healing, survival and tolerance (46). Those drought tolerance mechanisms are associated with plant survival and production. Water deficit stress avoidance is defined as the potential of vegetation to preserve water on the entire plant through reducing water loss from the shoots or through greater successfully extracting water from the soil (47). However, drought tolerance is defined as the capability of plants to withstand water deficit on the same time as maintaining appropriate physiological activities to stabilize and defend cell and metabolic integrity at tissue and cell levels. Survival is the potential of the crop to live on drought stress, irrespective of the yield it produces, at the same time as production is the potential of the crop to grow and yield under water pressure situations (46). Drought tolerance is a complex quantitative trait stimulated by way of many genetic and environmental factors (15).

The responses of various vegetation, species, or genotypes to drought are variable in terms of developmental level, duration of drought, and evolutionary edition of the crop (75). In sorghum, as an instance, varieties which can be tailored to arid and semi-arid environments showed better drought tolerance than styles of humid starting place (11). Several research have been performed in understanding the mechanism of drought resistance in vegetation and in figuring out crucial developments (traits) for drought tolerance (10). Drought resistance, consequently, involves the interplay of various morphological systems, physiological abilities, and biochemical expressions (13).

As reported by (39) stomatal conductance and leaf rolling have been determined to be reliable physiological indicators of drought tolerance in plants. Likewise, stomatal conductance and leaf rolling are strongly associated with leaf water capability (8). Similarly, roots are the number one plant organ affected by drought and different environmental stresses of the soil (68). In line with research findings found by (74) sorghum crown roots grow approximately 2 to 3 cm per day and root boom is specially tormented by the amount of carbon partitioned to the roots, even though it varies with environmental and genetic elements (9). Sorghum roots can also develop to depths of one to two m with the aid of the booting level, and may effectively extract water to a lateral distance of 1.6 m from the plant (74). Osmotic adjustment is some other predominant physiological drought adaptive mechanism in plant life (35). Sorghum and millet landraces, which might be gathered either dry or humid environments show differences in osmotic adjustment (11). Landraces that come from drier areas display greater osmotic adjustment than landraces from humid regions. Dehydration tolerance has also been outlined by as the capability of plants to take care of higher state of turgor potential within the plant cell underneath of water stress condition. It is often measured by tissue's water level, that is expressed in terms of water potential (10). This characteristic is extremely related to plasma membrane stability to take care of high level of cell water potential underneath drought condition (78). Transpiration efficiency (TE) is defined as biomass accumulation in keeping per unit water transpired (89). Sorghum genotypes with low inner CO₂ concentration and more suitable photosynthetic ability may be related

to high TE (89). Solutes are low-molecular-weight and extraordinarily soluble compounds which can be typically risk-free even at high cytosolic concentrations. Commonly they defend plants from stress through one of a kind manner which include contribution in the direction of osmotic adjustment, cleansing of reactive oxygen species, stabilization of membranes, and local systems of enzymes and proteins (28).

Leaf senescence is a programmed cell demise resulting from drought and other environmental pressures. It is characterized via lack of chlorophyll and gradual decline in photosynthetic ability (80). Premature plant tissue death commonly happens whilst flora are subjected to water pressure in the course of the grain filling period in sorghum (73). Stay green, alternatively, is a post-anthesis drought resistance trait in vegetation that offers resistance to pre-mature leaf senescence to the plant underneath excessive moisture stress condition at some point of grain fillingstage. It contributes to an advanced yield and yield stability under moisture stress circumstance (80). But, it reduces the source-sink translocation from leaves to grain. Stay-green is related to a better level of chlorophyll content material, cytokinin, and leaf nitrogen concentration under moisture shocked situations. The stay-green races display better tiers of chlorophyll content than the regular strains (90).

GENETICS OF DROUGHT RESISTANCE IN SORGHUM

The cause of examining the genetics of drought resistance in plant life is to discover genetic factors that determine the productivity of crops under drought pressure situations. Advances in crop betterment underneath water confined situations are only feasible if drought resistance traits are diagnosed and decided on for similarly to yield (75). They were concerned in controlling traits related to yield and yield additives, root systems, stay-green, plant height, flowering and adulthood (75). Some of traits associated with drought resistance have been diagnosed and mapped; but, the stay-green trait is identified as the most critical drought resistance trait in sorghum. Besides, (82) diagnosed 13 genomic areas associated with post-anthesis drought tolerance in sorghum. Four QTLs were recognized for yield and yield stability, seven for duration of grain development and seed weight, and two for the stay-green trait. There are 3 live-green gene assets (B

35, SC 56 and E 36-1) from which QTLs have been mapped onto 10 linkage groups on sorghum (41). (80) diagnosed two stay-green QTLs placed on linkage group B and I. Similarly, (90) identified four stay-green QTLs and mapped of the QTLs (Stg1 and Stg2) on linkage group A, and the alternative two, Stg3 and Stg4 onto linkage group D and J, respectively. The stay-green QTLs were ranked primarily based on their contribution to the stay-green phenotype as Stg2, Stg1, Stg3, and Stg4 of their order of advantage. furthermore, (90) additionally mapped three QTLs (Chl1, Chl2 and Chl3) for chlorophyll content, and the map position coincides with the stay-green QTLs. Six maturity genes (Ma1- Ma6) were recognized, and mapped onto the sorghum genome. Two maturity QTLs are positioned near a live-green QTL linkage group and the primary impartial maturity QTLs were found to be quite correlated with stay-green score (79).

SORGHUM BREEDING AND SELECTION METHODS FOR DROUGHT RESISTANCE

After having used yield under drought as an special breeding objective, most breeders progressively changed this empirical method through indirect choice (36) based on the choice for “secondary traits” or plant traits that provide extra facts about how the plant performs underneath a given environment (45). Generally, there are two main methods to enhance most economical yield, ie, the empirical approach in which the plant breeder at once selects the breeding material for yield and its components and the analytical technique which emphasizes the development of yield via oblique choice for morphological, physiological or biochemical traits related to yield. Empirical method outcomes within the development of plant population especially tailored to drought conditions and need to be accomplished within the target arid surroundings where drought is the permanent characteristic of the location. Yield has however a low heritability and consequently selection based totally on this complicated trait is hard and brings very gradual improvement. The choice criteria utilized in oblique selection should show relationship with yield under drought environment. Narrow sense heritability of the trait(s) of interest ought to be high so that breeding populations display proper reaction to selection. Furthermore, trait(s) need to be, as far as feasible, effortlessly measurable and non-plant detrimental (24).

SORGHUM BREEDING FOR DROUGHT RESISTANCE IN ETHIOPIA

Ethiopia is one of the major sorghum producer countries in Africa. Considering the crop's importance, breeding efforts have been focused in attaining high yielding, abiotic and biotic stress resistance sorghum genotypes in the face of climate change. As enabling environment, the Ethiopia national agricultural research systems was found to be the largest in Africa in terms of staff and budget and the country has been implementing agricultural-led growth strategy for many years now (86). Furthermore, the government of Ethiopia has allocated comparatively considerable resources to the breeding program as sorghum is the strategic and food security crop (48). On top of that Ethiopia owns a diverse wealth of sorghum germplasm adapted to a range of altitudes and rainfall conditions. It was also reported by (25) as Ethiopia has huge range of sorghum genetic diversity. In line with the Ethiopian Biodiversity Institute gene bank report, sorghum is among the top well studied cereal crops, so far there exist nearly 11,353 sorghum accessions gathered and conserved in the institute's gene bank, of which about 8,913 (~78%) accessions had been characterized by professional and amateur plant researchers, and further 2,440 sorghum accessions are not evaluated yet for their inherently useful characters. In support to the report, in the near past, the Ethiopian strategy for sorghum has been formulated by (26) for the years 2014-2024. This country strategic document narrated that "sorghum research was conducted in the last four decades with many success". Conversely, the document has also identified as there are research and development gaps along with the sorghum value chain, among the screened gaps the first came at the top of the agenda and primarily manifested by "the lack of improved varieties that combine high grain yield, multiple tolerance/resistance traits, grain quality and biomass adapted to the different agro-ecologies". These further exacerbated by "a limitation in generation of demand-driven technologies and innovation up scaling in an integrated and impacted oriented approach". Regardless of the very recent parser improvements made on the Ethiopian sorghum breeding for drought resistance, however, much of the improvements have been predominantly restricted to germplasm characterization using

phenotypic traits and combining ability tests to assess the heterotic patterns of exotic parental lines (2, 21).

IMPROVEMENTS ON PRODUCT, SELECTION ENVIRONMENTS AND CRITERIA AND RESEARCH APPROACHES

In Ethiopia, sorghum breeding program has been started since the 1950's (31) since then 51 modern sorghum varieties have been released, and Gambella-1107 is found to be the first (Table1). Pure line selections from landrace collections and pedigree breeding targeting the three major agroecologies has been the major focus of breeding activities for the past six decades. These activities have resulted in a number of sorghum open pollinated varieties being released for production (30). Most of the released modern sorghum varieties are OPVs targeted for the lowland dry areas, moist lowlands, intermediate altitudes and highlands in order (Table1). There exist two hybrids with high yield potential (ESH-1 and ESH-2) for the lowland dry areas the country with relatively high yield potential 5.3.t/ha and 5.2 t/ha respectively (Table1). Further, three striga resistance sorghum varieties namely Gobiye, Abishir and Berhan and are adapted to the lowland dry areas (Table-1). The majority (85%) of the improved varieties released for the lowland and intermediate environments have been developed using introduced lines, which are characterized by short plant stature, early maturity and lower grain size (1). In contrast, all the varieties released for the highland environment to date have been pure lines selected from the highland landrace collections; however, these released improved varieties only have limited yield advantage compared to the farmers' selected varieties or landraces which is one of the factors attributed to their lower adoption rate by farmers (49).

Based on few morphological and agronomic selection criteria the genetic diversity and post-flowering drought tolerance nature of Ethiopian sorghum germplasm at the field conditions have been investigated and promising accessions were discriminated (50, 91). An in-vitro screening experiment for drought tolerance in sorghum would be able to confirm that sorghum varieties meant for lowland dry are as namely 76T1#23, Teshale, Meko, Gambella-1107 and Melkam were performed better under drought conditions. While the researches confirmed the potential and importance of in-vitro screening for drought tolerance traits and cultivars in

Table 1 : Lists of sorghum released varieties sourced from exotic and landraces of Ethiopian germplams for lowland dry areas having drought tolerance and early maturing traits one way or the other targeted for water deficit stressed areas.

S. No.	Variety Name	Research Center	Year of release	Yield t/ha	Specific character/purpose	References
1.	Teshale	SARC	2000	6.1	Drought tolerant	(54)
2.	Abuare	SARC	2003	4	Drought tolerant	(57)
3.	Girana-1	SARC	2007	4	Drought tolerant	(58)
4.	Misikir	SARC	2007	4	Drought tolerant	(58)
5.	Raya	SARC	2007	2.5	Drought tolerant	(58)
6.	Gedo	SARC	2007	3.4	Drought tolerant	(58)
7.	Yeju	SARC	2000	5	Early maturing	(54)
8.	Abshire	SARC	2001	3	Early maturing	(55)
9.	Mesay	SARC	2011	3.9	Early maturing	(60)
10.	Melkam	MARC	2009	5.1	Lowland areas	(59)
11.	Meko 1	MARC	1997	3.6	Lowland areas	(53)
12.	Dekeba	MARC	2012	4.1	Low altitude areas	(61)
13.	ESH-1	MARC	2009	5.3	Lowland dry areas	(59)
14.	ESH-2	MARC	2014	5.2	Lowland dry areas	(62)
15.	76T1#23	MARC	1976	3.5	Moisture stressed dry land areas	(51)
16.	Gambella-1107	MARC	1976	3.9	Lowland moist areas	(51)
17.	Seredo	MARCH	1986	3.2	Lowland dry areas	(51)
18.	Alene	SARC	2017	4.3	Lowland dry areas	(63)
19.	Gobiye	MARC	2000	2.05	Lowland dry areas	(54)
20.	Red Swazi	MARC	2007	3.15	Lowland dry areas	(58)
21.	Macia	MARC	2007	4.3	Lowland dry areas	(58)
22.	Berhan	SARC	2002	4.0	Low land dry areas	(56)
23.	Hormat	SARC	2002	2.33	Lowland dry areas	(56)

Key : **SARC:** Sirinka Agricultural Research Center; **MARC:** Melekasa Agricultural Research Cente.

sorghum, and they suggested that further genetic analysis using molecular tools would be helpful (93). In the course of alleviating the above prevailing bottleneck in Ethiopia via molecular approaches, (88) could identify and localize some potential candidate genes exhibiting great involvement in combatting abiotic stress tolerance in general; the identified QTLs flanking on the chromosomes were Sb01, Sb04 and Sb06. The finding conferred the probability of identifying major QTL hubs and variability which are ready to manipulate for abiotic stress tolerance by utilizing highly dense markers in genetically diverse populations. Likewise, quantitative trait based genetic diversity study under moisture deficit environments by (4) had discriminated and made available sorghum landraces listed as 239167-B, 244725-A, 242049-B, 242050-A, 244711-A, 202508, 244729-A, 242046, 75454, 73056-B and 72457 which are believed to be

promising sources of water deficit stress resistance genes for sorghum betterment in the mandate areas. They also could realize that the accessions displayed high polymorphism for leaf rolling and stay-green traits which are important for selection under drought stress conditions.

Similarly, (92) had identified two markers (Xtxp136 and Xtxp015) linked to grain yield per panicle, one (Xtxp278) to days to 50% flowering and one (mSbCIR300) to panicle exsertion consistently at two locations. These SSR markers were co-localized with previously mapped QTLs for days to 50 % flowering, panicle exsertion and grain yield per panicle respectively. They suggested that these markers could be used for marker aided selection of traits for drought tolerance improvement programmes and selection for drought tolerant genotypes. In another related study, seven SSR markers were positioned on the

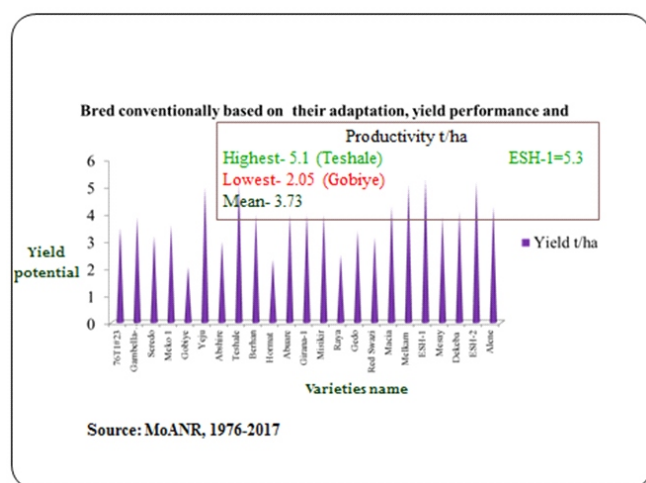


Fig. 1 : Yield potential and adaptation of drought tolerant Ethiopian sorghum varieties bred conventionally from 1976-2017.

chromosomes 1, 2, 3, 5, 6, 7 and 8 harboring one marker each namely xcup53, bSbCIR223, Xtxp114, mSbCIR248, Xtxp145, Xtxp278, and gbsp123 respectively. Most of them were mapped in chromosomal regions that have been previously reported as positions for drought tolerance-related traits, supporting the present findings (3). Hence, proper validation of the identified markers in different and/or related populations and in various environments before using them for further breeding would be advantageous.

The International Crops Research Institute for the Semi-Arid and Tropics had identified two lines sources stay green genes namely B-35 and E-36-1 from the Ethiopian gene pool, to date they are in use in different parts of the world to develop drought resistance sorghum varieties (43). Sorghum germplasm originated in Ethiopia is also said international as a supply for beneficial genes collectively with cold tolerance, good grain quality and disease/or insect resistance (43). Moreover, considering the prior screened QTLs related with stay-green in sorghum; study was carried out to confirm introgressed QTLs expression in the early generation of sorghum genotypes. As a result, an initial evaluation report was made available in case of both optimum moisture and water deficit stressed environments for post flowering in the BC2F3/BC1F4 generations, the four stable stay green QTLs (StgB, Stg1, Stg3 and Stg4) which were incorporated to the recipient senescent variety R 16 from the donor parent B35 were expressed phenotypically in the background variety (40).

According to them, many of the introgression lines could exhibit higher leaf chlorophyll levels at flowering and bigger percentage of green leaf area during the latter part of grain filling, than R 16, witnessing that the stay-green QTLs were expressed phenotypically in the R 16 background. In a similar fashion, (33) had reported that Sorcoll 163/07 and Afeso appeared to be more resistant to severe post-flowering drought stress than Sorcoll 141/07 and Sorcoll 146/07; this can be ascribed to maintaining the higher green leaf area, RWC, chlorophyll content index, assimilation rate, Fv/Fm, WUE, delayed leaf senescence, root dry weight and root to shoot ratio. Recently, Stg QTL introgressed lines were evaluated for their drought tolerance and high yield potential, and as a result Teshale/ E-36-1, Gambella 1107/ B35-5 and Meko/B35-12 were found to be drought tolerant and high yielder harboring the introgressed Stg QTL (38).

CONSTRUCTING CHALLENGES AND THEIR GENERAL WAY OF HANDLING IN SORGHUM BREEDING FOR DROUGHT RESISTANCE

In spite of the fact that considerable efforts have been exerting, the progress of generating drought resistance sorghum varieties is slow. This could be contributed due to be not limited to, water deficit induced stress occurrence is irregular in nature, and can happen at any stages of the crop development with a higher probability in the tropics and sub tropics both at the inception and session of the growing periods. According to (66) the polygenic nature of drought together with shallow insight of the yield physiological basis under water deficit conditions, it still remains being one of the most challenging issue to breeders. Its effect on sorghum basically depends on plenty of factors such as stage of plant growth and development, genetic makeup of the genotype, duration of the stress, severity of the stress, and largely the genotype and environment interactions (64). Hence, early plant establishment always severely affected by the early season moisture deficit stress, and when it comes at flowering and/or grain filling period could result in yield reduction or the whole crop failure (12). This entirely makes the problem very complex. Though, any crop variety can be adapted to several environments. These clusters of environments are termed as target population environments (29). So that, breeders' has to markedly delineate and define the target population environments for which each genotypes will be

evaluated on. Identifying and defining both the TPE and the mega-environment is basically based on spatial information about environmental bottlenecks including water deficit stress (69). It is unfortunate that there exist a huge non-predictable genotype and environment interactions across years led to inefficient clustering (17). The variability nature of the main atmospheric characteristics like air temperature, relative humidity, wind speed, precipitation, and on the other hand, soil related parameters such as soil fertility, soil depth, water holding capacity and toxicity should be recorded and registered (34). Para eventually the confounding effect of water deficit stress exacerbates the effect of the study and impaired the accuracy level of the evaluation. As many breeders agreed that and for example (5) stated plant breeding is not “a magic” any encouragement even to the level of the Green Revolution which were undertaken under the optimum moisture condition failed to represent for the water deficit stress environments. This was in line with the findings by (14) that breeders should expect small and gradual genetic advance out of the breeding for water deficit stress areas. Development of crop varieties for water deficit environments has a potential limitation to achieve the desired level of productivity as it is handicapped by low genetic advance from discrimination, this may restrict yield enhancement (87). According to the probability of productivity increment (double or triple) to feed the ever growing population left unsecure.

Overcoming the obstacles associated with breeding for water deficit stress tolerance is becoming a pivotal center for developing stable genotypes with inherit potential to perform consistently across delineated and defined water deficit stressed environments. The question is how? Primarily, the target population environment should be grouped systematically into relatively similar clusters in a way that the magnitude of genotype - environment interaction effect will be kept to its possible minimum range, and resulted better gain (16). Such kind of strata formation of test sites should be formed with a representative number of test genotypes with known pedigree. Such types of clustering usual based on oneness of biological responses of crops, edaphic and soil factors (83). Moreover, conserving the genetic base of crop species by using various possible strategies is needed. Many breeders suggested that maintaining of intra and inter species crop variability would offer biological

advantages while breeding in the water deficit stressed environments (20). As Ethiopia is a center of origin and diversity for sorghum and wise exploitation of it would help the country in solving the confounding water deficit stress problems. So that, homogeneity is not biologically necessary but diversity is desired to boost both performance and stability of cultivars on water deficit stressed areas (76).

To this end, breeding strategies may be employed to boost and maintain genetic variability to combat the water deficit stress in a meaningful manner. Both conventional and molecular breeding strategies can be used either solely or in a combination to boost breeding efficiency by harvesting their complementary effect. Conventional cereal breeding based on the phenotypic selection has been applying, though ample complexities are faced while operating, mainly due to genotype–environment interactions. Inseparably, the procedural testing methods are unreliable, expensive, and lengthy and made more difficulties, this would be even worse considering the nature of the trait under investigation example abiotic stresses (7). To lessen the limitations and boost conventional breeding's efficiency is became possible. The possibility became real with the advent of DNA-based genetic markers and numerous markers distributed in the entire genetic material of any species of interest and detection of markers linked to the trait of interest (37). This eventually led to the realization of marker assisted selection (MAS). Identification, mapping and nesting of conditioning QTL alleles in a given breeding population in a year with several selection cycles at any stage of plant development is possible and efficient (23). Considering the current advance of MAS it has been proven to be quick, free of environmental influence, not crop developmental stage dependent, relatively accurate and efficient. A wise manipulation of the blessings of conventional breeding strategies would be a plus for water deficit stress tolerant crop breeder.

CONCLUSION AND FUTURE PROSPECTS

Examining the genetic and physiological basis of drought resistance in sorghum is crucial so as to succeed in breeding fordrought resistance traits. Many scholars witnessed that via their research works, an early maturing genotype yields less as compared to an overdue maturing genotype in a beneficial environment. This is due to the fact drought escape by

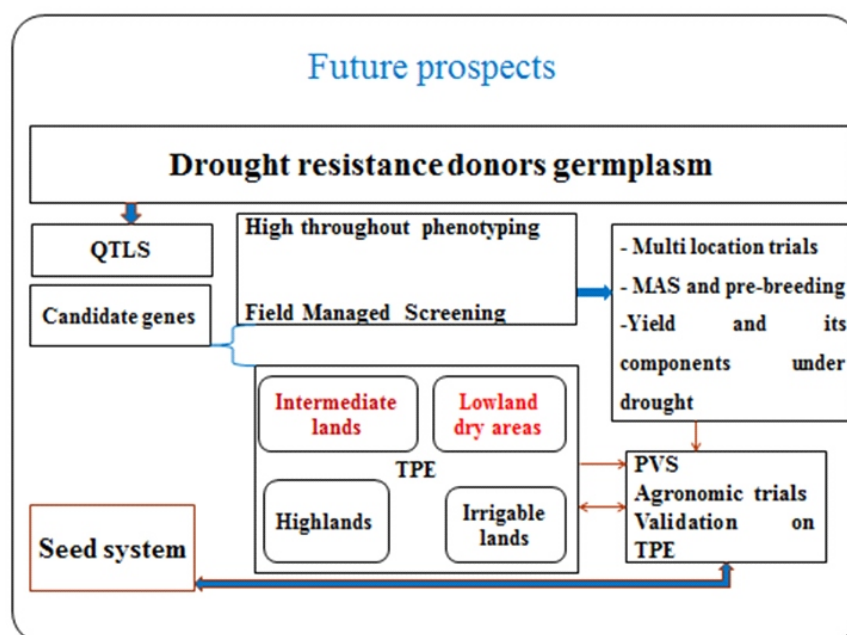


Fig. 2 : Possible and suggested framework for genetic enhancement of water deficit stress resistance in sorghum.

using shortening the growing duration is made at the expense of the crops genetic yield ability. To this end, many researchers have proposed diverse characteristics related to drought resistance that could be used in breeding and selection programmes. But, complete understandings of the physiological and genetic basis of adaptation in moisture pressure situations are nevertheless lacking. Moreover, the interaction among the exceptional characteristics inside a plant and the surroundings makes drought resistance breeding very complex. As a result, the possibilities of breeding drought resistant cultivars with all the critical characters are low. Despite the existing challenges and primarily based on ingesting direct selection technique (adaptation and yield stability) it was viable to develop above 23 drought tolerant and early maturing sorghum varieties targeted for the lowland dry regions of the country, Ethiopia. Eventually, on account that drought resistance is the interplay of various morphological, physiological, and biochemical traits, a combination of various resistance trends, rather than a unmarried trait, should be used as the overall selection criterion. Besides, emphasis should be given to the selection of particular traits as selection criteria which depend upon the crop species, the heritability, and the ease of switch of the traits.

The Ethiopian strategy for sorghum breeding for drought resistance should encompass and follow at least following :

Delineate precisely and purposely the drought-

prone target environments and state the most frequent types of water deficit stress and their intensity

Characterize the phenological, morphological, and physiological traits that make a contribution appreciably toward adaptation to water deficit stress within the target environments

Use simulation modeling and systems evaluation to examine crop response to the principal drought patterns, and determine the value of candidate physiological traits and their connection with crop productiveness in the target environment.

Generate and refine the phenotyping methodologies for characterizing genetic stocks that could serve as donors, characterizing the outcomes of genes and QTLs, and selecting cultivars with resistance to specific stresses.

Identify, map, and tag marker-aided breeding QTLs within sorghum germplasm which might be critical for drought resistance, and incorporate them into regionally adapted varieties.

Harness functional genomics, transgenics, and reverse genetics tools to apprehend the genetic manipulate of the applicable traits, and compare the effect in sorghum of sequences recognized to affect drought resistance in different species by transforming high-yielding but drought susceptible varieties.

Develop near-isogenic versions of vital

however drought-susceptible varieties containing QTLs/genes that have an effect on specific traits of interest to assess their worth in up drought adaptation of regionally tailored varieties.

Test the advanced marker-assisted selection products both in well-managed screening facility (rain out shelters) and in farmer participatory multi-location trials.

Along with water deficit stress management through breeding strategy, developing versatile and site-specific crop management options with attention on crop early establishment, weed management, and nutrient management, which help farmers to handle the massive abstraction and temporal variability of rain-fed sorghum fields would complement and enhance the management efficiency.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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SYNTHESIS, ANTI-MICROBIAL AND ANTI-TUBERCULOSIS ACTIVITIES OF SOME NOVEL QUINAZOLINONE ANALOGUES

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ABSTRACT

Various quinazolinone derivatives were prepared with the help of 2-Amino-3, 4, 5-trimethoxy benzoic acid and vilsmeier reagent. The structural features of synthesized compounds were confirmed by IR, ¹H-NMR and mass spectroscopy. All the synthesized compounds were evaluated for their in-vitro antibacterial and antifungal activities against gram (+) bacteria (*Bacillus subtilis* and *Bacillus cereus*), gram (-) bacteria (*E.coli* and *Serratia marcescens*), fungi (*Aspergillus niger* and *Alternaria alternata*) by disc diffusion method. MIC values reveals that most of the synthesized compounds possessed good antimicrobial activity but some of them showed a most potent anti-microbial activity like 4e, 4m, 4n, and 4o. Then, further these potent compounds were subjected to anti-tuberculosis activity against bacteria *mycobacterium H37Rv*. Results indicated that these synthesized quinazolinone analogues may be helpful in the discovery of new antimicrobial agents. This is also need of the hour to resolve the problem of drug resistance and infections.

Keywords : 2-amino 3,4,5-trimethoxy benzoic acid, vilsmeier Reagent, IR, ¹H-NMR, antibacterial, antifungal, anti-tuberculosis MIC, disc diffusion method.

INTRODUCTION

Quinazolinone, a fused heterocycle belongs to the important class of aromatic bicyclic compound. The structure of quinazolinone contains two nitrogen atoms at carbon position C-1 and C-3 respectively and carbonyl group at C-4. The aromatic benzopyrimidinone system in quinazolinone is made up of two fused six member simple aromatic rings namely benzene and pyrimidinone ring (1). Now-a-days, attempts are being made by the researchers to exploit the therapeutic potential of quinazolinone derivatives. Some of the majorly investigated therapeutic activities include anti-cancer, anti-inflammation, antibacterial, analgesia, anti-virus, anti-cytotoxin, anti-spasm, anti-tuberculosis, anti-oxidation, anti-malarial, anti-hypertension, anti-obesity, anti-psychotic and anti-diabetes (2). Incorporation of different active groups to the quinazolinone moiety via various synthetic methods has led to novel quinazolinone analogues which has exhibited desired biological activities. This structural manipulation of quinazolinone moiety has indicated remarkable

application of quinazolinone analogues in the field of biology, pesticides and medicine (3).

In the recent past, bacteria and fungi have emerged as the vital etiological agents of human infections. The researchers have significantly focused on such agents which have adopted resistance towards antimicrobials. Genetic mutations, misuse of antimicrobials in drug prescriptions and for other purposes and acquisition of antibiotic resistance determinants are the major factors responsible for increasing antimicrobial resistance (4). There has been an increasing demand of drugs for the cure of infections because many infections are being caused by antimicrobials. Quinazolinone derivatives have been found to exhibit diverse biological activities such as antimicrobial (5-7), antifungal (8), antibacterial (9), anti-inflammatory (10), insecticidal (11), CNS depressants (12) etc.

Tuberculosis (TB) caused by *Mycobacterium tuberculosis*, remains the leading cause of death from an infectious disease globally, currently, outranking HIV. In 2016 alone, 10.4 million became ill with TB, including 490,000 people who developed or acquired multi-drug resistant TB, against which the most potent

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first line drugs, Isoniazid and rifampicin are ineffective. Despite high cure rates for drug susceptible TB, the latest data for drug resistant TB shows that outcomes remain poor with treatment success reported for 54% and 30% of MDR-TB and XDR-TB respectively (13).

In this work, we have synthesized quinazolinone derivatives with the help of vilsmeier's reagent and the activity were performed with different strains and the compounds which showed good activity can be further be used as a lead molecule for the betterment in the treatment of tuberculosis disease.

MATERIAL AND METHODS

General methods-Melting point were determined in open capillary tubes on Thomas-Hoover melting point apparatus. The purity was checked by TLC (Thin layer chromatography) using Silica gel G coated glass plates taking mobile phase as Ethyl Acetate: N-Hexane (5:5). Spots were visualised by iodine vapours. IR spectra (KBr) were recorded on a Shimadzu FTIR Spectrophotometer. ¹H-NMR spectra (DMSO) were taken on a 400 MHz spectrometer and LCMS were entrusted on Shimadzu. All the compounds showed satisfactory analytical results.

Method of preparation of the compounds (4a-o) : A novel reaction occurs by treating 2-amino 3,4,5-trimethoxy benzoic acid (0.05 mmol) with the vilsmeier reagent. This reaction occurred between 80-90°C when two different substituted acids were reacted with a combination of DMF (20 ml) and POCl₃ (2.5ml). Then, at room temperature primary amines (0.05 mmol) were made to react with continuous stirring. After amine addition, temperature was raised to 90°C and the reaction was allowed to proceed for

3hrs on magnetic stirrer. Different substituted anilines derivatives (1-15) were prepared by the following methods—

6,7,8-Trimethoxy-3-phenylquinazolin-4(3H)-one

(4a) : Yield - 42%; Light grey solid; M.P - 370-375°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2982 (CH, str, Ali); 1680 (C=O, str, quinazoline); 1623 (C=N, str, quinazoline); 3080 (CH, str, Ar), ¹H NMR (, ppm/ DMSO-d₆) = 3.87 (m, 9H, 3*-OCH₃), 6.16-7.13 (m, 6H, Ar-H), 8.15-8.52 (m, 1H, Ar_{Quinazoline}), MS:m/e 312.11.

3-(4-Bromophenyl)-6,7,8-trimethoxy

quinazolin-4(3H)-one (4b) : Yield- 38%, Dark brown solid, M.P- 440-445°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2978 (CH, str, Ali); 1684 (C=O, str, quinazoline); 1630 (C=N, str, quinazoline); 3084 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆) = 3.84 (m, 9H, 3*-OCH₃), 6.25-7.23 (m, 5H, Ar-H), 8.23-8.52 (m, 1H, Ar_{Quinazoline}), MS:m/e 390.02.

3-(4-Chlorophenyl)-6,7,8-trimethoxyquinazolin-4-

(3H)-one (4c) : Yield- 38%, Fluffy white solid; M.P- 410-415°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2982 (CH, str, Ali); 1682 (C=O, str, quinazoline); 1622 (C=N, str, quinazoline); 3082 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆) = 3.92 (m, 9H, 3*-OCH₃), 6.67-7.58 (m, 5H, Ar-H), 8.30-8.49 (m, 1H, Ar_{Quinazoline}), MS:m/e 346.07.

6,7,8-trimethoxy-3-(3-nitrophenyl) quinazolin-

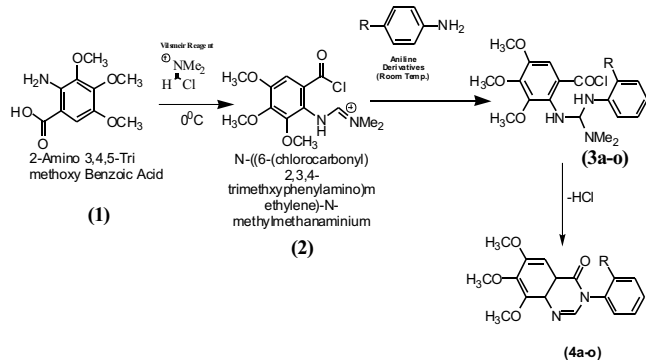
4(3H)- one (4d) : Yield = 41%, White solid; M.P- 430-435°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2978 (CH, str, Ali); 1685 (C=O, str, quinazoline); 1625 (C=N, str, quinazoline); 3086 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆) = 4.12 (m, 9H, 3*-OCH₃), 6.34-7.76 (m, 5H, Ar-H), 8.26-8.98 (m, 1H, Ar_{Quinazoline}), MS:m/e 357.10.

3-(2,4-dinitrophenylamino)-6,7,8-trimethoxyquinazolin-4(3H)-one (4e) :

Yield – 45%, Cream solid; M.P – 426-430°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2975 (CH, str, Ali); 1687 (C=O, str, quinazoline); 1626 (C=N, str, quinazoline); 3087 (CH, str, Ar) cm⁻¹, ¹H-NMR (DMSO-d₆) = 3.82 (m, 9H, 3*-OCH₃), 6.31-7.49 (m, 4H, Ar-H), 8.15-8.25 (m, 1H, Ar_{Quinazoline}), MS:m/e 417.09.

6,7,8-trimethoxy-3-(4-nitrophenyl)quinazolin-4(3H)-one (4f) :

Yield-52%, Light brown solid; M.P– 358-362°C, IR (KBr): $\bar{\nu}$ (cm⁻¹) = 2979 (CH, str, Ali); 1681 (C=O, str, quinazoline); 1625 (C=N, str, quinazoline); 3081 (CH, str, Ar) cm⁻¹, ¹H NMR (,



Scheme-A

ppm/ DMSO-d₆):= 3.92 (m, 9H, 3*-OCH₃), 6.21-7.51 (m, 5H, Ar-H), 8.30-8.45 (m, ¹H, Ar_{Quinazoline}), MS:m/e357.10.

3-(2-Chlorophenyl)-6,7,8-trimethoxyquinazolin-4-(3H)-one (4g) : Yield-60%, Dark black solid; M.P- 359-365°C, IR (KBr): ⁻ (cm⁻¹); = 2972 (CH, str, Ali); 1686 (C=O, str, quinazoline); 1624 (C=N, str, quinazoline); 3082 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 4.12 (m, 9H, 3*-OCH₃), 6.12-7.18 (m, 5H, Ar-H), 8.89-9.12 (m, 1H, Ar Quinazoline), MS:m/e346.07.

6,7,8-trimethoxy-3-(2-nitrophenyl) quinazolin-4(3H)-one (4h) : Yield = 58%, Dark brown solid; M.P- 486-490°C, IR (KBr): ⁻ (cm⁻¹); = 2971 (CH, str, Ali); 1688 (C=O, str, quinazoline); 1623 (C=N, str, quinazoline); 3084 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.96 (m, 9H, 3*-OCH₃), 6.04-7.16 (m, 5H, Ar-H), 8.56-8.70 (m, ¹H, Ar_{Quinazoline}), MS:m/e357.10.

3-(4-aminophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4i) : Yield = 48%, Light black solid; M.P- 468-475°C, IR (KBr): ⁻ (cm⁻¹); = 2985 (CH, str, Ali); 1686 (C=O, str, quinazoline); 1627 (C=N, str, quinazoline); 3086 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.89 (m, 9H, 3*-OCH₃), 5.1 (brs, 2H, -NH₂-Ar), 6.03-7.09 (m, 4H, Ar-H), 8.25-8.35 (m, ¹H, Ar_{Quinazoline}), MS:m/e327.12.

3-(3-Bromophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4j) : Yield = 52%, Light cream solid; M.P- 440°C-445°C, IR (KBr): ⁻ (cm⁻¹); = 2977 (CH, str, Ali); 1680 (C=O, str, quinazoline); 1623 (C=N, str, quinazoline); 3080 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.82 (m, 9H, 3*-OCH₃), 6.04-7.39 (m, 5H, Ar-H), 8.40-8.75 (m, ¹H, Ar_{Quinazoline}), MS:m/e390.02.

3-(3-chlorophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4k): Yield = 52%, Fluffy white solid; M.P- 410°C -415°C, IR (KBr): ⁻ (cm⁻¹); = 2983 (CH, str, Ali); 1686 (C=O, str, quinazoline); 1626 (C=N, str, quinazoline); 3084 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 4.25 (m, 9H, 3*-OCH₃), 6.36-7.51 (m, 5H, Ar-H), 8.92-9.20 (m, 1H, Ar_{Quinazoline}), MS:m/e 346.07.

3-(2-Bromophenyl)-6,7,8-trimethoxyquinazolin-4-(3H)-one (4l) : Yield = 60%, Brown solid; M.P- 442°C -445°C, IR (KBr): ⁻ (cm⁻¹); = 2970 (CH, str, Ali); 1681

(C=O, str, quinazoline); 1621 (C=N, str, quinazoline); 3081 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 4.30 (m, 9H, 3*-OCH₃), 6.40-7.10 (m, 5H, Ar-H), 8.90-9.10 (m, 1H, Ar_{Quinazoline}), MS:m/e 390.02.

3-(3,4-dichlorophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4m) : Yield = 54%, Dark yellow solid; M.P- 456°C -458°C, IR (KBr): ⁻ (cm⁻¹); = 2976 (CH, str, Ali); 1683 (C=O, str, quinazoline); 1623 (C=N, str, quinazoline); 3086 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.89 (m, 9H, 3*-OCH₃), 6.03-7.09 (m, 4H, Ar-H), 8.25-8.35 (m, 1H, Ar_{Quinazoline}), MS:m/e 380.03.

3-(4-Chloro-2-fluorophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4n) : Yield = 49%, Black solid; M.P- 426°C - 429°C, IR (KBr): ⁻ (cm⁻¹); = 2979 (CH, str, Ali); 1683 (C=O, str, quinazoline); 1625 (C=N, str, quinazoline); 3088 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.78 (m, 9H, 3*-OCH₃), 6.08-6.89 (m, 4H, Ar-H), 8.25-8.30 (m, ¹H, Ar_{Quinazoline}), MS:m/e 364.06.

3-(3-chloro-2-fluorophenyl)-6,7,8-trimethoxyquinazolin-4(3H)-one (4o) : Yield = 53%, White solid; M.P- 427°C - 429°C, IR (KBr): ⁻ (cm⁻¹); = 29782 (CH, str, Ali); 1687 (C=O, str, quinazoline); 1624 (C=N, str, quinazoline); 3087 (CH, str, Ar) cm⁻¹, ¹H NMR (, ppm/ DMSO-d₆):= 3.78 (m, 9H, 3*-OCH₃), 6.08-6.89 (m, 4H, Ar-H), 8.25-8.30 (m, ¹H, Ar_{Quinazoline}), MS:m/e 364.06.

In-vitro anti-microbial activity

The antibacterial and antifungal activities of synthesised compounds were determined using two gram positive bacterial strains [*Bacillus subtilis* (MTCC 1427), *Bacillus cereus* (MTCC 430)], gram negative bacterial strains [*Escherichia coli* (MTCC 405), *Serratia marcescens* (MTCC 4301)] and fungal strains [*Aspergillus niger* (ITCC 7787), *Alternaria alternate* (ITCC 4522)]. Amoxicillin and Fluconazole were used as standard drugs.

The antimicrobial activity was determined following Kriby-Bauer disk diffusion method (14). Initial screening of the derivatives and standard drugs was carried out at fixed concentration of 10mg/ml. The results for each compounds were in accordance with the average diameter as inhibition zones (IZ) of 24h for bacteria and 72h for fungal growth around the discs in mm. Results are shown in Table 2.

Determination of MIC

The minimum inhibitory concentration was determined by liquid dilution method against all bacterial and fungal strains (15). Standard stock solution of resultant compounds along with 2mg/ml, 4mg/ml, 6mg/ml, 8mg/ml, 10mg/ml, and 12mg/ml concentrations were prepared with suitable solvent. Amoxicillin and Fluconazole standard solutions were also prepared by this concentration and solvents bacterial and fungal strains inoculums were also prepared. Test tubes in a series containing 1ml derivative solution with varied concentration, 0.2ml of inoculums, and 3.8ml of the sterile water were added. Then, the test tubes were incubated for 24 h to check the turbidity. Same methods were adopted for rest of the derivatives and with standard drugs. In the test tubes, where there was visually no growth seen called minimum inhibitory concentration of the derivatives. All the resulted values of MIC are shown in Table 3.

Screening for anti-tubercular activity by Alamar-blue assay (Franzblau *et al.*, 1998)¹⁶

The anti-mycobacterial activities of compounds viz. quinazolinone derivatives were assessed against H37Rv (NCFT/TB/537)-Mycobacterium sensitive to Isoniazid(H), Streptomycin (S), Rifampicin(R) using the micro plate alamar blue assay (MABA). Briefly, 200 μ L of sterile deionized water was added to all outer-perimeter wells of sterile wells to minimize evaporation of the medium in the test wells during incubation. The wells were filled with 100 μ L of the Middlebrook 7H9 broth (having loopful inoculum of bacteria) and different dilutions of the respective compounds were made directly on the plate. The maximum concentration of the compound (s) tested was 100 μ g/ml. Plates were covered and sealed with parafilm and incubated at 37°C for five days followed by the addition of 25 μ L of a freshly prepared 1:1 mixture of Alamar blue reagent and 10% Tween 80 to the plates incubated for 24 h. A blue color in the well was interpreted as no bacterial growth, and a pink color was scored as growth. The MIC values of screened derivatives along with MIC of a standard drugs is shown in Table 4.

RESULT AND DISCUSSION

The chemical reaction between 2-amino 3,4,5-trimethoxy benzoic acid and vilsmeier reagent has

been exploited to produce different derivatives of quinazolinone. This reaction occurred at 90°C when two different substituted acids reacted with a combination of DMF and POCl₃ followed by the addition of substituted anilines to give the end products. The analytical data of the synthesised compounds are shown in Table 1. The 2-Amino 3,4,5-triamino benzoic acid (1) reacted with vilsmeier reagent at 0°C yielded N-((6-(chlorocarbonyl) 2,3,4-trimethoxyphenylamino) methylene)-N-methylmethanaminium (2). Then 2a reacted with primary anilines at room temperature in the presence of DMF different substituted quinazolinones were prepared (4d-4o). The steps involved in the synthesis are shown in scheme A.

Various spectral analytical techniques such as Infrared (IR), Proton Nuclear Magnetic Resonance (¹H-NMR) and mass spectra were employed to elucidate the chemical structure of quinazolinone derivatives. IR spectrum showed absorption band at 2950-2983cm⁻¹ (CH, Ali.), 3090-3080 cm⁻¹ (CH, Ar), 1690-1680 cm⁻¹ (C=O) and 1630-1620 cm⁻¹ (C=N). Further, ¹HNMR showed a multiplet of nine protons at (ppm) 3.87-4.50, multiplet for six protons at (ppm) 6.16-7.13 and multiplet of one proton of Aryl-quinazoline at (ppm) 8.15-8.52 respectively. Mass spectra revealed molecular ion peak in satisfactory intensity.

Kirby-Bauer disk diffusion method was used to determine the *in-vitro* antibacterial and antifungal activities of all the synthesized compounds (13). Gram-positive bacterial strains (*Bacillus subtilis* and *Bacillus cereus*), Gram-negative bacterial strains (*E. coli* and *Serratia marcescens*) and fungal strains (*Aspergillus niger* and *Alternaria alternata*) at 10 mg/ml concentration. The zone of inhibition were calculated and compared with amoxicillin and fluconazole. DMSO were used to prepare stock solutions of tested derivatives. The results showed that most of the compounds had variable activity against bacterial strains. Compounds 4e, 4m, 4n and 4o showed good antibacterial activity comparison to standard drug. Compounds 4d, 4f and 4h showed moderate antibacterial activity compared to standard drug and the compounds 4b, 4j and 4l showed least potent activity against antibacterial activity in comparison to standard drug.

The compounds with good antimicrobial activities were subjected to the determination of MIC value by liquid dilution method. A comparative analysis of MIC

Table 1 : Data of the synthesised compounds (4a-o).

Derivative Code	R	Molecular Formula	Rf value
4a	H	C ₁₇ H ₁₆ N ₂ O ₄	0.91
4b	4-Br	C ₁₇ H ₁₅ BrN ₂ O ₄	0.81
4c	4-Cl	C ₁₇ H ₁₅ ClN ₂ O ₄	0.76
4d	3-NO ₂	C ₁₇ H ₁₅ N ₃ O ₆	0.95
4e	2,4-NO ₂	C ₁₇ H ₁₅ N ₅ O ₈	0.71
4f	4-NO ₂	C ₁₇ H ₁₅ N ₃ O ₆	0.91
4g	2-Cl	C ₁₇ H ₁₅ ClN ₂ O ₄	0.81
4h	2-NO ₂	C ₁₇ H ₁₅ N ₃ O ₆	0.85
4i	4-NH ₂	C ₁₇ H ₁₇ N ₃ O ₄	0.81
4j	3-Br	C ₁₇ H ₁₅ BrN ₂ O ₄	0.71
4k	3-Cl	C ₁₇ H ₁₅ ClN ₂ O ₄	0.91
4l	2-Br	C ₁₇ H ₁₅ BrN ₂ O ₄	0.81
4m	3,4-Cl	C ₁₇ H ₁₄ Cl ₂ N ₂ O ₄	0.72
4n	2-F, 4-Cl	C ₁₇ H ₁₄ ClFN ₂ O ₄	0.72
4o	2-F, 3-Cl	C ₁₇ H ₁₄ ClFN ₂ O ₄	0.90

Table 2 : Zone of Inhibition of compounds (4a-4o) against different (+), (-) and fungal strains.

Compd.	Zone of Inhibition at 10 mg/ml					
	Fungi		Gram (+) bacteria		Gram (-) bacteria	
	<i>A. alternata</i>	<i>A. niger</i>	<i>B. cereus</i>	<i>B. subtilis</i>	<i>S. Marcescens</i>	<i>E. coli</i>
4a	10	08	10	10	09	12
4b	12	14	14	14	13	16
4c	11	09	09	10	08	10
4d	15	14	22	18	20	19
4e	21	20	29	22	29	24
4f	16	15	19	17	21	18
4g	08	07	07	09	07	10
4h	18	17	20	16	22	20
4i	11	08	06	11	09	08
4j	13	11	13	13	12	16
4k	10	09	06	10	09	09
4l	14	12	12	12	10	14
4m	20	21	28	21	28	23
4n	19	20	25	20	27	21
4o	20	21	27	19	26	22
Standard	22a	22a	30b	22b	30b	25b

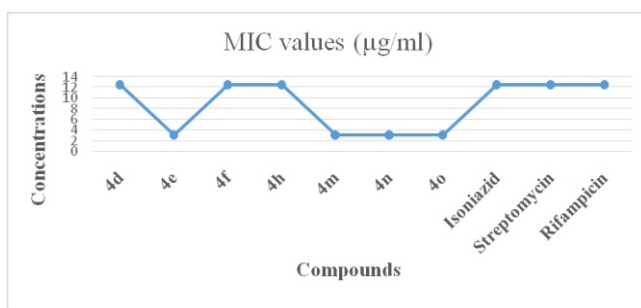
^aFluconazole ^bAmoxicillin.

Table 3 : MIC values of most active and standard compounds.

Compd.	MIC at mg/ml					
	Fungi		Gram (+) bacteria		Gram (-) bacteria	
	<i>A. alternata</i>	<i>A. niger</i>	<i>B. cereus</i>	<i>B. subtilis</i>	<i>S. Marcescens</i>	<i>E. coli</i>
4d	12	10	10	12	12	12
4e	10	08	06	04	04	06
4f	12	12	12	12	10	12
4h	12	12	10	12	10	12
4m	10	08	06	08	06	02
4n	04	06	04	04	08	06
4o	06	08	08	06	04	10
Standard	10a	10a	08b	10b	8b	12b

^aFluconazole ^bAmoxicillin**Table 4 : Anti-tubercular activity of the most active and standard compounds against mycobacterium H37Rv strains (as Alamar blue assay method).**

Compounds	MIC values (µg/ml)
4d	12.5
4e	3.12
4f	12.5
4h	12.5
4m	3.12
4n	3.12
4o	3.12
Isoniazid	12.5
Streptomycin	12.5
Rifampicin	12.5

**Fig 1 : Graphical representation of the MIC value of the active compounds.**

(µg/ml) of the therapeutically potential derivatives and the standard drugs against the test strains has been presented in Table-3.

CONCLUSIONS

Some novel (4a-4o) quinazolinone derivatives have been synthesized from 2-amino 3,4,5-trimethoxy

benzoic acid with vilsmeier reagent. The spectral analytical methods were employed to characterize and established the structural features of all synthesised compounds. All the synthesised compounds were biologically screened for their in vitro antibacterial and antifungal activity using Kriby-Bauer disk diffusion method. Four strains of bacteria and two strains of fungi were used for the purpose of biological activity. The results have indicated that compounds (4e, 4m, 4n, and 4o) were good against gram positive, gram negative and fungal strains, whereas compounds 4e, 4m, 4n and 4o were highly active against *M. tuberculosis* H37Rv. So, it can be inferred from the research study that structural manipulation carried out on quinazolinone moiety may suggest new ideas to explore therapeutically active novel antimicrobial agents.

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PERPETUATING 'STRUCTURAL' HIERARCHIES—STUDY OF 'E-CHOUPAL' AT MAHARASHTRA

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INTRODUCTION

Agriculture has been the source of livelihood for millions of people and continues to remain a major sector of the Indian economy, although the share of agriculture in GDP declined steadily from 55 percent in 1950-51 to 15 percent in 2009-10 (17). After independence, India faced a serious food grain shortage not just due to regular droughts, but because of the fact that population growth outpaced food production. Need of the hour for the state was to increase agricultural production to save the country from gravest crises it faced after independence. It was strongly felt that it would not be possible to attain and sustain food security without incentivizing farmers to adopt new technology and make investments in modern inputs. The primary agenda for the state was to achieve food grain self-sufficiency and food security which led to adoption of new agricultural strategy known as green revolution. Technological change, new information, and scientific inputs were the crucial components that facilitated the new agricultural strategy (7, 8 and 47).

(3) points out that while the first phase (from 1967 to 1980s) of the green revolution focused only on farmers who had access to resources (land, capital and irrigation) whereas the second phase (post 1990s) of green revolution witnessed the spread of commercial agriculture to the new sections like marginal and small cultivators and expanded into new regions (dry and semi-arid regions). Green revolution promoted the adoption of high yielding varieties and inputs like chemical fertilizers, pesticides, and mechanical implements like tractors, harvesters and scientific practices. Further, green revolution turned agriculture into 'knowledge based farming', which demanded appropriate knowledge levels to achieve high productivity and efficiency (4).

During second phase of green revolution 'knowledge' became central to agricultural production, whereas knowledge dissemination did not take place

accordingly. This discrepancy in knowledge dissemination is termed as 'knowledge gap'. The existence of this gap does not mean that the lower sections of farmers remain completely uninformed or even absolutely worse off in knowledge, but rather they become relatively lower in knowledge and hence the gap widens. There is a growing technology-knowledge gap which is threatening to make agriculture more vulnerable (41, 48). In this context, it is argued that generation and application of agricultural knowledge has become increasingly important after the adoption of high yielding varieties, especially for small and marginal farmers, who need relevant information in order to improve, sustain, and diversify their farm enterprises. Further it is argued that present agricultural system requires substantial knowledge transfer to and among farmers, including information about successful farming practices, new technologies or controls of pest and disease outbreaks, and new markets (12).

Farmers could no longer survive pest attack on their own after the introduction of green revolution which leads them to rely upon scientists to create newer seed varieties which could resist newer and evolving pests. In this context, State approached farmers to disseminate the agricultural information to the farmers and supported them in providing seeds, fertilizers, agricultural information and credit (36, 54). However, the agricultural initiatives and policies are intended to increase the income levels of the small and marginal farmers. In contrary, the agricultural policies and programmes benefitted large farmers. There are various extension programmes like DAATTCs = District Agriculture Advisory and Transfer of Technology Centres, KVK = Krishi Vigyan Kendra, ATIC = Agriculture Technology Information Centres, The Agricultural Technology Management Agency (ATMA) has initiated. State Agricultural Universities, the Agri-clinics and Agribusiness Centers (ACABC) Scheme and Farmer Field Schools are operated by State. It is, however, argued that despite number of

initiatives, policies and well-organized agricultural extension manpower, around 60 per cent of farmers in the country hitherto remained un-reached and un-served by any extension agency or functionary (1, 45).

Agricultural extension has been recognized as an essential mechanism for delivering information and seen as an important input of modern farming. It is said that appropriate, continuous and timely advice about farming is not reaching farmers with the existing (traditional) extension system, thus hampering the productivity. The problem with the traditional agricultural extension services is that they have become more bureaucratic with rigid hierarchical structures. Likewise, agricultural information in traditional extension system flows from top to bottom and is supply-driven rather than demand driven. In traditional extension system information is pushed to the farmer and lacks the feedback mechanism (25, 50).

In addition, the role of state has become minimal during the post-reform period and the policies pursued resulted in a reduction of public investment in rural infrastructure, including irrigation, agricultural research and extension services. There was a decline in the supply of rural credit to small and poor cultivators. The post-reforms, thus seen as inimical to petty production in general and agriculture in particular (10). (11) observe that the share of public spending on agricultural research and extension services in GDP of agriculture in India has been lower than that observed in the 1990s in developed nations (2 per cent to 4 per cent), and the average share in developing nations (0.75 per cent).

Table 1 shows public expenditure on research and extension in agriculture. The share of public spending on research and extension in GDP of agriculture was low since 1960s, as well as in the subsequent decades. In other words, public spending on agricultural research and extension services did not increase after reforms. It is quite important to mention that the state has become paralyzed in administering the agricultural sector due to the liberalization policies and the role of state has declined gradually on the development of agriculture sector. On the other hand, in the present context of globalization and market economy information has become essential in agriculture for the fact that expensive, imperfect and asymmetric information generates several problems for

farmers like increasing of risks associated with marketing, inefficient allocation of resources, higher transaction costs and poor decisions about marketing (56).

Table 1. Public Expenditure on Research and Extension in Agriculture and Allied Sector as Share of GDP of Agriculture and Allied Activities (%).

Year	Research & Education	Extension
1960–62	0.21	0.09
1970–72	0.23	0.14
1980–82	0.39	0.11
1989–91	0.41	0.16
1992–94	0.40	0.15
1995–97	0.38	0.14
1998–2000	0.44	0.15
2001–03	0.52	0.13
2004–06	0.52	0.13
2009–10	0.30	0.06
2011–12	0.32	0.05

Source : Balakrishnan et al (2008). Figures for 2009–10 and 2011–12 are computed by the author from Finance Accounts, Comptroller and Auditor General of India.

As a result of reduction of public investment in extension services on one hand and the advent of Information Communication technologies (ICTs) on the other (after post-reforms) led to new ways of managing knowledge in agricultural system. With the advent of ICT initiatives, the way we communicate transact and deliver things has gone for a paradigm shift. Increasing digitization, decentralized access, simultaneity and interconnectivity have produced strikingly different outcomes in the private digital space and made access to Internet by public easy. It is being realized that the advantages of ICT based agricultural extension services allow two way communication, cover larger geographical areas, speedy delivery of quality information, huge data storage and retrieval capacity. In this context, many private agencies and MNCs have begun initiatives in agricultural extension using ICTs (9, 39, 40).

The advocates of technological interventions for agricultural development vouch for making use of the advances in agricultural extension and scholars are of the view that ICTs in agricultural extension would help the newcomers into agriculture, who belong to the marginal and small farmers' category, coming from the marginalized sections of society, located in the fragile

regions of the country, and who lack expertise in making the best use of external input. Further it is believed that ICTs are most natural allies to facilitate the outreach of Agricultural Extension system in the State and highly relevant for Agricultural Extension scientists, researchers, functionaries and organizations. ICTs are expected to reduce the uncertainty, intermediaries and claimed to dissolve the old hierarchies which are inherent in the stratified society in agricultural information dissemination (16, 34, 45, 57).

There are a number of web-based ICT initiatives in agriculture. Some web portals like the Tamil Nadu Agricultural University's Agritech web portal act as information repositories. Another web portal AGMARKNET provides marketing information on the latest commodity prices from 2,800 major agricultural produce wholesale markets. Other web portals include Agropedia, AGRISNET, DACNET, e-Krishi, Agriwatch, and i-Kisan. Similarly, a number of initiatives are launched to communicate information directly to farmers by using mobiles. These include IKSL, e-Sagu (IFFCO Kisan Sanchar Ltd. in collaboration with Airtel), Mandi on Mobile (BSNL and Uttar Pradesh Marketing Board), Reuters Market Light, Kisan Sanchar and Nokia Life Tools. Most of these approaches provide market information through SMS or voice messages, or question-and-answer approach (1, 37, 42). Above all initiatives provide agricultural information whereas e-Choupal is one of the ICT based initiatives in agricultural extension, which integrates information services with market facilities. e-Choupal promises to bring efficiency to the supply chain by removing intermediaries and by reducing transaction costs and enabling farmers to make decisions.

Emergence and function of e-Choupal

Traditionally, agricultural produce is sold in the mandis. Mandis are the age old major agricultural marketing centers in rural areas. A typical mandi is a local market, which is specific to a particular geographic location where a large majority of the small and marginal farmers sell their produce. Mandis are laced with various problems and largely controlled by middlemen who are said to make most of the profit. They decide the price of the product usually with a low price when compared to the national and international market. It is argued that, present marketing system and

marketing institutions were plagued by inefficiencies, corruption, bureaucratic control and politicization (7, 21, 30).

Due to inefficient market linkages and ineffective procurement system, small and marginal farmers have been facing many difficulties in marketing their produce. As a result, they mostly prefer to sell off most of their produce in the traditional local markets at very low prices immediately after the harvest. It is argued that, the rural markets witness interlinked transactions and are dominated by certain sections of people (traders and money lenders) who thrive on the exploitative practices. As a result, small and marginal farmers suffer serious disadvantages in the traditional marketing and distribution. Their smaller outputs, fragmented landholdings and often distant location from major markets deprive them in accessing markets where high prices are offered for their produce. Moreover, farmers have only an approximate idea of price trends and have to accept the price offered to them at auctions on the day they bring their produce to the mandi (6, 32, 53).

However, it is a known fact that social (caste) and economic barriers (market power, economies of scale, asymmetry or costly information) can lead to exclusion of marginal and small farmers from certain markets. Lack of information can create inefficiencies and major losses for farmers. When there is an asymmetry of information between buyer and the seller or when relevant market information does not exist, an imperfect market will prevail (13). In mandi system the main sources of market information for farmers are their peers and market intermediaries. Intermediaries, in general, are not perceived to be transparent when doing business as they are oriented to maximize profit. Even though they perform an important role in the market, they are often criticized by farmers because they take advantage of the farmer's unfamiliarity about market prices through control of information. In order to raise the income of small and marginal farmers and to reduce their vulnerability of social, economic, and environmental challenges, enhancing market information is one of the important needs (51).

In this context, e-Choupal has started in the year 2000 by ITC's Agri Business Division with an objective to provide linkage between farmers and the agricultural markets. The major focus of the initiative is to provide information about market prices on different crops to

farmers at the village level. e-Choupal can be seen as a medium of delivering critical market information, thus allowing farmer an empowered choice of where and when to sell the crop. e-Choupal claims to tackle the problems of fragmented farms, weak infrastructure, and large number of market intermediaries in the Indian agriculture. This model uses information technology, i.e., Internet as an important tool to deliver information. ITC - IBD conducts the meetings in the regions where the commercial crops are cultivated. It conducts meetings with the farmers and creates awareness among the farmers about the marketing/procuring their produce at ITC-hub (place where the procurement takes place) and how it reduces the time and transportation costs and increases transparency. Based on the interest of farmers the ITC - IBD will set up e-Choupal centre in that particular village (22, 45).

e-Choupal kiosk is equipped with a computer and Internet connectivity. The computer with Internet connectivity in the e-Choupal enables farmers to obtain information on market prices, good farming practices and offers scope to place orders for agricultural inputs such as seeds and fertilizers online. e-Choupal also provides information on crop prices, weather, scientific farming practices, crop insurance and soil-testing services. This access to information helps farmers in improving the quality of produce and obtaining better prices. e-Choupal claims that it serves both as a place for social gathering where exchange of information on agricultural practices and market trends takes place between farmers of the village (2).

Two important stages that farmers should go through if once farmer decides to sell the produce at the ITC-IBD procurement center.

(i) Inspection and (ii) Grading & Payment

Inspection and grading

When farmers bring the produce to the ITC-IBD Hub the Quality Controller (Chemist) tests its quality by taking a sample. The quality of the produce is assessed physically by observing the produce for any foreign matter (other than the produce that is sold, for example, soybean is checked for any other matter than seeds, hay, stones, etc.). Deduction for foreign matter is done in the presence of stones, hay, etc. Based on the Chemist's assessment of the quality and appropriate deductions (if any) to the benchmark price, a conditional quotation is given to the farmer. After this,

the sample is tested for quality and moisture content by using an electronic machine. This is done in the laboratory by the Agricultural Scientist employed by the ITC (18, 19).

It is to be mentioned that these quality control checks are transparent as the process is done in the presence of farmer and farmer has the right to accept and reject the price quoted. If the farmer feels any inconvenience about the results s/he can ask for re-sampling and retesting the quality. The previous day's closing price at the ITC Hub for specific produce is used to determine the benchmark for Fair Average Quality (FAQ) price. Generally the previous day ITC Hub prices are communicated to the Sanchalak through the e-Choupal portal. Usually farmers enquire about the previous day's price information and current day's price before they take their produce to the procurement Hub (27, 34).

Payment

The higher price is paid to the high quality produce. The quality of the produce is deemed to be high when the bad seed (2%) and foreign matter (2%) are within the limits and moisture-free (not more than 10%). Inferior quality material fetches a lesser price. Once a farmer accepts the price, the entire produce is weighed on a large, automated scale instead of a manual scale. It is important to note that the presence of the Sanchalak is not compulsory during the procurement process, but usually Sanchalak comes to the Hub to gain trust of the farmers. The material handling systems at the ITC collection center ensures that tractors, trolleys or trucks can directly unload the produce without spilling any grain and a modern weighbridge ensures precise weighing (18, 19, 20).

After the sale of the produce is complete, ITC-IBD performs laboratory test of the sample produce collected. Based on these results, farmers are given customized feedback/suggestions on the ways to improve the crop quality. Every stage in the procurement process is accompanied by documentation. The farmer is given a copy of lab reports of the quality checks, price quotation, and receipts for the transaction. At any stage of the transaction, farmer is free to interact with the Agricultural Scientist (employed by ITC) and others to clarify doubts regarding the quality and estimate. The only hindrance found with the procurement through e-Choupal is that the number of transactions per village

is limited. Thus, those farmers who come first will stand a chance to sell their produce on the given day. Those who come late will have to wait for their turn in the coming days (19, 28).

METHODOLOGY

In the given context, the present study made an attempt to provide a comprehensive understanding on e-Choupal and its potentials. There is a need to understand the issues of access and inclusion of ICT based agricultural information to all sections of farmers critically. The question to be probed was to what extent the ICT initiative could overcome the existing social hierarchies and barriers in communication. The study relied on empirical evidence. Qualitative and quantitative methods were used in data collection. In-depth interviews and intensive interactions with the respondents and participant observation constituted the core of the study methodology. Data were collected using semi-structured questionnaire and interview method. Interviews were aimed at capturing the perception of farmers about the agricultural information communication so as to understand how agency acts and responds to the new information technology based initiatives in agricultural extension. The process of interaction was spread overextended and leisurely conversation mode to suit the needs of the farmers. Data were collected from 120 households in Parbhani district spread across two villages (Asola and Malsonna). The researcher aimed to understand the organizing and functioning of e-Choupal by studying different variables like level of education, advices received from different channels, marketing produce and by ranking of information needs.

Profile of the Respondents

Data were collected from 120 farmers located in two villages. Respondents belong to different castes like Kumbi, Patil, Dhangar and Vanjari, Mahar and Mang. The name OC is used to refer to these castes because all these castes are the dominant castes in the region. The status of dominant caste comes from the large land holdings the castes own in these villages. These castes are also politically dominant. Table 1 suggests that apart from the respondents belonging to OC (35 per cent) respondents from SC, BC and NT are also included in the study.

Table 1: Caste wise distribution of respondents

Caste	No. of respondents (%)
Other castes (OC)	42(35)
BC	22(18)
S C	31(26)
Nomadic Tribes (NT)	25(21)
Total	120

OC= Upper caste, BC = Backward caste, SC = Scheduled caste (Dalit) and NT = Nomadic Tribe

Landholding pattern among respondents

The size of land holding plays a crucial role in accessing agricultural information, credit, and in the commercialization and mechanization of agriculture. A majority of the respondents included in the study belong to the marginal and small farmer category. Table 2 suggest that about sixty one per cent of the respondents own less than five acres of land. About five per cent of the respondents include farmers belonging to the large farmers' category and 67 per cent respondents belong to OC category who own more than five acres of land each, whereas a large majority of the SC and NT farmers (84 per cent and 72 per cent respectively) own less than five acres each. Out of 31 SC farmer respondents 17 (55 per cent) are marginal farmers. One respondent belonging to the NT category reported owning more than 25 acres of land. Data also reveals that the majority (59 per cent) of the total land holdings is marginal and small.

Table 2: Landholding pattern

Type of land holding	Number of respondents (%)
Marginal (below one 1 ha.)	43 (36)
Small (1 to 2.0 ha.)	28 (23)
Semi-Medium (2 to 4 ha.)	26 (22)
Medium (4 to 10ha.)	17 (14)
Large (above 10 ha.)	6 (5)
Total	120 (100)

Education

India's rural population is characterized by significantly lower levels of education. Data on the educational profile of the respondents of the field site suggests that about 25 per cent of the respondents have no formal education. Out of these 25 respondents 22 (88 per cent) belong to SC and NT categories. A large majority of the OC farmer respondents is educated

Table 3 : Caste and Education level among the respondents.

Caste	No. of respondents (%)					
	No formal Education	Primary	Secondary	High School	Above 10th	Total
OC	4 (10)	7 (17)	13 (30)	7 (17)	11 (26)	42 (100)
BC	3 (13)	7 (32)	6 (27)	1 (5)	5 (23)	22 (100)
SC	16 (51)	3 (10)	3 (10)	0 (0)	9 (29)	31 (100)
NT	16 (64)	2 (8)	3 (12)	1 (4)	3 (12)	25 (100)

Table 4 : Advice on field problems.

Caste	No .of respondents (%)						
	Neighbors	AO.	Call centers	Input dealers	Sanchalak	Multiple Sources	Total
OC	4 (10)	4 (10)	0 (0)	10 (24)	22 (52)	2 (4)	42 (100)
BC	0 (0)	0 (0)	0 (0)	10 (45)	7 (32)	5 (23)	22 (100)
SC	5 (16)	0 (0)	0 (0)	15 (48)	4 (13)	7 (23)	31 (100)
NT	0 (0)	0 (0)	0 (0)	3 (12)	20 (80)	2 (8)	25 (100)

beyond secondary school. Table 3 suggests that there is a marked difference in the levels of education along caste lines.

‘It is reported by the famers who belongs to SC and NT community that education is one of the important factors to access the information provided by the e-Choupal or by any other agricultural extension services. As they are illiterate, they couldn’t access the updated information and they are unable to question the queries regarding the new agricultural practices. Hence they couldn’t adopt the new practices and innovative methods. Agricultural officials are also not interested to provide information to the illiterate farmers. They are often discriminated at agricultural meetings. Even though illiterate farmers are interested in adopting new technologies but they are not encouraged to adopt new agricultural practices. Illiterate farmers are often deceived by the traders and agents. However, it is said that the initiative developed by ITC-IBD doesn’t make any difference from their former situation. Illiterate farmers stated that Sanchalak informs only about the price of soyabean, he is also not interested in disseminating agricultural information. Only the educated and large land holding farmers can easily access the agricultural information and adopt new technologies’.

Table 4 presents the data regarding the agricultural information received by the famers through various means. OC farmers (52 per cent) and NT farmers (80 per cent) depend on Sanchalak for information while

the majority of the BC and SC farmers depend on input dealers for information.

It is reported by one of the farmer who belongs to SC community that ‘he usually seeks agricultural advice from their neighbours who are from the same community. He also stated that majority of houses of their community is far from Sanchalak’s house. It is very hard for them to visit Sanchalak’s house regularly. He said that neither he seeks any kind of information or advise from the Agricultural officer’s normakes a call to the call center due to lack of awareness. Further, he reported that majority of Dalit (SC) farmers possess small land holdings and non-irrigated lands. Due to this reason, the Agricultural officers and other agricultural bureaucratic officials never visit agricultural fields. He said that usually he attends and participates in most of the gatherings or meetings and interact with the farmers who belong to same community. From this narration it is evident that caste and education profile are the key factor in accessing agricultural advice and governmental schemes’.

Table 5 makes it clear that 96 per cent of the respondents sell their produce at the e-Choupal procurement hub. When the reasons for such a shift from traditional market to e-Choupal hub were ascertained from the respondents, it was found that e-Choupal procurement system is hassle-free transparent and has an immediate payment system. Farmers observe that e-Choupal services are better than local mandis as the transactions in local mandis are secretive and exploitative. It is said that while the

Table 5 : Marketing the produce.

Caste	No. of respondents (%)			
	(ITC-IBD)	Middlemen	Local Market (nearby towns)	Total
OC	42 (100)	0 (0)	0 (0)	42 (100)
BC	22 (100)	0 (0)	0 (0)	22 (100)
SC	30 (25)	1 (1)	0 (0)	31 (100)
NT	22 (100)	0 (0)	3 (3)	25 (100)

Table 6 : Caste wise ranking of information needs.

Rank	Farmers' information needs	No. of farmers (%)			
		OC	BC	SC	NT
1.	Procurement of the produce	42(100)	19(86)	15(48)	22 (88)
2.	Latest agricultural practices	40 (95)	10 (45)	13 (41)	11 (44)
3.	Input services	40 (95)	11 (50)	11 (35)	9 (36)
4.	Access to the Sanchalak of e-Choupal	37 (88)	7 (32)	4 (13)	11 (44)
5.	Market information and price trends	37 (87)	20 (91)	13 (41)	18 (72)
6.	Export of produce	33 (79)	10 (45)	9 (29)	7 (28)
7.	Solution to the problems in cultivation	33 (79)	16 (72)	5 (16)	7 (28)
8.	Reduce the cost of cultivation	33 (79)	9 (41)	13 (42)	15 (60)
9.	Weather Forecast	33 (78)	12 (54)	12 (38)	10 (40)
10.	Soil testing	28 (66)	7 (32)	6 (19)	9 (36)
11.	Crop Insurance	27 (64)	18 (81)	9 (29)	11 (44)
12.	Field trails	19 (45)	1 (1)	0 (0)	4 (16)
13.	Information on crop loans	18 (42)	18 (81)	25 (80)	17 (68)
14.	Advices from scientists	14 (33)	9 (40)	5 (16)	6 (24)
15.	Government policies	13 (30)	17 (77)	9 (29)	8 (32)

mandi traders pay the amount in instalments or pay after a few months e-Choupal allows them to collect cash immediately. Moreover mandi collects a fee from farmers. Many farmers stated that at the local mandi, the marketing process is very complex and unfair, whereas in e-Choupal it is transparent and the loading and unloading charges are paid by e-Choupal itself.

Table 6 highlights the varied priorities among farmers. The variation in the priorities may be explained in terms of caste. Caste is a key social institution which plays an important role in agriculture. This is because caste determines the extent of social capital farmers have. The anxieties of BC, SC and NT farmers, for example, about the information on crop loans, crop insurance and knowledge about practices related to reducing the cost of cultivation are not the priorities of the OC farmers. The OC farmers who were the first beneficiaries of green revolution have required knowledge about crop loans, crop insurance, etc.

whereas the BC, SC and NT farmers who lack the social capital and who entered into commercial agriculture recently feel the necessity of seeking information on those issues which add risk to agriculture. Table 6 suggests that except on marketing the produce and price trends there is a common feeling across castes, other information priorities do not match with each other. This finding highlight the fact that the information accessed by the farmers are not uniform and vary based on the caste and land holdings.

Small farmer who belongs to SC community stated that 'he needs information regarding the government policies like loan waive and subsidies. It is stated that majority of small and marginal farmers are interested in knowing the monetary policies which benefits them directly. He also stated they least bothered about the scientific agricultural practices and new techniques of cultivation. Quite interestingly he stated that he benefitted from the e-Choupal as he use to sell his

soyabean to the middleman earlier but with e-Choupal set up at his village he sold soyabean at ITC hub. He completed his procurement process within five hours and amount paid immediately to him by the ITC. He also said that, the interaction between sanchalak and SC farmer takes place only during the time of procurement. Information needs differ from person to person and he stated that e-Choupal is not providing holistic information to the farmers'. It is quite interesting to know that farmers irrespective of caste are informed regarding the price of soyabean during the procurement. Even sanchalak encourages each farmer to sell their produce at e-Choupal as he receives commission for every transaction.

FINDINGS

Success and failure of ICT projects in rural areas can allow us to engage with some of the emic meanings of technology. In case of e-Choupal, Sanchalak is one of the farmers of the village and a key functionary in e-Choupal. e-Choupal kiosk at the village level is maintained by the Sanchalak. In the process of organizing the e-Choupal, Sanchalak is a catalyst in disseminating agricultural information. Most of the Sanchalaks employed by e-Choupal belong to the upper castes. The Sanchalak may be compared with the progressive farmer notion of the conventional/traditional extension system. If the agricultural scientists and extension officials relied on progressive farmers for information dissemination under the conventional extension system the e-Choupal model emphasizes on the role of the Sanchalak. The socioeconomic characteristics of the Sanchalak and the progressive farmer are same. Although the functions of the Sanchalak are slightly different from that of the progressive farmer, structurally both the positions operate similarly.

The present study observes that the design and usage of ICT is greatly influenced by the non-state actor whose interests lie in agriculture. It may also be observed that the new technological initiatives seldom bother about breaking the old structures rather they work with the existing structures. ICTs are used as a new medium of intermediary to hold the structural relations. Thus, it is understood that the ICT-IBD initiative doesn't replace or weaken the old hierarchy rather maintain in a new avatar strengthens. The assumption in the design of e-Choupal that information accessed by the literate farmers would be shared with the non-literate farmers

appear to be problematic as the social structural impediments block such information flow between upper and low caste farmers. It is said that the establishment of e-Choupal has increased the income of the farmers by reducing the cost of marketing the produce (transportation and baggage costs) and by providing quick and transparent process of sale.

One of the consequences of e-Choupal is that the government agricultural extension services have become non-functional in the villages where e-Choupal kiosks are set up. Since the requirements of the farmers in the villages are taken care by e-Choupal, the state agricultural department officials have stopped visiting the villages. Moreover, e-Choupal is primarily interested in procurement of soyabean, the information requirements of farmers for other crops are being affected by the absence of state extension services in the villages. It also observed that e-Choupal being a private initiative farmer cannot demand services from it. In fact, since the e-Choupal being driven by profit motive, it doesn't bother much about the issues concerning biodiversity and environmental risks. It promotes the crops in which it has commercial interests. Due to the favourable market for soyabean, the majority of the small and marginal farmers have given up cultivating traditional crops like jowar, tur and sorghum. In fact, it was observed to be reinforcing the old hierarchies that operate in the agrarian social relations.

CONCLUSION

According to (52) and (55), new technologies lead new forms of hegemony of technology. It has given no space to understand the role of broader socio-cultural forces or the classical relations of power through caste, class and gender. The emergence of global capitalism shifts the balance of class forces towards capital and as a result the relative autonomy of state declines. The state is retreating from its welfare commitments on one hand, and it aggressively intervenes in favour of global capital on the other. Thus, the role of the state is taken a back seat, vacating public spaces hitherto prominently occupied by it. As it is discussed, green revolution is directed by capitalist, in the same line ICTs initiatives intended for globalized economic interests. Thus, the present study suggests that ICTs are shaped by structural forces and are deeply embedded in the social and economic milieu. The discourse on information and communication technologies and development has

engendered the digital divide as a binary divide (44) have ethnographically demonstrated that much of the ICT literature suffers from macro- level assumptions about technology and/or development, which make complex grass-roots experiences of ICTs more inaccessible. It is one of the common findings encountered by researchers that the benefits of social development are distributed unequally. In other words, those who are in relatively higher status get the maximum benefit of social development and the vice versa. Thus, programmes for social development always end up in only benefiting privileged section of the society. In case of Internet technology, it is continuously diffusing around the world but they enter in different social contexts and behave differently (Castells 2000).

ICTs, similar to other technologies are politically neutral. However, the social embeddedness of ICTs becomes problematic. The design for use and the design to use are problematic for the scholars engaged in the social studies of science and technology. The ICT initiative in agricultural extension is designed in such a way that it has to be mediated by individuals. As far its operationalization is concerned, e-Choupal is to be mediated by the Sanchalak. Not only the social structural forces that influence the selection of Sanchalak is problematic, but the demand e-Choupal's web portal places on its users, say farmers of the village where e-Choupal kiosk is set up is the concern. The information on the web portal is available in Hindi and in local languages and accessing it needs some amount of computer literacy on the part of the users. Thus its direct access to a non-literate farmer is limited.

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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE STUDY IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

The present investigation consists of seventeen Wheat genotypes and the experiment was conducted during Rabi-2016- 2017 and 2017-2019 in Randomized Block Design with three replications. The experiment consisted of 17 parents (13 lines and 4 testers) and 52 F₁s developed from line x tester mating design (13 x 4). The data were recorded on 14 quantitative characters (12 agronomical and 2 quality characters) viz; days to 50% flowering, days to maturity, plant height (cm), spike length (cm), spikelets per spike, productive tillers per plant, grains per spike, flag leaf area (cm²), biological yield per plant (g), grain yield per plant (g), harvest index (%), 1000 grain weight (g), gluten content (%) and ash content (%). The data were recorded for 15 quantitative characters to study genetic variability, heritability and genetic advance. On the basis of mean performance, high Plant height was exhibited by different genotypes. Analysis of variance among 17 genotypes showed significant differences for all traits studied. Highest genotypic coefficient of variation (GCV) & phenotypic coefficient variation (PCV) was observed for Grain Yield/Plant followed by Plant Height, Harvest Index and Ash Content indicating that these characters could be used as selection for crop improvement. On the basis of high estimates of heritability coupled with high genetic advance was observed for Plant Height, Biological Yield/ Plant, Harvest Index and Grain Yield/Plant indicating predominance of additive gene effects and possibilities of effective selection for the improvement of these characters.

Keywords : Bread Wheat, *Triticum aestivum*, Genetic variability, Heritability and Genetic Advance.

INTERODUCTION

Wheat (*Triticum aestivum* L.; 2n=42) is a self-pollinated crop belong to *Poaceae* family and one of the most leading cereal of world including India. It is the most important food crop of India and is a main source of protein and energy. Wheat is an important Rabi season crop extensively grown as under irrigated condition. Yield is complex character which dependent on the various yield contributing traits. Thus the study of correlation between yield and its component is of primary importance in formulating the selection criteria under crop improvement. Selection of any desirable trait is generally preformed based on the phenotypic value of the plants (22). It is a C₃ plant grown in temperate, irrigated to dry and high-rain-fall areas and in warm, humid to dry, cold environments. . In India, wheat is the second most important food crop after rice both in terms of area and production. It is grown on an area of 30.23 m ha with a production of 95.90 million tons and productivity of 3144 kg /ha. In

Uttar Pradesh, wheat is grown on an area of 9.65 m ha with a production of 26.87 million tonnes and productivity of 2785 kg /ha (Agriculture statistics at a glance 2016). Total production of wheat in the world is around 751.99 m tonnes covering an area of about 222.16 m ha and productivity of 3.38 mt/ha. (38). In crop improvement, only genetic component of variation is important since only this component is transmitted to the next generation. The extent of contribution of genotype to the phenotypic variation for a trait in a population is ordinarily expressed as the ratio of genetic variance to the total variance, *i.e.*, phenotypic variance, for the trait; this is known as heritability. However, when we are dealing with segregating generations, the genetic variance consists of additive and dominance components. Since in self-pollinated crops we develop homozygous lines, the dominance component will not contribute to the phenotype of homozygous lines derived from a population. Consequently, in such cases, only the additive component of the genetic variance is relevant.

Therefore, for the segregating generation, the ratio of additive component of variance to the total phenotypic variance is a more appropriate estimate of heritability; this is referred to as narrow sense heritability. The researcher is able to appreciate the proportion of variation that is due to genotypic (broad sense h^2) or additive (narrow sense h^2) effects, that is, the heritable portion of variation in the first case, and the proportion of genetic variation that is fixable in purelines in the latter case. Hence in present investigation an attempt was made to assess the variability on grain yield and biological yield contributing traits which indicating genetic variability.

MATERIAL AND METHODS

The present investigation was carried out with 17 parents and 52 F_y's developed from line x tester mating design. The parental genotypes with these lines and testers (13 lines and 4 testers) were grown in RBD with three replications during *rabi*, 2015-2016 and 2016-17 at Crop Research Center (Chirodi Block) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The wheat crop was recommended packages of practices were followed with seventeen genotypes viz. K-9107, K-6525, HD-3076, MP-4010, RAJ-4246, K-9434, HD-3095, HD-2864, PBW-984, K-607, K-802, UP-2325, HUW-658, K-9423, PBW-533, DBW-71 and K-9267 of bread wheat during *Rabi*- 2015. Observations were recorded on five randomly selected plants in each genotype and replication for fifteen traits. These attributes were computed on basis of mean data after computing for each observation was subjected to standard method of analysis of variance following (24) phenotypic and genotypic coefficient of variation, heritability (BS and NS) and genetic advance as percent of mean were estimated by the formula al suggested by (8) and (19).

RESULTS AND DISCUSSION

The existence of genetic variability in the population provides ample opportunities for selection being effective. Genetic variability in any crop is pre-requisite for selection of superior genotypes over the existing cultivars. The analysis of variance for different characters indicated the existence of highly significant differences for all the fourteen traits study at 1% level of significance suggesting each and every genotype are genetically divergent from each other and

Table-1: Analysis of variance for different characters in bread wheat (*Triticum aestivum* L.)

Source of variation	DF	Days to 50% Flowering	Days to maturity	Plant height (cm)	Flag Leaf Area (cm ²)	Productive Tillers/Plant	Spike Length (cm)	Spikelets/Spike	Grains/Spike	Biological Yield/Plant (gm)	Grain Yield/Plant (gm)	Harvest Index (%)	1000 grain weight (gm)	Gluten Content (%)	Ash Content (%)
Replication	2	1.057	1.454	0.536	0.994	1.026	0.281	1.298	0.299	1.538	0.423	3.158	1.265	0.054	0.040
Treatments	68	9.349***	11.038***	496.615***	20.330***	0.786***	0.474***	3.012***	36.521***	93.698***	63.914***	85.636***	18.359***	0.466***	0.038*
Error	136	1.665	1.262	1.409	1.933	0.315	0.222	0.503	1.724	1.467	1.255	3.200	0.839	0.090	0.025
Total	206	12.071	13.754	51.606	23.257	2.127	0.977	4.813	38.544	96.703	65.592	91.994	20.463	0.61	0.103

*** Significant at 5% and 1% probability level respectively.

Table-2 : Estimates of components of variance, degree of dominance, additive and dominance components and heritability (narrow sense) for 14 characters in bread wheat (*Triticum aestivum* L.).

Characters	Grand mean	Range	S.E.	PCV (%)	GCV (%)	Heritability (%)		GA (5%)	Gen. Adv. as %
						Broad sense	Narrow sense		
Days to 50% Flowering	91.58	87.00-96.33	0.73	2.25	1.75	60.59	30.97	2.57	2.80
Days to Maturity	140.35	136.00-144.66	0.64	1.51	1.29	72.07	54.29	3.16	2.25
Plant Height (cm)	106.03	92.73-136.46	0.68	12.17	12.12	99.15	97.86	26.35	24.86
Flag Leaf Area (cm ²)	38.07	32.06-48.51	0.79	7.46	6.50	76.03	39.01	4.45	11.68
Productive Tillers/Plant	10.02	8.60-10.80	0.32	6.86	3.95	33.20	10.86	0.47	4.69
Spike Length (cm)	10.78	9.10-11.50	0.27	5.14	2.69	27.46	14.22	0.31	2.90
Spikelets/Spike	21.12	18.46-23.40	0.40	5.48	4.33	62.41	32.96	1.49	7.05
Grains/Spike	68.97	58.63-75.16	0.75	5.29	4.94	87.06	19.36	6.55	9.49
Biological Yield/ Plant (gm)	65.39	51.20-73.80	0.69	8.68	8.48	95.44	14.97	11.16	17.06
Grain Yield/Plant (gm)	31.39	21.69-40.63	0.64	14.99	14.56	94.33	15.15	9.14	29.13
Harvest Index (%)	47.96	33.51-60.67	1.02	11.55	10.93	89.57	22.57	10.22	21.31
1000 grain weight (gm)	46.13	40.76-50.09	0.52	5.60	5.24	87.43	25.76	4.65	10.09
Gluten Content (%)	8.87	8.30-9.96	0.17	5.24	4.00	58.07	20.28	0.56	6.27
Ash Content (%)	1.52	1.28-1.78	0.09	11.36	4.33	14.52	6.66	0.05	3.40

there is ample scope for selection of attributes from these diverse sources for yield and its components (Table 1). The pool of genotypes was therefore, assessed for variability analysis. The existence of wide diversity among the constituent genotypes with regard to characters under study was confirmed through various statistical parameters. These findings were in accordance with the findings of (22). A wide range of variance was observed for all the traits. In general the phenotypic coefficient of variance was higher than genotypic coefficient variance for all yield and its contributing observations indicate the influence of environmental factors on these characters. The basic material, therefore offers positive opportunities for investigation furtherance of the aforesaid objectives. The estimates of mean, range, variability, heritability (Broad sense) and genetic advance in per cent of mean presented for F₁ generations in Table- 2. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) ranged between (1.28 and 1.78) to (136.00 and 144.66) for ash content and days to maturity respectively. The highest GCV and PCV was recorded for grain yield/plant (14.99 and 14.56) followed by plant height (12.17 and 12.12), harvest index (11.55 and 10.93), ash content (11.36 and 4.33), biological yield/ plant (8.68 and 8.48), flag leaf area (7.46 and 6.50), productive tillers/ plant (6.86 and

3.95), 1000 grain weight (5.60 and 5.24), Spikelets/spike (5.48), grains/ spike (5.29) and gluten content (5.24) attributes. Similar results were also reported by Kumar *et al.* (2017). Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV is presenting Table-2 among the all traits and high values of GCV and PCV for these traits suggested the possibility of yield improvement through selection of these characters. Closely relationship between GCV and PCV was found in all the attributes and PCV values were slightly greater than GCV, observing very little influence of environment for their expression. The amount of genetic variation considered alone will not be of much use to the breeder unless supplemented with the information on heritability estimate, which gives a measure of the heritable portion of the total variation. It has been suggested by (8) that the GCV along with heritability estimate could provide a better picture of the amount of advance to be expected by phenotypic selection. Since genetic advance is dependent on phenotypic variability and heritability in addition to selection intensity, the heritability estimates in conjunction with genetic advance will be more effective and reliable in predicting the response to selection. Heritability in broad sense includes both additive and non-additive gene effects. While, narrow

sense heritability includes only additive components. In the present study, heritability in broad sense was estimated. Highest heritability in broad sense (> 60%) was recorded in the case of plant height (99.15), biological yield per plant (95.44), grain yield per plant (94.33), harvest index (89.57), 1000 grain weight (87.43), grains per spike (87.06), flag leaf area (76.03), days to maturity (72.07), spikelets per spike (62.41) and days to 50% flowering (60.59). However, moderate heritability (30-60 %) was observed for 2 characters viz; gluten content (58.07) and productive tillers per plant (33.20) whereas, low heritability (<30) was observed for 2 characters like spike length (27.46) and ash content (14.52). The high heritability denotes high proportion of genetic effects in the determination of these characters and can be adopted for improving yield per plant. Studied have been reported earlier also by (3, 4, 5, 16, 22, 28). Maximum genetic advance expressed as percentage of mean was observed high (>20%) for grain yield per plant (29.13) followed by plant height (24.86) and harvest index (21.31). Characters viz; biological yield per plant (17.06), flag leaf area (11.68) and 1000 grain weight (10.09) exhibited moderate genetic advance (10-20%). High heritability (h^2) coupled with high genetic advance was observed for Grain Yield/Plant, Plant Height, Biological Yield/ Plant, Flag Leaf Area and 1000 grain weight. High heritability coupled with high genetic advance for some of these traits have also been observed earlier by (3, 4, 5, 16, 22, 28). This indicates substantial contribution of additive genetic variance in the expression of these attributes and can be more useful in hybridization and selection for higher grain yield and these characters are largely controlled by additive gene action.

CONCLUSION

In the present investigation which included 17 genotypes of bread wheat was carried out in order to study the nature and amount of variability, heritability and genetic advance for 14 quantitative/polygenic traits. In this study illustrated the existence of wide ranges of variations for most of the trait among the bread wheat genotypes and opportunities of the genetic gain through selection or hybridization. Hence, improving one or more of these attributes could result in high seed yield for wheat. Analysis of variance among 17 genotypes showed significant difference for all characters under studied. Highest genotypic

coefficient of variation (GCV) & phenotypic coefficient variation (PCV) was observed for Ash Content and days to maturity respectively. The highest GCV and PCV was recorded for Grain Yield/Plant followed by plant height, harvest index, ash content, biological yield/ plant, flag leaf area, productive tillers/ plant, 1000 grain weight, spikelets/ spike, grains/ spike and gluten content that these traits could be used as selection for crop improvement. High heritability coupled with high genetic advance as percent of mean estimated for grain yield/plant, plant height, biological yield/ plant, flag leaf area and 1000 grain weight indicating predominance of additive gene effects and possibilities of effective selection for the improvement of these attributes.

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IMPACT OF INTEGRATED NUTRIENT MANAGEMENT ON FRUIT QUALITY AND LEAVES NUTRITIONAL STATUS OF LEMON (*CITRUS LIMON* BURM) CV. PANT LEMON-1 IN SANDY LOAM SOIL UNDER WESTERN UTTAR PRADESH CONDITIONS

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ABSTRACT

The present orchard experimental trail was carried out to find out the impact of integrated nutrient management on fruit quality and leaf nutrient status of lemon cv. Pant Lemon-1 in sandy loam soil under Western Uttar Pradesh conditions at Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut during summer season of 2011-12 and 2012-13. The maximum TSS (5.794 & 5.928), acidity (5.828 & 5.900 %) and ascorbic acid (52.06 & 52.44 %) were recorded under the treatment consisting of 75% NPK (315g N+ 210g P+315g K) + 10 kg NC + 200g PSB + 200g Azotobacter during the both years of investigation, respectively. This treatment also recorded superiority in leaves nutrient status like nitrogen content in leaves (3.415 & 3.527 %), phosphorus content in leaves (0.245 & 0.251 %) and potassium content in leaves (2.105 & 2.141 %) during the both years of investigation, respectively. High ascorbic acid and acidity recorded in autumn flush as compared to spring flush while less TSS observed in autumn flush as compared to spring flush.

Key words : Pant Lemon-1, NPK, FYM, Vermicompost, Neem cake, PSB and azotobacter.

INTRODUCTION

Among all the fruits in India, citrus have second rank in which citrus fruits are the third important fruit next to mango and banana. The important citrus species commercially grown in India are mandarin (*Citrus reticulata*) followed by sweet orange (*Citrus sinensis*) and acid lime (*Citrus aurantifolia*), sharing the area 41, 23 and 23 per cent, respectively, of the total production of all citrus fruits (16). Among the Rutaceae family, Lemon (*Citrus limon* Burm) is one of the most important fruit crops. Under Western Uttar Pradesh conditions, lemon has been found to be the most suitable citrus fruit due to its adaptability and high market demand throughout the year. Among several cultivars of lemon, Pant Lemon-1 is the most promising cultivar. Lemon is a good source of citric acid, which is used for pharmaceutical purposes and for aerated water. In recent years, the quick and substantial response to fruit production due to mineral fertilizers eclipsed the use of organic manures; the inadequate supply of the litter sources exacerbated this change (8). However, these fertilizers are energy intensive and costly. Moreover, extensive use of chemicals fertilizers has resulted deterioration of soil

fertility and health as well as reduced the organic matter content and beneficial soil microorganisms also. For sustainable fruit production, integrated nutrient management play a vital role to enhance the quality production of fruits at low inputs by using organic, inorganic and bio-fertilizers. Organic manures supply important plant elements, favour aggregation of fine soil particles, thereby promoting good soil structure and it is also essential for development of soil micro-organisms which farther carry out biochemical transformations, play active role in decomposing organic matter and help in releasing the essential plant nutrients. On the other hand organic manure are considered as bulk manure and they may not full fill the whole requirement of macro plant nutrients for the proper growth and development of plant. So, there is a need to use judicious combination of organic and inorganic fertilizers for the sustainable fruit production. Besides sustainable fruit production, all round improvement in physical, chemical and biological make up of soils is the main aim of integrated nutrient management (3).

MATERIALS AND METHODS

The experiment was conducted at the Horticultural Research Center of Sardar Vallabhbhai Patel

University of Agriculture and Technology, Meerut, 250110 (UP) during the two consecutive years i.e.; 2011-12 and 2012-13. The treatments involved in the study were 11 in numbers i.e. T₁ RDF (420g N + 280g P + 420g K) + 35kg FYM, T₂ 100% NPK (420g N + 280g P + 420g K) + 15kg VC, T₃ 75% NPK (315g N + 210g P + 315g K) + 20kg VC, T₄ 100% NPK (420g N + 280g P + 420g K) + 5kg NC, T₅ 75% NPK (315g N + 210g P + 315g K) + 10kg NC, T₆ 50% NPK (210g N + 140g P + 210g K) + 15kg VC + 10kg NC, T₇ 100% NPK (420g N + 280g P + 420g K) + 15kg VC + 200g PSB + 200g Azotobacter, T₈ 75% NPK (315g N + 210g P + 315g K) + 25kg VC + 200g PSB + 200g Azotobacter, T₉ 100% NPK (420g N + 280g P + 420g K) + 5kg NC + 200g PSB + 200g Azotobacter, T₁₀ 75% NPK (315g N + 210g P + 315g K) + 10kg NC + 200g PSB + 200g Azotobacter, T₁₁ 100% NPK (420g N + 280g P + 420g K) + 35kg FYM + 200g PSB + 200g Azotobacter per tree and the experimental design was laid out in factorial randomized block design (FRBD) with three replications. Eleven year old uniform lemon trees were selected for the experimentation. All the trees were maintained under uniform cultural practices during the course of investigation. The organic manure like FYM was incorporated in the lemon trees two weeks before fertilizers application, where as vermicompost, neem cake, PSB and azotobacter were mixed with soil prior to one week of fertilizers application. The fertilizers were applied separately in each tree in a ring made around the tree (60cm away from the tree trunk). The fertilizers were mixed thoroughly into 20 cm depth of soil according to treatment wise. Full dose of FYM, vermicompost, neem cake, P and K and half dose of N were applied in October and remaining half dose of N was applied in April-May during The experiment was conducted in lemon orchard during 2011-12 and 2012-13. TSS of the juice was determined with the help of digital pocket refractometer. For the analysis of N, P and K in leaves, the leaf samples were collected between 8-10 A.M. to reduce variability. The standard procedure for washing, drying, grinding and storage of leaves were followed before chemical analysis. Total nitrogen in leaves was determined by Micro-kjeldahl method (9) and phosphorus determined by “Vando- molybdo-phosphoric yellow colour method” as described by (9). Similarly total potassium in leaves samples was determined with the help of ‘Flame-photometer’ (9).

RESULTS AND DISCUSSION

Fruit quality parameters and leaf nutrient status were

significantly influenced by integrated nutrient management under autumn and spring flush in two years of study of lemon. Results obtained from the present study revealed that different treatments had significant effect on TSS, ascorbic acid and acidity and N, P and K status of leaves (Table-1 and Table-2). Combined application of 75% NPK (315g N + 210gP+315g K) +10 kg NC+200g PSB+200g azotobacter (T₁₀) produced maximum value of TSS (5.794 & 5.928 °B), while minimum under (RDF) treated plants in both the years, 2011-12 and 2012-13 respectively. (13) reported that the application of 50% recommended fertilizer dose (RDF) + 50% FYM resulted in the highest TSS content (6.08%) and Ascorbic acid content (26.76 mg/100g). The higher TSS might be due to improvement in the metabolic and enzymatic activity during fruit formation and maturity, which might have triggered the process related to quality as reported by (10) and (11). The trees receiving 75% NPK (315g N + 210gP+315g K) + 10kg NC+200g PSB+200g azotobacter (T₁₀) dose gave maximum acidity (5.828 & 5.900 %) in lemon fruits and minimum in RDF (5.014 & 5.065 °B) during both the years of investigation respectively. These findings are in agreement with the results obtained by (5). Similar results also have been reported by (14) and (7) they informed that nitrogen and potassium gave maximum acidity in all flushes of fruits of citrus cultivars. This may be due to the application of organic manures reduces the soil bulk density, increase the porosity of the soil and EC etc., it favored physical property of soil resulted aeration and moisture. Similarly, the maximum ascorbic acid (52.06 & 52.44 %) was determined with the application of 75% NPK (315g N + 210gP+315g K) + 10 kg NC+200g PSB+200g azotobacter, which was found similar with 75% NPK (315g N + 210gP+315g K) +25 kg VC+200g PSB+200g azotobacter in autumn flush and spring flush as compared to RDF. The humic and fulvic acid fractions in the soil organic matter contributed by the organic sources would have probably formed water soluble complex with the micronutrients, thereby, increasing their availability as well as uptake, which resulted in better quality of fruits. The results reported in the present study were also supported by (13). The improvement in quality of fruit may be due to improvement in the soil physical properties, water holding capacity, structure, porosity, bulk density, hardness, chemical properties i.e. nutrient status, soil pH, hormone and biological properties i.e. bacteria,

Table-2 : Impact of integrated nutrient management on leaves nutritional status of lemon (*Citrus limon* Burm) cv. Pant Lemon-1 in Sandy Loam Soil under Western Uttar Pradesh conditions.

Notati on	Nitrogen content in leaves (%)				Phosphorus content in leaves (%)				Potassium content in leaves (%)									
	2011-12		2012-13		2011-12		2012-13		2011-12		2012-13							
	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean						
T ₁	3.105	2.952	3.029	3.172	3.021	3.097	0.217	0.213	0.215	0.219	0.214	0.217	1.695	2.184	1.940	1.712	2.195	1.954
T ₂	3.193	3.124	3.159	3.215	3.135	3.175	0.221	0.219	0.220	0.227	0.220	0.224	1.709	2.192	1.951	1.724	2.210	1.967
T ₃	3.295	3.185	3.240	3.314	3.204	3.259	0.228	0.226	0.227	0.230	0.228	0.229	1.735	2.219	1.977	1.739	2.225	1.982
T ₄	3.290	3.220	3.255	3.375	3.241	3.308	0.226	0.224	0.225	0.226	0.227	0.226	1.727	2.203	1.965	1.730	2.214	1.972
T ₅	3.311	3.270	3.291	3.341	3.310	3.326	0.230	0.229	0.230	0.234	0.232	0.233	1.754	2.225	1.990	1.764	2.229	1.997
T ₆	3.325	3.300	3.313	3.402	3.371	3.387	0.232	0.232	0.232	0.235	0.236	0.236	1.768	2.230	1.999	1.819	2.240	2.030
T ₇	3.361	3.340	3.351	3.482	3.400	3.441	0.235	0.235	0.235	0.238	0.237	0.238	1.826	2.238	2.032	1.837	2.250	2.044
T ₈	3.407	3.390	3.399	3.513	3.501	3.507	0.244	0.237	0.241	0.248	0.239	0.244	1.880	2.252	2.066	1.895	2.261	2.078
T ₉	3.397	3.370	3.384	3.474	3.474	3.474	0.240	0.237	0.239	0.244	0.240	0.242	1.832	2.247	2.040	1.885	2.255	2.070
T ₁₀	3.430	3.400	3.415	3.561	3.492	3.527	0.250	0.240	0.245	0.257	0.245	0.251	1.947	2.262	2.105	2.010	2.272	2.141
T ₁₁	3.349	3.330	3.340	3.410	3.374	3.392	0.233	0.233	0.233	0.238	0.236	0.237	1.808	2.233	2.021	1.834	2.245	2.040
	Mean	3.315	3.262		3.387	3.320		0.232	0.230			0.236		1.789	2.226		1.814	2.236
CD at 5%	Season	0.045				0.050		0.005				0.006		0.052			0.056	
	INM	0.189				0.207		0.013				0.014		0.120			0.105	
	Season x INM	N/A				N/A		N/A				N/A		N/A			N/A	

fungi, actinomycetes and earthworm activity in soil (4). The superiority of fruits in respect of quality characters in autumn season may be due to the effect of low temperature obtaining at the time of fruits ripening. Low temperature not only retards the excessive loss of respiratory substances (12).

Experimental results pertinent to nutritional status of leaves revealed that season and various INM treatments had significant effect on nitrogen content in leaf. The maximum leaf nitrogen content (3.415 & 3.527 %) was found in plants receiving 75% NPK (315g N+ 210gP+315g K) +10 kg NC+200g PSB+200g azotobacter as compared to RDF (3.029 & 3.097 %) during both years of experiment respectively. The available nitrogen increased with nitrogen application due to fertilizer directly contributing to available nitrogen and it may also enhance the decomposition of organic materials (2). (15) noted that nitrogen application increased nitrogen content in leaves of sweet orange (*Citrus sinensis* Osbeck).

Investigation revealed that 75% NPK (315g N+ 210gP+315g K) +10 kg NC+200g PSB+200g azotobacter gave the maximum phosphorus content in leaf (0.245 & 0.251 %) as compared to RDF (0.215 & 0.217 %) in both the years respectively. The results are in agreement with the findings of (6) and (7), they found that increased phosphorus content of leaves was due to gradual increase in phosphorus application. Interaction effect between season and treatments was also found significant with maximum P content under T₁₀ in autumn season during both the years. Maximum potassium content in leaves (2.105 & 2.141 %) was recorded with 75% NPK (315g N+ 210gP+315g K) +10kg NC+200g PSB+200g azotobacter. This may be due to the augmentation of beneficial soil microbes and their activities, thus increasing availability of major and minor nutrients to the plants (1).

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ROLE OF HERBS IN NON-COMMUNICABLE DISEASES—ASYSTEMATIC REVIEW

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ABSTRACT

Introduction: The non-communicable diseases are the diseases that are not transmissible directly from one person to another. The most common non-communicable diseases that have serious threat on the public health are Hypertension, Diabetes and cancer.

Objective: To describe the therapeutic effects of various herbs and their role in treatment of non-communicable diseases like Hypertension, diabetes and cancer.

Methodology: Review of evidences for the therapeutic effects of various herbs in treatment of non-communicable diseases like hypertension, diabetes and cancer from the various published articles.

Results: Evidences have shown that there is a valuable and proven benefit of various herbs in treatment of non-communicable diseases like hypertension, diabetes and cancer.

Conclusion: Evidences suggests that various herbs in one's diet or other one can have a positive therapeutic effect on the non-communicable diseases like Hypertension, diabetes and cancer. The Physicians should advice their patients about the importance of herbs and their benefits in the Hypertension, diabetes and cancer.

Key words : Herbs, Non communicable disease, Hypertension, Diabetes and cancer.

A non-communicable disease is a disease that is not transmissible directly from one person to another. The most common non-communicable diseases that have serious threat on the public health are Hypertension, Diabetes and cancer.

Non-communicable diseases are the leading cause of death globally. In 2012, they caused 68% of all deaths up from 60% in 2000. (1). There is advancement in the treatment of these ailments with modern drug therapy. But there are disadvantages like drug resistance, adverse effects and even toxicity. Today, many treatments involving medicinal plants are recommended (34). Plants having flavonoids, terpenoids, alkaloids, glycosides can have anti diabetic effects (4).

Diabetes mellitus also referred as hyperglycemia is a complex metabolic disorder resulting from the insulin deficiency or insulin dysfunction. It affects the people in both developing and developed countries. According to statistics, 2.8% of the world's population suffer from this disease and it is expected to increase to more than 5.4% by 2025 (41). Corsolic acid obtained from insulin plants is reported to have anti-diabetic properties (*C. igneus*, *C. pictus*, *C. speciosus*, *C.*

acuminate, *C. pinnatifida*, *C. roseus*, *E. japonica*, *L. angustifolia*, *L. polyphylla*, *T. vulgaris* and *U. molinae*).

Hypertension (HTN) or high blood pressure (BP) is a chronic medical condition in which the BP in the arteries is elevated. It is classified as either primary (essential) or secondary. About 90 to 95% of cases are termed primary HTN, which refers to high BP for which no medical cause can be found. (19). The remaining 5 to 10% of cases, called secondary HTN, are caused by other conditions that affect the kidneys, arteries, heart, or endocrine system (13).

Cancer is one of the major causes of death in the world, and it is the second leading cause of mortality after cardiovascular diseases. Cancer starts with the deformation of a natural cell caused by genetic mutations in DNA. (59). These abnormal cells are reproduced in an abnormal way by asexual reproduction, that is, it ignores signals related to regulation of cell's growth around it and obtain invasion characteristics and cause changes in surrounding tissues (53).

Plants produce a variety of chemicals compounds that apparently have no direct role in the plants growth which are known as Secondary metabolites. They are

Alkaloids, terpenoids, flavonoids, pigments and tannins. These compounds have an excellent anti-inflammatory, anti-cancerous, anti-diabetic, anti-hypertensive, and contraceptive and many other therapeutic benefits.

The aim of this paper is to review the published articles with various evidences on the researches about the therapeutic benefits of various herbs in treatment or prevention of non-communicable diseases like Hypertension, Diabetes and Cancer.

DIABETES

Gurmar : *Gymnema sylvestre* (Asclepiadaceae), popularly known as “gurmar” for its distinct property as sugar destroyer, is a reputed herb in the Ayurvedic system of medicine. The phytoconstituents responsible for sweet suppression activity includes triterpenesaponins known as gymnemic acids, gymnemasaponins, and a polypeptide, gurmarin. The herb exhibits a broad range of therapeutic effects as an effective natural remedy for diabetes, besides being used for arthritis, diuretic, anemia, osteoporosis, hypercholesterolemia, cardiopathy, asthma, constipation, microbial infections, indigestion, and anti-inflammatory. *G. sylvestre* has good prospects in the treatment of diabetes as it shows positive effects on blood sugar homeostasis, controls sugar cravings, and promotes regeneration of pancreas. (57).

Giloy : Guduchi (*Tinospora cordifolia*) is reported as highly potent Pramehahara (anti-diabetic) herb in Ayurveda and Guduchi Satva (GS), popularly known as Giloy is popularly used to treat Paittika type of Prameha. GS prepared from the stem of *T. cordifolia* was evaluated for hypoglycemic and anti-hyperglycemic activity in 18 hour fasted mice. GS was suspended in distilled water and administered to animals at the dose of 130 mg/kg that showed the marginal reduction in blood sugar level (BSL) at all the time intervals in normoglycemic mice. In anti-hyperglycemic activity, administration of GS prior to glucose overload failed to attenuate BSL at all-time interval in comparison to glucose control group. The study concludes that mild hypoglycemic insignificant anti-hyperglycemic activities of GS. (49).

Chiraita : *Swertia chirayita* (Gentianaceae), a popular medicinal herb commonly known as Chiraita, indigenous to the temperate Himalayas is used in traditional medicine to treat numerous ailments such as

liver disorders, malaria, and diabetes and are reported to have a wide spectrum of pharmacological properties. Its medicinal use is well-documented in Indian pharmaceutical codex, the British, and the American pharmacopeias and in different traditional medicine such as the Ayurveda, Unani, Siddha, and other conventional medical systems. The wide-range biological activities of *S. chirayita* are attributed to the presence of a diverse group of pharmacologically bioactive compounds belonging to different classes such as xanthenes and their derivatives, lignans, alkaloids, flavonoids, terpenoids, iridoids, secoiridoids, and other compounds such as chiratin, ophelic acid, palmitic acid, oleic acid, and stearic acid (44, 46).

Tecoma : *Tecomastans* aqueous extract (TAE) is widely used as a traditional antidiabetic remedy in Mexico; the main antidiabetic effect of TAE is due to intestinal alpha-glucosidase inhibition by decreasing the postprandial hyper-glycaemia peak (5).

Bel : *Aegle marmelose*, which is very commonly known as Bel fruit, on oral administration of the aqueous extract derived from *Aegle marmelose* fruit (125 and 250 mg/kg) in streptozotocin diabetic Wistar rats twice daily for approximately 4 weeks caused a significant decrease in blood glucose, plasma thiobarbituric acid reactive substances, hydroperoxides, ceruloplasmin, alpha-tocopherol, and a considerable increase in plasma reduced glutathione, and vitamin C. The use of a 250 mg/kg dose of the extract was more effective than glibenclamide in the improvement of these parameters. In this research, results clearly show the hypoglycemic activities of *Aegle marmelose* extract.

Jamun : *Syzygium cumini* commonly in India known as Jamun. Its seed extract is composed of many phytochemicals, such as triterpenoids, anthocyanins, oleic acid, essential oils, glycosides, saponins, and several members of the flavonoids (e.g., rutin, quercetin, myricetin, and myricitrin). Hence, the observed anti-diabetic effects of *Syzygium cumini* seed extract may be due to a single component or a combination of these components that could have direct or indirect effects on insulin resistance and β -cell function. Jamun stimulates the secretion of pancreatic insulin. Jamun administration is reported to restore the architecture of the pancreatic β -cell in diabetic experimental animal cells. (28, 50).

Bitter Gourd : *Momordi cacharantia* (*M. charantia*), also known as bitter melon, karela, balsam pear, or bitter gourd, is a popular plant used for the treating diabetes-related conditions amongst the indigenous populations of Asia, South America, India, the Caribbean and East Africa. The main constituents of bitter melon which are responsible for the anti-diabetic effects are triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic compounds. In particular, four triterpenoids have AMP-activated protein kinase activity which is a plausible hypoglycaemic mechanism of *Momordi charantia*.

Apart from the above mentioned herbs, the following herbs also have anti-diabetic effects : *Acacia Arabica* (56), *Achyranthes Aspera* (35), *Acosmium Panamense* (25), *Allium sativum* (garlic) (29), *Aloe barbadensis* Miller (51), *Andrographi spaniculata* (60), *Annona squamosal* (27), *Azadirachta indica* (31), *Coriandrum sativum* (43), *Mangifera indica* (3).

HYPERTENSION

***Agathosma betulina* (Buchu) :** It is a South African medicinal plant and has been used by the indigenous people of the area for centuries to treat wider ailments. It is an effective diuretic and anti-inflammatory agent. Early Dutch settlers used buchu to make a brandy tincture, which is still used today to treat many disorders (52).

***Annona muricata* (Soursop) :** *Muricata* is a member of the family of custard apple trees called Annonaceae and a species of the genus *Annona*, known mostly for its edible fruits *Annona*. The tree grows natively in the Caribbean and Central America. The leaf extract of the plant has been reported to lower an elevated BP by decreasing the peripheral vascular resistance (23).

***Avena sativa* (Oat) :** A diet containing soluble fiber-rich whole oats can significantly reduce the need for antihypertensive medication and improve BP control. Considering the lipid and glucose improvements as well, increased consumption of whole oats may significantly reduce cardiovascular disease risk. (14).

***Blond psyllium* (desert Indianwheat) :** Preliminary clinical research shows that taking a *B. psyllium* (*Plantago* species) supplement 15 g daily can modestly lower BP; systolic by about 8 mmHg and diastolic by 2 mmHg (14).

***Cassia absus* (cassias) :** This plant is found in the tropical region and is found everywhere in India. It has been reported that an intravenous administration of a crude extract of *Cassia absus* produces a dose-related (1-30 mg/kg) decrease in BP, accompanied with a decrease in HR at the higher doses (10 and 30 mg/kg). (15).

***Cassia occidentalis* (coffee senna) :** It is a small tree growing 5 to 8 m in height. The leaf of this plant is used in local folk medicine as an antihypertensive agent. In vitro studies of the leaf extract have shown a relaxant effect on the aortic rings. The studies revealed that cassia extract may be relaxing smooth muscle and reducing BP by inhibiting Ca^{2+} influx through receptor-operated channel and voltage-sensitive channel, showing its non-selectivity on these Ca^{2+} channels. (6).

***Castanospermum austral* (Black Bean) :** Crude extract of *Castanospermum australe* has been reported to cause a fall in systolic as well as diastolic BP in a dose-dependent manner (1-100 mg/kg). This fall in BP has been attributed to the saponin fraction and medicogenic acid glucoside present in the crude extract. (21)

***Crataegus pinnatifida* (Chinese haw) :** It has been used in China as a decoction for treatment of HTN for thousands of years. Pharmacological and clinical trials have shown that it lowers BP. The two main substances that contribute to hawthorn's beneficial effects on heart are flavonoids and oligomeric procyanidins, which are potent antioxidant agents. (39).

CANCER

***Vinka Rosea* :** *Catharanthus roseus* also known as *Vinka rosea* is an important medicinal plant found in various parts of the world. The *Catharanthus* alkaloids have been used in traditional medicine since ages for treating a variety of ailments. The serendipitous discovery of anti-neoplastic property of *Catharanthus* alkaloids in the 1950s has had far reaching effects in clinical oncology and has paved the path for the discovery of a number of plant-derived anticancer drugs. The *Catharanthus* alkaloids are of wide importance in clinical medicine and vincristine (VCR) and vinblastine (VLB) form an essential component of standard chemotherapy regimens. Alkaloids are naturally occurring chemical compounds containing basic nitrogen atoms. Extracts of *Catharanthus* have

Table 1 : Various herbs and their medicinal use.

S. No.	Plant name	Common Name	Used in	Part Used	Picture
1.	<i>Gymnema sylvestre</i>	Gurmar	Diabetes	Leaves	
2.	<i>Tinospora cordifolia</i>	Guduchi	Diabetes	Leaves	
3.	<i>Swertia chirayita</i>	Chiraita	Diabetes	Stem	
4.	<i>Tecoma stans</i>	Tecoma	Diabetes	Flower	
5.	<i>Aegle marmelose</i>	Bel	Diabetes	Fruit	
6.	<i>S. Cumini</i>	Jamun	Diabetes	Leaves, bark and seeds	
7.	<i>Momordica charantia</i>	Bitter Gourd	Diabetes	Fruit	
8.	<i>Agathosma betulina</i>	Buchu	Hypertension	Leaves	
9.	<i>Annona muricata</i>	Annona	Hypertension	Leaves	
10.	<i>Avena sativa</i>	Oats	Hypertension	seeds	
11.	<i>Blond psyllium</i>	Dessert Wheat Indian	Hypertension	Seed husk	

S. No.	Plant name	Common Name	Used in	Part Used	Picture
12.	<i>Cassia absus</i>	Cassia	Hypertension	Seeds	
13.	<i>Cassia occidentalis</i>	Coffee weed	Hypertension	Leaf	
14.	<i>Castanospermum austral</i>	Black bean	Hypertension	Crude extract	
15.	<i>Crataegus pinnatifida</i>	Chinese haw	Hypertension	Fruit	
16.	<i>Catharanthus roseus</i>	Vincarosea	Cancer	Roots and shoots	
17.	<i>Cordyceps sinensis</i>	Entoparasitic fungus	Cancer	Water extracts	
18.	<i>Curcuma longa</i>	Curcumin	Cancer	Stem	
19.	<i>Zingiber Officianate</i>	Ginger	Cancer	Root	
20.	<i>Curcuma Wenjulin</i>	Curcumin	Cancer	Stem	
21.	<i>Vitex negundo</i>	Nirgund	Cancer	Leaves	
22.	<i>T. cordifolia</i>	Guduchi	Cancer	Stem and root	
23.	<i>Crocus sativus</i>	Saffron	Cancer	Flower	

significant anticancer activity against numerous cell types. The greatest activity is seen against multi-drug resistant tumor types, which suggests that there are compounds in *Catharanthus* that work in association with anti-neoplastic elements by inhibiting resistance to them (10).

Entoparasitic fungus : *Cordyceps sinensis*, a fungus that parasitizes on the larva of Lepidoptera, has been used as a valued traditional Chinese medicine. The effects of water extracts of *Cordyceps sinensis* (WECS), has anticancer and anti-metastatic actions. Based on *in vitro* studies, WECS showed an anticancer action, and this action was antagonized by an adenosine A3 receptor antagonist. Moreover, this anticancer action of WECS was promoted by an adenosine deaminase inhibitor. (30).

Curcuma Longa : Curcumin asserts its anti-tumor activity in cancer cells by altering the deregulated cell cycle via (a) cyclin-dependent, (b) p53-dependent and (c) p53-independent pathways. Such influences of curcumin upon key signal transduction pathways of cell cycle and effectiveness in animal model systems have qualified it as a multiple edged sword in combating the deadly disease – cancer. (48)

Zingiber Officinale : Gingers are perennial herbs belonging to the family Zingiberaceae have been widely used as spices, condiments and herbal medicine for treatment of cold, fever, headache, nausea and digestive problems. Ginger and its general compounds such as gingerols, shogaols, paradols and zingerone exert immuno-modulatory, anti-apoptotic, anti-tumorigenic, anti-inflammatory, anti-hyperglycaemic, anti-hyperlipidaemic, antioxidant and anti-emetic activities. The pharmacological actions of ginger leaves, have the anti-cancer activity and elucidate the potential mechanism by which ginger leaves induces the reduction of cell viability and apoptosis in human colorectal cancer cells. (45).

Curcuma Wenyujin : Among various ingredients eligible for adjuvant therapy for gastric cancer, the significance of natural products, particularly the essence extracted from Chinese herbs are gaining increasing attention in basic and clinical research . α -elemene (1-methyl-1-vinyl-2, 4-diisopropenyl-cyclohexane) is a novel anticancer agent extracted from the Chinese medicinal herb *Curcuma wenyujin*. (9).

Nirgund : *Vitex negundo* is a perfect example of medicinal plant credited by numerous medicinal qualities validated by modern science and used since ancient times. It belongs to the family of Verbenaceae, and the genus consists of 250 species and most of them have commercial and medicinal importance. The leaves contain an alkaloid, flavonoids like flavones, luteolin-7-glucoside, casticin, iridoid, glycosides, an essential oil and other constituents like vitamin C, carotene, glucononital, benzoic acid, β -sitosterol and glycoside. VN extract significantly enhanced antioxidant activity and proposed a tumor preventive action against HepG2 cell lines at a dose and time-dependent manner but with lower toxicity toward WRL68 cells. (26).

Guduchi : T. cordifolia (Guduchi) is a large, glabrous, perennial, deciduous, climbing shrub of weak and fleshy stem found throughout India. It is a widely used plant in folk and ayurvedic systems of medicine. The chemical constituents reported from this shrub belong to different classes, such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides. Various properties of *T. cordifolia*, described in ancient texts of Ayurveda, like Rasayana, Sangrahi, Balya, Agnideepana, Tridoshashmaka, Dahnashaka, Mehnashaka, Kasa-swasahara, Pandunashaka, Kamla-Kushta-Vataraktanashaka, Jwarhara, Krimihara, Prameha, Arshnashaka, Kricch-Hridroganashak, etc., are acquiring scientific validity through modern research adopting “reverse pharmacological” approach. Potential medicinal properties reported by scientific research include anti-diabetic, antipyretic, antispasmodic, anti-inflammatory, anti-arthritic, antioxidant, anti-allergic, anti-stress, anti-leprotic, anti-malarial, hepato-protective, immuno-modulatory and anti-neoplastic activities. (58)

Crocus Sativus : Saffron has been found to have non-mutagenic and non-antimutagenic activities against BP-induced mutagenicity. In the *in vitro* colony formation test system, saffron displayed a concentration-dependent inhibitory effect only against human malignant cells (2). (12) demonstrated that *C. sativus* and its major constituent, crocin, significantly inhibited the growth of colorectal cancer cell lines (HCT-116, HT-29, SW-480) and non-small cell lung cancer cell line (NSCLC). However, the extract did not affect non-cancer young adult mouse colon cells

(YAMC) at concentrations used to inhibit malignant cells.

Other Herbs used in treatment of cancer are as follows: Green tea: (20). *Wedelia chinensis* (Asteraceae) (32), *Platycodon grandiflorum* (Campanulaceae), *Morus alba* (Moraceae), *Prunus armeniaca* (Rosaceae), *Rhus verniciflua* (Anacardiaceae), *Perilla frutescens* (Labiatae), *Stemona japonica* (Stemonaceae), *Tussilago farfara* (Compositae), and *Draba nemorosa* (Brassicaceae) (36) *Veratrum californicum* (17), *All Spice*, (7, 33, 47). Basil, (16, 38, 42), Cardamom, (32), Cinnamom, (54), Coriander, (8, 11), Garlic, (40).

CONCLUSION

From many centuries, various herbs are used in treatment of non communicable diseases like Diabetes, Hypertension and cancer in traditional medicine in many countries and their cultures. From the above review it is exemplified that medicinal herbs have various therapeutic benefits and have pharmacological effects. Thus the natural plants and herbs can be used as source of drugs for many non communicable diseases including Hypertension, diabetes and cancer, with fewer side effects and better bioavailability.

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FERTILIZER PRESCRIPTION BASED ON SOIL TEST CROP RESPONSE APPROACH IN MARIGOLD-URD CROPPING SYSTEM GROWN IN SOILS OF UTTARAKHAND

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ABSTRACT

Field experiments were conducted on marigold *Tagetes species* var. (Pusa narangi) and urd *Vigna mungo* var. (Pant Urd-31) during 2013-14 and 2014-15 using Ramamoorthy's inductive methodology for the quantification of soil test and crop requirement based integrated fertilizer prescription of primary nutrients for targeted yield of marigold and urd at Norman E. Borlough Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar. The results of the experiment indicated that 1.06 kg N, 0.34 kg P and 1.32 kg K were required to produce one quintal of marigold flowers in Mollisols of Pantnagar. The contributions (%) of N, P and K from soil for marigold were 26.23, 54.03 and 42.02. Contribution from fertilizer with FYM for marigold was 98.35, 40.25 and 168.68 Percent contribution of nutrient from fertilizer without FYM for respectively. The fertilizer prescription equations were developed and nomograms were formulated based on the equations for a range of soil test values and desired yield targets of marigold. The results of the experiment indicated that 3.18 kg N, 0.63 kg phosphorus and 2.54 kg potassium were required to produce one quintal of Urd grain in Mollisols of Uttarakhand. The contribution of (%) of N, P and K from soil for Urd was 38.15, 72.61 and 36.51. Contribution of nutrient from fertilizer with FYM for urd was 187.65, 15.88 and 96.08. Percent contribution of nutrient from fertilizer without FYM for Urd was 169.81, 17.19 and 94.98 respectively. The fertilizer prescription equations were developed and nomograms were formulated based on the equations for a range of soil test values and desired yield targets of Urd. **Key words:** Aquic Hapludoll, Coefficient of multiple regression, nutrient requirement, Fertilizer adjustment equations, exhaust crop.

The conventional production systems in flower crops depends on blanket recommendations involving indiscriminate and imbalanced use of fertilizers accelerating ecological and environmental concerns in relation to soil plant system (1). To maintain balance and manage soil variability in precision with crop needs, soil test based site and crop specific nutrient application helps the farmers by suggesting meaningful doses in relation to crop yield and quality (2). Integrated use of chemical fertilizers with inorganic sources contributes to rapid mineralization of nitrogen, mobilization of phosphorus and indirectly improves the availability of potassium and other nutrients, thereby sustaining soil health and fertility (3). In the current stress on sustainability issues, the design and implementation of proper nutritional programs involving soil test crop response based site specific integrated nutrient management (STCRSSINM) is of prime importance to ensure agronomic, economic, social and environmental

sustainability (Ortega 2015). Research in this frontline area is completely missing in flower crops, especially those grown in open field in which soil plays a major role in crop production. Marigold is one such flower crop, widely grown outdoors around the world on account of its hardiness, ease in cultivation and extensive adaptation. Prospects of marigold commercialization is increasing at higher pace for its diversified uses, viz. loose flowers being used in social and religious ceremonies, ornamental landscape plant in borders and bedding, a source of carotenoid pigments for food colorants and nutritional supplements, essential oil for its bio-active compounds that are widely used as insecticides, nematicides, fungicides and compounding in high grade perfumes (4). It is a heavy feeder of nutrients with positive response to plant nutrition (5). This flower crop occupied a sizable area (55.89 thousand ha) with significant production of 511.31 thousand MT (6) where growers are more inclined to use unscrupulous

amount of nutrients from fertilizer sources to meet the expected yield and quality. Balanced nutrition is one of the utmost important aspects which directly influence growth, yield and xanthophyll content in marigold (Ahmad *et al.* 2011). Keeping these points in view, STCR studies involving integrated plant nutrition system (IPNS) was undertaken with an objective to recommend balanced manure fertilizer N, P and K, for marigold (Pusa narangi) and half the dose of N, were applied as basal dose and remaining dose of nitrogen was top dressed at 45 days after transplanting. Twenty eight days old seedlings of marigold were transplanted with a spacing of $45 \times 45 \text{ cm}^2$ and recommended cultural practices were followed. Soil samples were collected from each plot before planting and after harvesting of each test crop. The collected samples were air dried, passed through 2 mm sieve and used for analyzing available NPK. Marigold flower and plant samples were collected separately from each plot were dried in hot air oven at $65 \pm 20^\circ\text{C}$, grounded to a homogenous powder and were chemically analyzed for N, P and K content as per the procedure described by (10). Total N, P and K uptake by the crop was computed using the dry biomass yield of marigold flower and plant. Using the data on marigold flower yield, nutrient uptake, initial soil available nutrient status, and fertilizer manure doses applied, basic parameters, viz. nutrient requirement (NR) for the production of 100 kg flowers and contribution efficiencies (%) of soil available nutrients (CS), fertilizer (CF) and FYM (CFYM) were computed as outlined by (12). These parameters were used for the development of fertilizer prescription equations and ready reckoner of NPK fertilizer doses alone and in conjugation with manure (FYM) for a range of soil test values and desired yield targets ($\pm 10\%$ of potential yield) of marigold.

RESULTS AND DISCUSSION

Descriptive statistics of pre planting soil available nutrients, flower yield and total nutrient uptake of two years mean data is presented in Table 1. Mean values of Alkaline $\text{KMnO}_4\text{-N}$, Olsen's-P and $\text{NH}_4\text{OAc-K}$ during the two years of experimental study were observed as 189.24, 208.73, 219.46 kg/ha of N; 20.81, 25.91, 30.13 kg/ha of P and 211.62, 236.31, 250.81 kg/ha of K in strip I, II and III respectively. The soil available NPK values increased with increase in fertilizer doses and were the highest in $\text{N}_3\text{P}_3\text{K}_3$ of strip III, followed by

strip II and lowest in strip I, which indicated that the establishment of marked fertility gradient by application of graded doses of fertilizers and FYM. Such extent of gradient build up has also been reported by (Rawat *et al.* 2015) with a preliminary oat crop in mollisols of Uttarakhand, India. Variation in soil available nutrients within the strip was explained by coefficient of variation and it was less in soil available N in comparison with P and K. An operational range of variability was created with respect to soil NPK which is a major prerequisite for conducting STCR experiment (Santhi *et al.* 2011). Range and mean values of flower yield and NPK uptake (Table I) revealed that the highest output and nutrient uptake were obtained from strip III followed by strip II and lowest in unfertilized strip. Mean flower yields from over all plots were in the ascending order of 29.33, 30.39 and 30.62 tonnes/ha in strip I, II and III respectively. However, the highest yield (34.29 tonnes/ha) was recorded in $\text{N}_3\text{P}_3\text{K}_3$ of strip II with FYM @ 5 tonnes/ha and lowest and K schedule for marigold (*Tagetes patula* L.). Marigold cv. *Pusa Narangi* Gaiinda belongs to the family Asteraceae is among one of the most commonly grown loose flowers and used extensively on religious and social functions in different forms. They are planted in beds for mass display, in mixed borders and can also be grown in pots. It occupies a special importance due to its hardiness, easy culture, including inexpensive packaging, low-pest menace, and wider adaptability to varied agro-climatic conditions. The low hills of the state owing to their mild climate, *vis-a-vis* the adjoining plains, offer congenial conditions for its cultivation. Marigold is among the most commercially cultivated flowers in India and all over the world as well. It accounts for more than half of the national loose flower production and is best suited for landscape planting in beds, pot, borders, baskets, etc. Its flowers are used in religious and in social functions, as loose flowers, flower decorations and in making garlands. Marigold is also grown for color extraction. Apart from the significance in ornamental horticulture, it has been valued for some another purpose too. It has some additional medicinal properties, e.g., it acts as an anti-inflammatory, and anti-tumor agent, and as a remedy for healing wounds. Plant pharmacological studies have suggested that marigold flower extracts have some antiviral, antigenotoxic viral, cytotoxic anti-tumor, anti-inflammatory and lymphocyte

activation properties. In India, there is a huge potential for its cultivation and use of the ornamental. Importance of fertilizer to increase production is well recognized. Agricultural production is intensifying by the sharp increase in fertilizer plants and flowers because of their growing demand. Therefore, in the floriculture cultivation of this flower is receiving much attention in many countries. But the firm foundations on which this ornamental flower can be built up as an industry has to be supplied with a well-planned research and experimentation. The major trade centers for black gram in India are governed by domestic production and influenced by prices in Myanmar. India the largest consumer of pulses is also largest pulse processor in the world. India imported 0.71 mt of black gram in 2009-10, showing a rise of 60 percent over the consumption of the previous year. India inherited nearly 85 percent of black gram requirement from Myanmar. Consumption, but productivity gains of added nutrients are declining. Nutrient supply from chemical fertilizers is the key to increase the agricultural production. Enhanced land productivity results from the synergistic effects of chemical fertilizers, organic manures, biofertilizers and other locally available nutrient sources, which improve soil organic carbon, and nutrient status. Consequently chemical, physical and biological properties of soil. Since, plants derive nutrients from both soil and fertilizers, it is necessary for minimizing the wastage of fertilizer status in the soil to ensure their economic and judicious use. The need to use renewable forms of energy has revived the use of organic fertilizers worldwide. During the post green revolution period, the production of pulses recorded a negative growth rate. This disturbing trend in the production of pulses had adversely affected the per capita availability of pulses. The daily per capita availability of pulses had decreased from 69 grams during sixties to less than 40 grams as against the FAO/WHO's current recommendation of 80 grams per day. Therefore, a paradigm shift in approach to increase and sustain pulses production in future is very necessary. Fertilizer is a key component of this approach and is preordained to ensure adequate and balanced supply of nutrient to the growing crop. It has been likely that 18-73 percent of yield increase could be attributed due to the fertilizer alone. In the beginning, general fertilizer recommendations were second-hand for different crops, but these are not efficient and economical.

General recommendations have also the limitation in that they do not consider the large-scale variations in field-to-field fertility levels. Soil testing is one of the important tools to access the fertility status of soil and provide the basis of nutrient requirement for a crop/cropping sequence. This helps to economize the cost of fertilizer use and will increase the fertilizer use efficiency. Today, we are overwhelmed to hear that Soil Test Crop Response (STCR) based prescription are gaining popularity due to their superiority over blanket general fertilizer recommendations. Field trials conducted in different agro-ecological zones with different cropping systems revealed that the STCR produced a higher yield and therefore maintains a better nutrient status as compared to the blanket fertilizers recommendation. This approach of efficient fertilizer management increases the production potential for the yield of pulses. Fertilizers will continue to play a key role in increasing the agricultural production as the crop yield may be increased considerably by using the appropriate doses of fertilizers. Soil test-based fertilizer recommendation results in an efficient fertilizer use and maintenance of the soil fertility. In this technique fertilizers are recommended separately for different plots in a holding based on the soil test and present a uniform yield target depending upon the availability of fertilizer input. The efficiency of applied fertilizer nutrient and the nutrient already present in the soil is very much location specific and calibrations are needed for every set of the crop-soil climatic complex under the optimal agronomic practices. For this reason, the soil testing has become the foundation for fertilizing our soils in a balanced proportion and we must understand that about the nutrient losses from the soil. The soil test values should be correlated and calibrated for recommending the fertilizer requirement of a crop on a specific soil climatic zone. In the absence of such information, no precise fertilizer recommendations would be possible. Keeping these factors in view, an All India coordinated Research project on soil test-crop response correlation was started by the Indian Council of Agricultural Research in 1967-1968. The concept of formulating optimum fertilizer recommendation for targeted yield was first given by (7), which was further modified by (8). The relationship between yield of economic part and uptake of a nutrient will usually be linear. This suggests that by obtaining a given yield, a definite quantity of a nutrient must be taken up by the plant.

Once this requirement is known for the given yield, the fertilizer used can be estimated by taking account of efficiency or contribution from the nutrient availability in the soil and from the fertilizer applied. The data obtained from the field experiment of Soil Test Crop Response provides a range in soil test values, nutrient uptake and yield levels, which enable us in calculating three basic parameters, *i.e.* nutrient requirement, the percent contribution of available nutrient from the soil and the percent contribution from the applied nutrient through chemical or organic sources. Field trials conducted in different agro-ecological zones with different cropping systems revealed that the STCR produce higher yields and maintains a better nutrient status in comparison to the blanket or soil test-crop response based inorganic fertilizers alone.

MATERIAL AND METHODS

Field experiment was conducted in D₇ block of Norman E. Borlaug's Crop Research center (C.R.C), of G.B. Pant University of Agriculture and Technology, Pantnagar, Distt. U.S. Nagar, Uttarakhand at 29°N latitude, 79°29'E longitude and an altitude of 243.84 m above the mean sea level. on Soil Test Crop Response Studies as per the technical program me of AICRP during, 2013-14 2014-15. Climate of Pantnagar is humid, subtropical with hot and dry summers and cool winters. The monsoon season usually start from third or fourth week of June and extends up to last week of September. Few spells of downpours are generally received during winter season (November to March). The average annual rainfall of the area is 1433.3 mm and approximately 80-90 percent of it is received during rainy season. The soil of the experimental site was sandy loam in texture

Physical and chemical properties of experimental soil : The soil of the experimental site was sandy loam in texture. Soil of experimental field had 176.15 kg/ha alkaline permanganate oxidizable N (9), 18.19 kg/ha 0.5 N sodium bicarbonate extractable P (Olsen *et al.*, 1954), 155.13kg/ha neutral N ammonium acetate exchangeable K (Hanway and Heidel, 1934), 0.70% organic carbon (Walkley and Black, 1934), pH of 6.43 and electrical conductivity of 0.63 dS/m in 1:2.5 soil to water (10).

Fertility gradient experiment : Prior to test crop experimentation, fertility gradient experiment was conducted to create soil fertility gradient using

'inductive methodology' developed by (8). For this purpose, field was divided into three equal rectangular strips and graded doses of fertilizer N, P and K were applied as N₀ P₀ K₀, N₁P₁K₁ and N₂ P₂ K₂ (N₂ P₂ K₂ represents 200, 200, 200 kg/ha of N, P₂ O₅ and K₂O, respectively) in strip I, strip II and strip III, respectively. K was applied at a static rate of 200 K₂ O kg/ha. Soil fertility gradient with respect to farmyard manure (FYM) was developed by applying FYM @ 0, 5 and 10 tones/ha in three strips across the fertilizer applied strips. This created distinct nine blocks (3 in each strip) in field receiving different nutrient doses. Preliminary exhaustive fodder sorghum crop (variety: Pant Chari-7) was grown to stabilize soil fertility and it was then harvested as a fodder. Twenty-four soil samples (0-15 cm) from each strip were collected after harvest of exhaustive fodder crop and analyzed for alkaline KMnO₄ -N, Olsen's P and Ammonium Acetate-K.

Test crop experimentation : After fertility gradient experiment, each strip was divided into 24 plots to accommodate 24 treatments (21 treatments + 3 controls) making total of 72 plots. Three blocks (comprising 8 treatments) were made within each strip. The experiment was laid out in fractional factorial randomized block design. The treatments comprised of selected combinations of four levels of nitrogen (0, 60, 120 and 180 kg N/ha), phosphorus (0, 30, 60 and 90 kg P₂ O₅ /ha) and potassium (0, 30, 60 and 90 kg K/ha) and three levels of FYM (0, 5, 10 tones FYM/ha). Treatments were randomized in each strip and replicated thrice. N was applied in three equal splits as basal and two top dressings. However, full basal dose of P and K was applied at the time of sowing. Test crop 'Pusa Narangi and Pant Urd-31 was grown. Twenty-four soil samples (0-15 cm) were collected from each strip before and after sowing of test crop Sorghum and analyzed for alkaline KMnO₄ -N, Olsen's-P, Ammonium Acetate-K. Grain and straw was separated by threshing. Grain and straw samples collected from each plot were oven dried at 60±20° C till a constant weight. Oven dried samples were digested for chemical analysis in di-acid mixture (HNO₃ : HClO₄ in the ratio of 9:4 v/v) for phosphorus and potassium (10). Total phosphorus content in the digest was determined by vanado-molybdate phosphoric acid yellow colour method (10) and total potassium was measured turbidimetrically (11). Total nitrogen content in grain and straw was analyzed using

modified micro-kjeldahl's method (10). Basic parameters Total uptake of N, P and K were computed using flower, grain and straw yield and total nutrient content in the grain, straw and flower. Using data on nutrient uptake, pre-sowing soil available nutrients and applied fertilizer doses, basic parameters viz., nutrient requirement (NR), contribution of nutrients from soil (CS) and fertilizer (CF) were calculated as described by (8). Contribution of FYM (CFYM) was estimated using data from FYM treated and non-treated plots.

Total nutrient uptake

Uptake by straw (kg ha^{-1}) = Per cent nutrient in grain or straw $\times$ Grain or straw yield (kg ha^{-1})/100

Total nutrient uptake by plant (kg ha^{-1}) = Uptake by straw (kg ha^{-1}) + Uptake by grain (kg ha^{-1})

Basic data for fertilizer recommendation

Following basic data were calculated with the help of crop yield, nutrient uptake and soil test values.

Nutrient requirement for production of one quintal of economic produce (grain)

The nutrient requirement was calculated as follows :

Nutrient requirement (NR) = Total nutrient uptake (grain + straw) kg ha^{-1} / Grain yield (q ha^{-1}) The values were reported as kg of nitrogen (N), phosphorus (P) and potassium (K) required for producing one quintal of grain. These values were calculated

separately for each plot and then averages were taken.

Contribution of nitrogen, phosphorus and potassium from soil (C_s)

In this method, the efficiency of soil nutrients was calculated from soil test values of unfertilized plots. The soil efficiency was calculated as a ratio of total uptake and soil test value of a nutrient for each control plot and makes their average. The soil contribution in each plot was determined by multiplying the soil test value of the plot with the average soil efficiency as determined from the unfertilized plots. The soil efficiency was calculated as follows:

Percent contribution of nutrient from soil (C_s) =

Total uptake of nutrient in control plot / Soil test value of that nutrient in control plot $\times 100$

The mean of all control plots with respect to nutrient in question was calculated.

Contribution of concerned nutrient from fertilizer (C_f)

The fertilizer efficiency was calculated from treated plots after giving allowance for soil contribution. The fertilizer efficiency was calculated as a ratio of the difference between the total uptake and soil contribution and applied fertilizer dose in each treated plot.

(2) Percent contribution of concerned nutrient from fertilizer (C_f) = {(Total uptake of nutrient in treated plots) - (Soil test value $\times$ CS/100)/Amount of nutrient added in question as fertilizer} $\times 100$

Contribution of nitrogen, phosphorus and potassium from FYM (C_{fym})

FYM efficiency of any nutrient was calculated only from the FYM treated plots. For calculating the efficiency of fertilizer in FYM treated plots, the value of nutrient uptake from that treatment be deducted from uptake of that nutrient supplied through soil and further divided by added nutrients by FYM respectively. The values were calculated as given in the following formula:

Percent contribution of nutrient from FYM

{(Total uptake of nutrient in FYM treated plot) - (Soil test value $\times$ Cs/100)/Amount of nutrient added as FYM} $\times 100$

Fertilizer requirement for targeted yield

Equations for fertilizer requirement of nitrogen, phosphorus and potassium for targeted yield was worked out as follows: Fertilizer requirement of nitrogen, phosphorus and potassium for targeted yields were worked out as follows:

$$FN = (NR/C_f) \times 100T - (C_s/C_f) \times SN$$

$$FP = (NR/C_f) \times 100T - (C_s/C_f) \times SP$$

$$FK = (NR/C_f) \times 100T - (C_s/C_f) \times SK$$

Fertilizer requirement equations for nutrients through conjoint use of chemical

fertilizer and FYM

$$FN = (NR/C_f) \times 100T - (C_s/C_f) \times SN - (C_{fym}/C_f) \times M$$

$$FP = (NR/C_f) \times 100T - (C_s/C_f) \times SP - (C_{fym}/C_f) \times M$$

$$FK = (NR/C_f) \times 100T - (C_s/C_f) \times SK - (C_{fym}/C_f) \times M$$

Where,

FN = Fertilizer nitrogen (kg N ha⁻¹)

FP = Fertilizer phosphorus (kg P ha⁻¹)

FK = Fertilizer potassium (kg K ha⁻¹)

NR = Nutrient requirement of nitrogen, phosphorus and potassium

Cf = Percent contribution of concerned nutrient from fertilizer

CS = Percent contribution of concerned nutrient from soil

T = Targeted yield (q ha⁻¹)

SN = Soil test value for available nitrogen (kg ha⁻¹)

SP = Soil test value for available phosphorus (kg ha⁻¹)

SK = Soil test value for available potassium (kg ha⁻¹)

Cfym = Percent contribution of concerned nutrient from FYM

M = Concerned nutrient content in organic matter

Multiple regressions for maximum and economic yield

Multiple regression approach is used to calculate the dose of nutrient (s) required obtaining the maximum yield of crops under given set of experimental conditions. It can further be used to calculate the economic dose of fertilizer nutrients by incorporating a constant factor, *i.e.* per unit cost of produce divided by per unit cost of input (fertilizer) in the original equation. In this approach yield is regressed with soil nutrients, fertilizer nutrients, their quadratic terms and the interaction term of soil and fertilizer nutrients as given below.

$$Y = A \pm b_1 SN \pm b_2 SN^2 \pm b_3 SP \pm b_4 SP^2 \pm b_5 SK \pm b_6 SK^2 \pm b_7 FN \pm b_8 FN^2 \pm b_9 FP \pm b_{10} FP^2 \pm b_{11} FK \pm b_{12} FK^2 \pm b_{13} FNSN \pm b_{14} FPSP \pm b_{15} FKSK$$

$$Where$$

Where

Y = Crop yield (kg ha⁻¹)

A = Intercept (kg ha⁻¹)

Bi = Regression coefficients (kg ha⁻¹)

SN, SP, SK = Available soil nitrogen, phosphorus and potassium (kg ha⁻¹), respectively.

FN, FP, FK = Fertilizer nitrogen, phosphorus and potassium (kg ha⁻¹), respectively

RESULTS

Field experiment was conducted as per the technical programme of soil test crop response correlation studies. To evaluate a meaningful regression between soil test values of the various plots and crop response to fertilizer, possible large variations in the fertility levels (soil test values) of different strips of selected field was created. The experimental success is entirely depending on the extent of the artificial gradient of soil fertility created. In principle strip III should be richest in fertility followed by strip II and strip I with poorest fertility. Hence highest amount of fertilizer nitrogen, phosphorus and potash was applied in strip III followed by strip II while no fertilizer was applied in strip I. Before conducting main experiment on Marigold and Urd in the preceding crop season preparatory trial was conducted by growing exhaust crop sorghum (var. Pant chari-7). The yield obtained and nutrient uptake by sorghum crop is shown in table 1.

The yield data and nutrient uptake clearly indicate that the fertility gradient has been created since crop yield and nutrient uptake follow the same trend as applied fertilizer nutrient *i.e.* strip III > strip II strip first.

Statistical verification of proper creation of fertility gradient

Analysis of variance was carried out by using the soil nutrients, soil nitrogen (SN), soil phosphorus (SP) and soil potassium (SK) separately as dependent variables. The results obtained are given in table 2.

It is seen that in case of SN, SP or SK as dependent variable the effect of the strip is highly significant. This indicates that the fertility gradient was created in respect of N, P and K. Therefore, it can be concluded from the above results that the Organic carbon, alkaline KMnO₄ N, Olsen's-P and neutral normal NH₄OAc-K content of soil increased in the order of strip I < strip II < strip III of the experimental field which represents that there was a proper creation of the fertility gradient with the application of graded doses of nitrogen, phosphorus and potassium. It is also statistically proved that there was proper creation of fertility gradient and it is significant in respect of N, P, K and FYM levels. Based on statistical verification of fertility gradient it can be concluded that the experimental field is suitable for soil test crop response studies for the

Table 1 : Strip wise fertilizer dose, forage yield and uptake of exhaust crop.

Strip	Fertilizer Dose (kg/ha) N, P ₂ O ₅ & K ₂ O	Forage yield (q/ha)	Uptake (Kg/ha)		
			N Uptake	P uptake	K uptake
I	0,0,0	25.24	13.12	5.80	14.63
II	100,100,100	26.31	14.73	13.94	23.41
III	200,200,200	26.59	17.28	19.94	26.05

Table 2 : Analysis of variance using soil nutrients, soil nitrogen, and soil phosphorus and soil potassium.

Dependent Variable	Probe. > F	R square	Coefficient of Variation	Mean
SN	<0.0001**	0.544	5.907	123.44
SP	<0.0001**	0.546	1.844	13.41
SK	<0.0001**	0.337	6.073	122.98

*Value given in parenthesis is mean of strip

next season crop. Similar types of findings were also reported by (13) in the Mollisol of Uttarakhand.

From the given table it may be concluded that pH, EC (ds/m), Organic carbon (%), Alkaline KMnO₄-N (kg/ha), Olsen's phosphorus (kg/ha) and ammonium acetate potassium (kg/ha) among the strip varies as the order given below :

1. **pH**- Strip I> Strip II>Strip III.
2. **EC**- Strip II> Strip I> Strip I.
3. **Organic carbon (%)**- Strip II> Strip III> Strip I.
4. **Alkaline KMnO₄-N (Kg/ha)**- Strip III>Strip I> Strip II.
5. **Olsen's Phosphorus (Kg/ha)**- Strip III> Strip I> Strip II.
6. **Ammonium acetate potassium (kg/ha)**: Strip III> Strip II> Strip I.

Basic data to calculate nutrient dose through fertilizer for a targeted yield of marigold, nutrient uptake, soil test values, added fertilizer doses and manure are all presented in table 4:

In this table 4 more than 100 per cent contribution of potassium from fertilizer as per cent of applied potassium (K₂O), in case of marigold might be due to combine effects of several factors. The additive effect of higher doses of nitrogen and phosphorus and priming effect of starter doses of potassium might have caused the release of potassium from non-labile pool to labile pool, which resulted in increased uptake of native soil sources. Thus, here fertilizer potassium overestimated which had enhanced the efficiency of

fertilizer potassium. More than 100 percent efficiency of fertilizer efficiency was also reported in potato by Adinaryana, (1975), (14) in rice and by Bhatia, (1985) in rice in Mollisols of tarai region of Uttarakhand.

Fertilizer adjustment equations :

Fertilizer adjustment equations were developed for fertilizer recommendation of nitrogen, phosphorus and potassium for marigold with the help of basic data.

From the given table it may be concluded that pH, EC (ds/m), Organic carbon (%), Alkaline

KMnO₄-N (kg/ha), Olsen's phosphorus (kg/ha) and ammonium acetate potassium (kg/ha) among the strip varies as the order given below:

1. **pH**-Strip III> Strip II>Strip I.
2. **EC**-Strip III> Strip II> Strip I.
3. **Organic carbon (%)**- Strip III> Strip II> Strip I.
4. **Alkaline KMnO₄-N (Kg/ha)**- Strip III=Strip II> Strip I.
5. **Olsen's Phosphorus (Kg/ha)**- Strip III> Strip II> Strip I.
6. **Ammonium acetate potassium (kg/ha)**: Strip III> Strip II> Strip I.

Basic data to calculate nutrient dose through fertilizer for a targeted yield of Urd, nutrient uptake, soil test values, added fertilizer doses and manure are all presented in table.

*Soil test values (0-15 cm. depth): alkaline KMnO₄-N (kg/ha), Olsen's-P (kg/ha) and NH₄OAc-K (kg/ha)

Table 3 : Range and mean of the soil test value under different strips of marigold.

Sl. No.	Particular	Strip I Range (Mean)	Strip II Range (Mean)	Strip III Range (Mean)	Average
1.	pH	6.55-7.25 (6.79)	6.22-7.87 (6.82)	6.20-6.78 (6.38)	6.20-7.87 (6.65)
2.	EC (ds/m)	0.103-0.201 (0.137) 0	0.205-0.252 (0.22)	0.201-0.212 (0.205)	0.103-0.252 (0.186)
3.	Organic carbon (%)	0.23-3.12 (1.95)	1.40-3.354 (2.64)	0.546-3.939 (2.20)	0.23-3.939 (2.25)
4.	Alkaline KMnO ₄ -N (Kg ha ⁻¹)	31.36-125.4 4 (68.44)	31.36-106.62 (68.40)	40.77-128.58 (84.49)	31.36-128.58 (73.78)
5.	Olsen's-P (Kg ha ⁻¹)	10.00-52.00 (30.60)	10-38.82 (20.39)	10.00-59 (31.62)	10.00-59 (31.62)
	NH ₄ OAc-K (Kg ha ⁻¹)	112-174.72 (136.3)	114.24-192.64 (143.52)	122.08-187.04 (156.34)	112-192.64 (145.39)

* Value given in parenthesis is mean of strip.

Table 4: Basic data for calculating fertilizer doses with and without FYM for a targeted yield of marigold as given below :

Particular	Without FYM			With FYM		
	N	P	K	N	P	K
NR (Kg/q)	1.06	0.34	1.32	1.06	0.34	1.06
CS (%)	26.23	54.03	42.02	26.23	54.03	4202
CF (%)	83.25	38.96	168.51	98.35	40.15	168.68
C FYM (%)	-	-	-	46.81	61.30	128.54

Table 5 : Fertilizer adjustment equations for Marigold.

Fertilizer dose	With FYM	Without FYM
Nitrogen dose (kg/ha)	FN = 1.08T-0.27SN-0.48FYM-N	FN = 1.27T-0.32SN
Phosphorus dose (kg/ha)	FP = 1.88T-3.09SP-3.50 FYM-P	FP = 1.99T-3.18SP
Potassium dose (kg/ha)	FK = 0.94T-0.30SK-0.92FYM-K	FK = 0.94T-0.30 SK

Multiple regression study of soil test values and fertilizer dose with yield of Marigold and Urd

The multiple regression enables fertilizer recommendation based on soil tests to be very dynamic to The multiple regressions enable fertilizer recommendation based on soil tests to be very dynamic to meet various demands of the country from time to time for (i) maximum yield per hectare (ii) maximum profit per hectare at varying input and produce prices and (iii) maximum profit per rupee invested on fertilizer. Another feature of this dynamic approach is being made to develop and extend a methodology for

making fertilizer recommendation for varying yield targets which are particularly suited to the situation of resource constraint in India and other countries. The relationship between grain yield as dependent variable and the soil test values, fertilizer doses, and FYM doses, interactions between soil test values, fertilizer doses and among fertilizer nutrients as independent variables were established through a multiple regression equation of quadratic model. Soil test values used in these equations were alkaline KMnO₄-N, Olsen-P and neutral normal ammonium acetate-K kg ha⁻¹, as recommended soil test methods for tarai soils of Uttrakhand (14). Fertilizer doses used in the form of

Table 6 : N, P, K requirements for different yield targets of marigold without using FYM.

Soil test value (kg/ha) Alkaline KMnO ₄ -N	Yield target (q/ha)		
	Fertilizer nitrogen		
	75	100	125
50	79.74	119.21	152.95
75	71.86	103.70	135.53
100	63.99	95.82	127.65
125	56.11	95.98	129.32
Olsen's-P (kg/ha)	Fertilizer Phosphorus		
15	41.80	62.97	31.56
20	37.71	59.53	81.35
25	30.78	52.60	74.42
30	23.85	45.66	67.48
35	38.00	88.00	13.70
Ammonium acetate-K (kg/ha)	Fertilizer Potassium		
100	33.04	53.39	72.97
125	27.57	47.16	66.74
150	21.34	40.92	60.50
175	15.10	34.69	54.27

Table 7 : N, P and K requirement for different yield targets of marigold using 10 tones FYM.

Soil test values (kg ha ⁻¹)	Yield Target (q ha ⁻¹)		
Alkaline KMnO ₄ -N	75	100	125
	Fertilizer nitrogen		
50	73.32	105.15	136.98
75	65.44	97.27	129.10
100	57.56	89.39	121.23
125	49.69	81.52	113.35
Olsen's- P	Fertilizer Phosphorus		
15	43.12	64.94	86.76
20	36.19	58.01	79.82
25	16.16	42.34	72.89
30	22.32	44.14	65.95
35	15.39	37.20	59.02
Ammonium Acetate -K	Fertilizer Potassium		
100	23.52	43.10	62.69
125	17.28	36.87	56.45
150	51.03	30.63	50.22

nutrients N, P₂O₅ and K₂O kg ha⁻¹. In the present experiment following multiple regression equations obtained for different functions with their regression coefficient were developed and described below.

A. Multiple regression study of soil test values and fertilizer dose with yield of Marigold

$$Y=13.35577+0.931439SN-0.55226SN^2+0.57396SP-0.0059SP^2+0.005731SK+-0.00146SK^2-0.08955FN$$

Table 8 : Soil test values obtained for nitrogen, phosphorus and potassium in experimental field of Urd.

Sl. No.	Particular	Strip I	Strip II	Strip	Average
		Range (Mean)	Range (Mean)	Range (Mean)	
1.	pH	6-7.0 (6.60)	6.2-7.6 (6.98)	6.00-11.24 (7.01)	6.67
2.	EC (ds/m)	0.102-0.252 (0.14)	0.12-0.265 (0.15)	0.123-0.356 (0.16)	0.154
3.	Organic carbon (%)	0.16-1.20 (0.59)	0.19-1.17 (0.73)	0.23-1.20 (0.80)	0.16 to 1.20 0.59
4.	Alkaline KMnO ₄ -N (Kg ha ⁻¹)	62.72-200.70 (138.50)	112.89-263.42 (145.30)	75.26-213.24 (145.30)	75.26-263.42 145.25
5.	Olsen's-P (Kg ha ⁻¹)	41.77-60.23 (50.35)	51.49-66.06 (59.18)	38.86-95.20 (61.40)	10.60-67.03 16.04
6.	NH ₄ OAc-K (Kg ha ⁻¹)	60.48-151.87 (97.38)	69.88-227.13 (138.09)	100.8-227.13 (166.93)	60.48- 227.13 135.16

Table 9 : Basic data for calculating fertilizer doses with and without FYM for a targeted yield of Urd.

Particular	Without FYM			With FYM		
	N	P	K	N	P	K
NR	3.18	0.63	2.54	3.18	0.63	2.54
CS	38.15	72.61	36.51	38.15	72.61	36.51
CF (%)	169.81	17.19	94.98	187.65	15.88	96.08
CFYM (%)	-	-	-	78.34	17.05	38.21

Table 10 : Fertilizer adjustment equations for Urd.

Fertilizer dose (Kg ha ⁻¹)	With FYM	Without FYM
Nitrogen Dose (Kg ha ⁻¹)	FN = 1.69T-0.20 SN-0.42FYM-N	FN = 1.87T- 0.23 SN
Phosphorus Dose (kg ha ⁻¹)	FP = 9.09T-10.46 SP-2.45FYM-P	FP = 8.39T-9.67SP
Potassium Dose (Kg ha ⁻¹)	FK = 3.17T-0.46SK-0.48FYM-K	FK = 3.23T-0.46SK

Table 11 : N, P and K requirement for different yield targets of Urd without using FYM.

Soil test value (kg/ha) Alkaline KMnO ₄ -N	Yield target (q/ha) Fertilizer nitrogen		
	20	25	30
75	20.60	29.96	39.33
100	14.98	24.35	33.71
125	9.37	18.73	28.09
150	3.75	13.11	22.48
Olsen's-P (kg/ha)	Fertilizer Phosphorus		
	20	25	30
15	9.93	28.26	46.58
20	-	7.14	25.46
25	-	-	4.34
30	-	-	-
35	-	-	-
Ammonium acetate-K (kg/ha)	Fertilizer Potassium		
	20	25	30
100	15.04	28.41	41.78
125	5.43	18.80	32.17
150	-	9.19	22.56
175	-	-	12.95

Table 12 : N, P and K requirement for different yield targets of Urd using 10 tones FYM.

Soil test value (kg/ha) Alkaline KMnO ₄ -N	Yield target (q/ha)		
	Fertilizer nitrogen		
	20	25	30
75	10.16	19.53	28.89
100	4.55	13.91	23.27
125	-	8.29	17.66
150	-	2.68	12.04
Olsen's-P (kg/ha)	Fertilizer Phosphorus		
15	8.864	27.18	45.51
20	-	6.07	23.39
25	-	-	3.27
30	-	-	-
35	-	-	-
Ammonium acetate-K (kg/ha)	Fertilizer Potassium		
100	14.05	27.42	40.79
125	1.44	17.81	31.18
150	-	8.20	21.57
175	-	-	11.96

$$-0.27863FN^2 + 0.805243FP + 0.000721FP^2 + 0.000787FK - 0.00593FK^2 - 0.00051FNSN + 0.0058FPSP - 0.00161FKSK \dots\dots\dots(i)$$

$$R^2 = 0.473963^{**}$$

(Alkaline KMnO₄-N, Olsen's-P, Amm. Ac.-K)

Y = Grain yield (kg ha⁻¹)

FN = Nitrogen through fertilizer (kg ha⁻¹)

FP = Phosphorus through fertilizer (kg ha⁻¹)

FK = Potassium through fertilizer (kg ha⁻¹)

FYM = Farmyard manure (t FYM ha⁻¹)

SN = Soil test value for nitrogen, alkaline KMnO₄-N as an index (Kg ha⁻¹)

SP = Soil test value for nitrogen by % O.C. As an index

SK = Soil test value for potassium neutral normal NH₄OAC-K (Kg ha⁻¹) as an index.

B. Multiple regression study of soil test values and fertilizer dose with yield of Urd

$$Y = 70.77643 + 0.136425SN - 2.64082SN^2 + 0.776193SP - 0.00191SP^2 + 0.057217SK + 0.000952SK^2 - 2.74201FN + 0.527603FN^2 + 0.977356FP + 0.0066253FP^2 + 0.004952FK - 0.00049FK^2 + 0.01263FNSN - 0.02695FPSP - 0.01032FKSK \dots\dots\dots(ii)$$

$$R^2 = 0.545032^{**}$$

(Alkaline KMnO₄-N, Olsen's-P, Amm. Ac.-K)

Y = Grain yield (kg ha⁻¹)

FN = Nitrogen through fertilizer (kg ha⁻¹)

FP = Phosphorus through fertilizer (kg ha⁻¹)

FK = Potassium through fertilizer (kg ha⁻¹)

FYM = Farmyard manure (t FYM ha⁻¹)

SN = Soil test value for nitrogen, alkaline KMnO₄-N as an index (Kg ha⁻¹)

SP = Soil test value for nitrogen by % O.C. As an index

SK = Soil test value for potassium neutral normal NH₄OAC-K (Kg ha⁻¹) as an index.

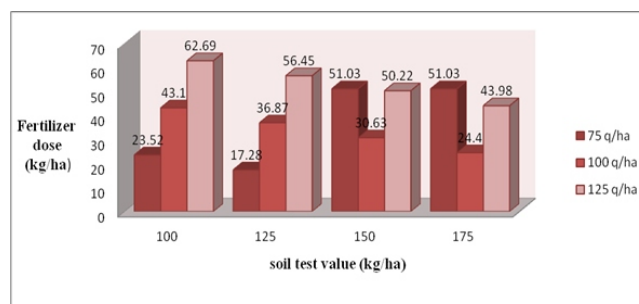
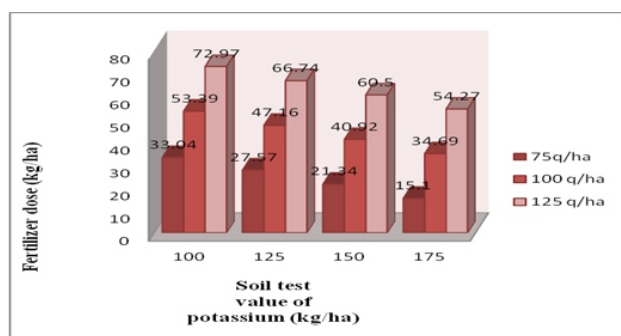
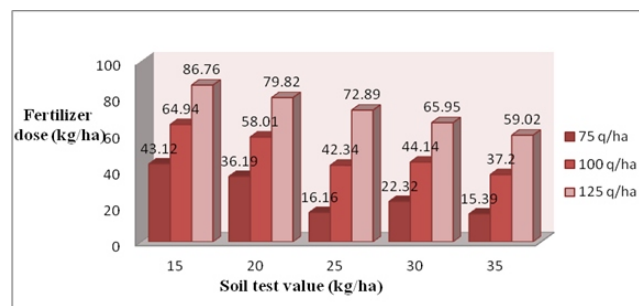
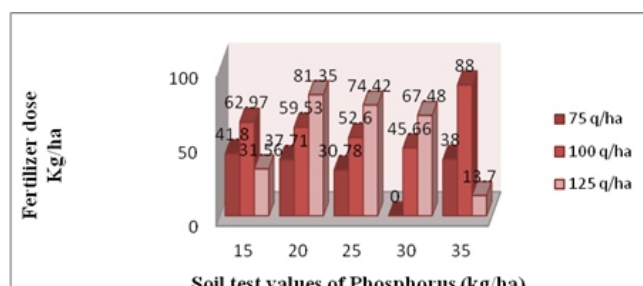
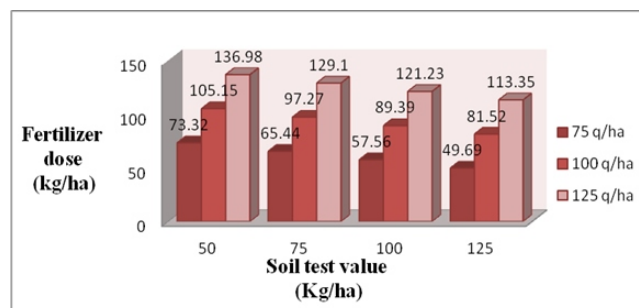
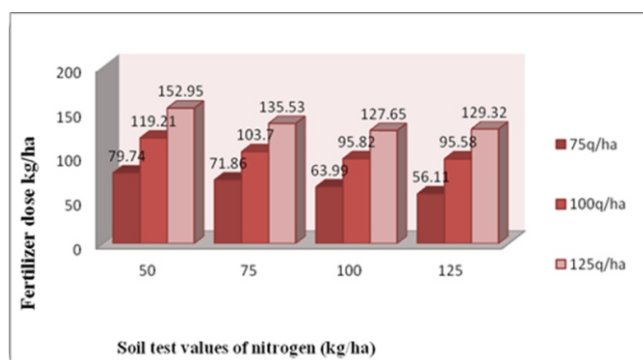


Fig. 1 : Soil Test based N, P and K fertilizer doses without FYM of Marigold

Fig. 2 : Soil Test based N, P and K fertilizer doses for 10 t FYM/ha for Marigold.

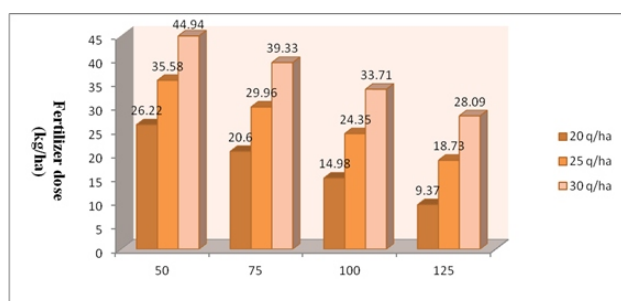


Fig. 3 : Nitrogen requirement of urd at different soil test value and yield target

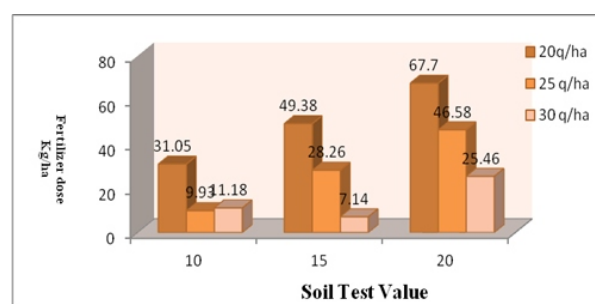


Fig. 4 : Phosphorus requirement of urd at different soil test value and yield target without using FYM.

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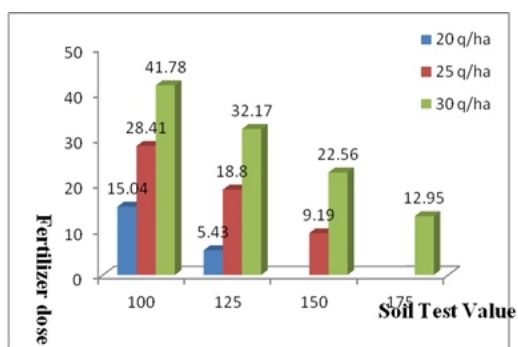


Fig. 5 : Potassium requirement of urd at different soil test value and yield target without using FYM.

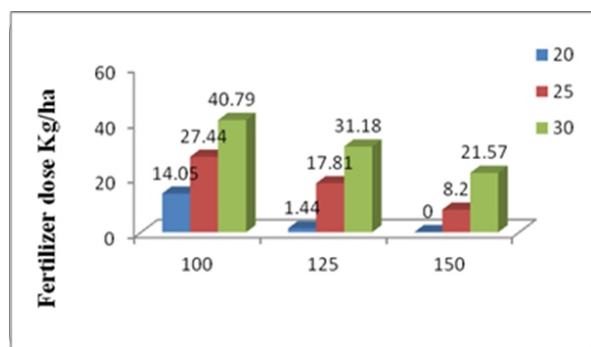
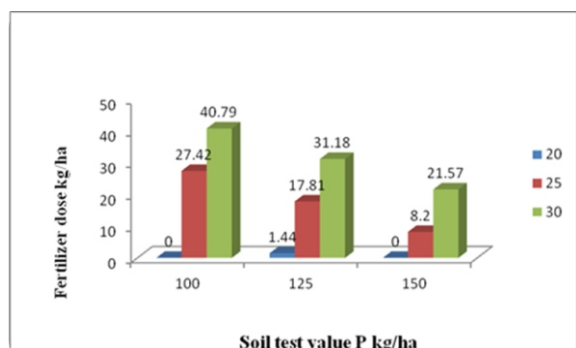
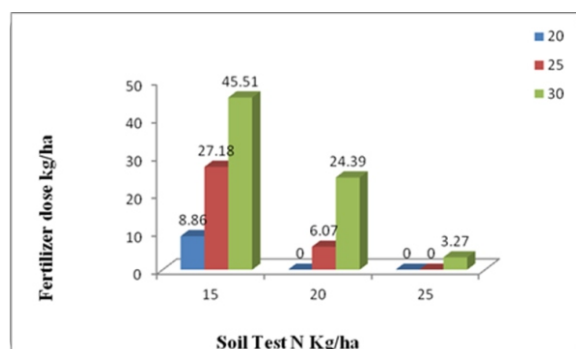


Figure 6 : N, P and K requirement of Urd at different soil test value and yield target.

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IDENTIFICATION, DIAGNOSIS AND SUCCESSFUL THERAPY OF DERMATOPHILOSIS IN AN ORGANIZED DAIRY HERD OF BUFFALOES

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ABSTRACT

An organized dairy farm of buffaloes was reported with history of hair loss, itching in some animals and crusty lesions on different body parts. Skin scabs and scrapings and impression smears from lesions were collected under sterile conditions for laboratory examination. The impression smears taken from the lesions were also stained with Giemsa's stain and Gram's stain and examined under the oil immersion objective of microscope. The skin scrapings were also subjected to direct microscopical examination using 10 percent potassium hydroxide to rule out fungal elements and mites. Isolation of *Dermatophilus congolensis* was carried out using Haalstra's technique. The isolates were stained by Gram's method and identification was carried out using various morphological, cultural, biochemical and sugar fermentation tests of the isolates. The isolates were positive for catalase, oxidase and urease tests and were able to digest gelatin and Loeffler's coagulated serum, indicating proteolytic activity. The isolates showed hydrolysis of starch and casein. All the isolates showed negative results with nitrate test and indole test. Three injections of long-acting tetracycline (20 mg/kg) weekly were effective to solve the cases of generalized bovine dermatophilosis. **Key words:** Giemsa's stain, Gram's stain, dermatophilosis, *Dermatophilus congolensis*, long-acting tetracycline.

INTRODUCTION

Dermatophilosis (*Cutaneous streptothricosis*, Lumpy wool disease, Strawberry foot root, Senkobo skin disease in central Africa, Kirchi in Nigeria, and Saria in Malawi) is an infectious, cosmopolitan, actinomycetic disease of a wide variety of animals and also humans (10). *Dermatophilus congolensis* is a well-recognized Gram-positive, non-acid-fast, branching filamentous rod (cocci). These microorganisms are facultative anaerobic, capnophilic or aerobic tolerant bacteria that belong to the *Actinomycetales* order (12). The hyphal forms of the organism produce motile zoospores which are released when scabs are exposed to moisture (10). It has been reported by the Food and Agricultural organization (FAO) to be one of the four major bacterial diseases which affect cattle and other animals in the tropical and subtropical regions (Hashemi Tabar *et al.*, 2004). The pathogen causes exudative dermatitis affecting mainly livestock, occasionally companion animals (2) and wildlife, and rarely humans (1). It is an atypical bacterium, because it produces infective motile zoospores and aerial mycelia (3). The natural habitat of the organism is controversial (7), although it is a normal inhabitant of the livestock skin (13). It is

also found in water, organic material, and in the environment of livestock farms (17). Direct transmission occurs by means of zoospores from the skin, contact between carrier or sick and susceptible animals. High and long rainfall and warm temperatures reduce the normal superficial protective factors of the skin and predispose animals to clinical lesions (9).

In addition, contamination of puncture wounds and utensils, flies and tick bites, and face and limb lesions caused by pointed-tip pasture (*Brachiaria* sp.) may predispose animals to indirect infection. Micro-environmental conditions (temperature, humidity) may lead to the activation of dormant skin zoospores, producing germ tubes containing active multi-flagellated zoospores that invade the epidermis. Cutaneous lesions are determined by a cyclical pattern of invasion, epidermis inflammation, serous exudation, and micro-abscesses, followed by regeneration that result in the formation of scabs and crusts containing the pathogen (8). The cutaneous virulence of *D. congolensis* is intimately associated with the ability of the strains to produce alkaline ceramidase, phospholipases, proteolytic enzymes, and hemolysins (3). Geographical variation of isolate-to-isolate related to

genetic diversity has been observed among *D. congolensis* obtained from livestock of different countries and in regions of the same country (7). Ticks and biting flies compromising the skin integrity might be involved in the mode of transmission (12).

MATERIALS AND METHODS

A dairy farm of buffaloes was reported with history of hair loss, itching in some animals and crusty lesions on different body parts of body (Fig. 1 and 2). Before our consultation, the owner of the farm had contacted a local para-vet for treatment of the said animals, but the animals showed no clear response. Clinical examination showed normal temperature, heart beat and respiration. Skin scabs and scrapings and impression smears from lesions were collected under sterile conditions for laboratory examination. Small pieces of skin were taken from the underside of the scabs and softened in few drops of distilled water on a clean microscopic slide; a smear was made and stained with Giemsa and Gram's stains (11). The impression smears taken from the lesions were also stained with Giemsa's stain and Gram's stain and examined under the oil immersion objective of microscope. The skin scrapings were also subjected to direct microscopical examination using 10 percent potassium hydroxide to rule out fungal elements and mites. Isolation of *D. congolensis* was carried out using Haalstra's technique (4). Skin scabs were minced with a sterile scalpel blade and placed in glass bottles. One milliliter of sterile water was added to each specimen. The bottles were allowed to stand open for three and a half hours at room temperature. Then the opened bottle was transferred to candle jar, with a candle burned within the jar to obtain 10 to 20 percent carbon dioxide tension. Under CO₂ tension the motile zoospores if present, were chemotactically attracted to the surface of the distilled water. After 15 minutes, the bottle was carefully removed and a loopful taken from the water surface was seeded on blood agar plates and incubated at 37°C in 20 percent carbon dioxide for 24 to 48 h. The plates were examined for colonies of *D. congolensis* (11). The isolates were stained by Gram's Method and identification was carried out using various morphological, cultural, biochemical and sugar fermentation tests of the isolates.

RESULTS AND DISCUSSION

Microscopical examination of Giemsa or Gram's

stained smears of the scab material from the lesions revealed characteristic Gram positive septate branching filaments which were longitudinally as well as transversely divided to form spherical or ovoid cocci in multiple rows, with typical 'tramtrack or rail road appearance' suggestive of *D. congolensis* in all samples (Fig. 3). This distinctive morphology of the organism was demonstrated by most of the workers as the most practical diagnostic method for dermatophilosis (11). The organisms were observed in different forms depending on the stage of development varying from long branching filaments, filaments packed with zoospores and mature free zoospores released from the filaments. Culture of the scab materials from all animals yielded typical beta haemolytic colonies of *D. congolensis* in sheep blood agar in presence of 10 percent carbon dioxide (Fig. 4).

There were variations in the shape, colour and texture of the colonies. Microscopical appearance of organisms in Gram stained smears from colonies were also highly variable with Gram positive branching filaments in different stages of segmentation, packets of coccoid forms, germinating spores or combinations of the above forms depending on the age of the culture and strain of the isolate (Fig. 5). The wet mount preparation of all the isolates revealed motile zoospores. All the isolates were haemolytic producing clear zones of haemolysis in seven percent sheep blood agar within a period of 24 to 72 h of incubation.

Dermatophytes were isolated from three buffaloes along with *D. congolensis*. Concurrent infection with *D. congolensis* and dermatophytes has been reported in several studies (15). Although mites such as *Chorioptes* spp. have been identified as a cause of dermatitis in cattle, no mites could be demonstrated in the lesions in the present study.

The isolates were positive for catalase, oxidase and urease tests and were able to digest gelatin and Loefflers coagulated serum, indicating proteolytic activity. The isolates showed hydrolysis of starch and casein. All the isolates showed negative results with nitrate test and indole test. Similar biochemical characteristics were also reported for *D. congolensis* by several workers (6, 16). All the five isolates produced acid from glucose, fructose and sucrose within 24 h of incubation. But variable results were obtained with maltose, mannitol and lactose. The isolates were unable to produce acid from sorbitol and



Fig. 1. Affected body with Dermatophilosis.



Fig. 2. Dermatophilosis affected buffalo showing erythema with dense scab formation.

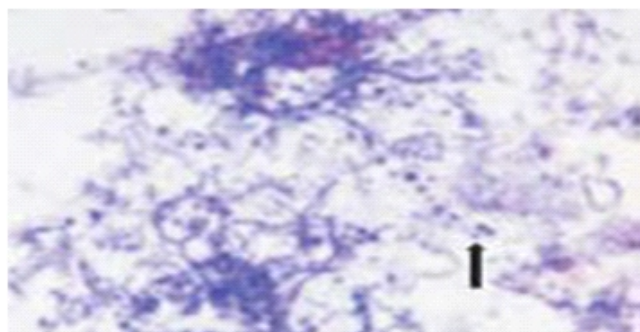


Fig. 3. Geimsa stained showed characteristic rail road track arrangement of organisms.

xylose. This is in agreement with previous findings (6, 14). None of the isolates produced gas from the sugars. No fungal elements or mites could be detected on microscopical examination of skin scrapings using 10 percent potassium hydroxide.

Different protocols for the *in vivo* treatment of bovine dermatophilosis have been reported, although beta-lactams (penicillin), aminoglycosides (streptomycin), and tetracyclines are reported as the first-line antimicrobials to the treatment of localized cutaneous lesions of dermatophilosis among livestock (3). In the current report, three injections of long-acting tetracycline (20 mg/kg) weekly were effective to solve the cases of generalized bovine dermatophilosis with



Fig. 4. Greyish-white haemolytic colonies of *D. congolensis* on sheep blood agar.



Fig. 5. Branching filaments of *D. congolensis* in different stages of segmentation from culture (Gram stain 1,000 $\times$).

chronic evolution. Besides *in vitro* effectiveness of oxytetracycline on the isolates, this drug was chosen for therapy due to its commercial availability, low cost, and reduced number of injections required to conclude the treatment.

CONCLUSION

In any animal with the history of hair loss, itching and crusty lesions on different body parts, dermatophilosis should be in the list of differential diagnosis. Merely by judging any case which is showing the above mentioned signs is not correct. So in our opinion the use of microscope is very valuable, besides these three injections of long-acting tetracycline (20 mg/kg) weekly were effective to solve the cases of generalized bovine dermatophilosis with chronic evolution.

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STUDIES AN INTERVENTION AND ADOPTION OF FLOWERS PRODUCTION TECHNOLOGIES AMONG THE FARMERS IN MEERUT DISTRICT CONDITIONS : A SUCCESSFUL VENTURE

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ABSTRACT

The case study was observed in Meerut conditions with the part of western Uttar Pradesh. The six villages viz., Hastinapur khas, Ganeshpur, Phulabda, Lawar, Dabka and Pipli khera were randomly selected, further four blocks namely Hastinapur, Mawana, Sardhana and Kharkhonda in Meerut district were selected. From each block 40 farmers were selected. Thus, in all 160 farmers were randomly selected. The finding indicated on cost returns aspect of flower crops cultivation. The data collected on during 2016-17 and 2017-18 was subjected to the anglicized. It can be effectively, virtually and successfully venture put under the cultivation of flowers like marigold, chrysanthemum, gladiolus and tuberose under the programme of front line demonstrations (FLDs) and their update knowledge like is practices farmers (PF) trainings. Due to weather is good for better in flowers cultivation during period and availability of irrigation facility, potential seeds and fertilizers, farmers in Meerut district. The case study was also monitored regularly. The high yielding varieties of flowers recorded significantly higher yield and with quality produces in the field over the local varieties. The farmers recoded on average yield of marigold (168.6 q/ha), chrysanthemum (217840 sticks/ha), gladiolus (128520 spikes/ha) and tuberose (120600 spikes/ha) in high yielding varieties respectively.

Key words : Flowers, FLDs, cost of production.

Floriculture has been a major thrust area for diversification of horticulture. Growing of flowers and ornamental crops is rapidly expanding enterprise. The floriculture continues to generate employment opportunities to people in rural area. An area under flower cultivation can support a family consisting of 4 to 6 members. Flowers are the beauty and better in human life. All flowers cultivation in condition of Meerut is getting popular among the farmers. The state Uttar Pradesh is blessed with some famous religious shrines and huge amount of flowers are needed for worship. In spite of the increasing demand for the crop the production is low to fulfil the domestic demand. Main reason for low production and less adoption of flower crops in their farming system is lack of awareness regarding scientific package of practice and its economic importance (2). There is expansive or wide potential for growing flowers because the Meerut district areas can be effectively, virtually and successfully put under the cultivation of flowers like marigold, chrysanthemum, gladiolus and tuberose.

Due to weather is good for better in flowers cultivation during period and availability of irrigation facility, potential seeds and fertilizers, farmers in Meerut district areas, Western Uttar Pradesh conditions. Hastinapur khas, Ganeshpur, Phulabda, Lawar, Dabka and Pipli Khera villages district Meerut can be grown these flowers throughout the year. As these villages were well connected by road, there will be no problem of marketing also. There is also near NCR New Delhi area, due to huge demand and supply gap of flowers in the local market, the traders directly come to the farmers field to collect fresh flowers regularly. The recommendations for suitable high yielding varieties of flowers were also available with the IARI, New Delhi and NBRI, Lucknow. Thus, it was hypothesized that cultivation of flowers will improve the household economy of flowers in the villages.

INTERVENTION AND ADOPTION OF TECHNOLOGYIES

Observing the interest of few farmers in flower

cultivation, FLD's, and training programme was organized to provide the "Know How and Do How" of farmers cultivation for the farmers in Meerut villages. Initially farmers were provided with the quality seeds and seedlings of high yielding varieties (HYV) of Marigold, Chrysanthemum, Gladiolus and Tuberose.

The planting was done by the farmers under the scientific knowledge their update and supervision with advised of Horticulture Scientist (HS) of Krishi Vigyan Kendra, Hastinapur, Meerut but the crop was managed by the farmers himself with his inputs and labour. The high yielding varieties of flowers results is recorded significantly higher yield and with quality produces in the field over the local varieties. The farmers recoded on average yield of marigold (168.6 q/ha), chrysanthemum (217840 sticks/ha), gladiolus (128520 spikes/ha) and tuberose (120600 spikes/ha) in high yielding varieties respectively. To the introduction of Pusa Narangi, Pusa Arpita and Calcutta variety in marigold during the programmes. It has been observed that the plants of marigold grow straight upwards to their height and develop into terminal flower bud. However, if the terminal portion of shoot is removed early, emergence of side branches starts earlier and more number of flowers of good quality and uniform size are produced. By production of terminal flower bud, side buds become free from correlative inhibition of apical dominance and these buds develop into branches to produce flowers. and the Jaimla, Golden Bounty and Indian pink variety in chrysanthemum is very effective in Western Uttar Pradesh condition. The standard chrysanthemum varieties have the genetic potential to produce single bigger sized bloom on a branch if disbudding and proper feeding is done. Similarly more number of pinching can be done to produce more standard flowers per plant. and gladiolus varieties considered as a White Prosperity, Friendship, Nova Lux, American beauty, Pusa Kiran and Pusa Chandni. Now, as well as Tuberose varieties is Shirangar, Pearl double, Vaibhav and Subhasini, it produce waxy, white and fragrant flowers on long spikes which are mostly used as cut flower, for making garlands and extracting essential oil. All flowers crop are recorded 30 - 42 percent higher flowers yield over the farmer's local variety. It is more importantly flowers with the considered of varieties were cultivated commercially and scientifically for the first time by the progressive farmers in these Meerut district conditions.

MATERIALS AND METHODS

The present study was carried out and observed by Krishi Vigyan Kendra, Hastinapur during 2016-17 to 2017-18 in the farmers field of Meerut district conditions. The district comprises of six villages viz., Hastinapur khas, Ganeshpur, Phulabda, Lawar, Dabka and Pipli khera were randomly selected, further four blocks namely Hastinapur khas, Mawana, Sardhana and Kharkhonda in Meerut district were selected. From each block 40 farmers were selected. Thus, in all 160 farmers were randomly selected. All the intercultural operations were adopted according to package of practice. Materials for the present study with respect to Front Line Demonstrations (FLD's) and Farmers Practice (PF) were given in the table B. Trainings, field day and regular monitoring were also conducted. All the finding indicated on cost returns aspect of flower crops cultivation. The data collected on during 2016-17 and 2017-18 was subjected to the anglicized. The cost ratio concepts approaches to farm casting are widely used in India (3) and study of the technology gap and technology index were calculated as suggested by (4).

IMPACT AND IMPLICATIONS

Successful and commercial cultivation of flowers created a positive impact and uplifted the socio economic of the farmers in the villages. There net return varied marigold, chrysanthemum, gladiolus and tuberose from 153820.00 Rs/ha, 257810.00 Rs/ha, 182050 Rs/ha and 154800.00 Rs/ha due to cultivation of flowers successfully. The flowers wife and children were also engaged in value addition of flowers through making boundless, packaging, garland and there by more employment was generated along with more empowerment of the farm woman, thus through the introduction of floriculture, a positive and significant impact was created in the villages. At present about 30 – 35% of the requirement of flowers are meet locally from the farmers field (5). There is increasing demand for flower cultivation in these villages after successful demonstration of technology in the farmer's field through Front Line Demonstrations (FLD's). Flowers cultivation has for reaching beneficial consequences in these areas. Commercial flowers cultivation has increased the income stability of the flower crops with better income distribution throughout the year (6). As flower cultivation is less require much application of

Studies an intervention and adoption of flowers production technologies among the farmers in Meerut district conditions

Table 1 : Impact of adoption of commercial floriculture in farmers field.

Impact indicators	Before	After
a. Employment generated	38	186
b. Average household (Rs.)	16500.00	29500.00
c. Income stability	More fluctuating	Stable

Table B. Yield and Economics of flowers in the farmers field in Meerut conditions.

Crops (Local variety/ High Yielding Variety)	Yield (q/ha or No. of spikes & stick/ha)	Cost of cultivation (Rs/ha)	Total Gross return (Rs/ha)	Net return (Rs/ha)	B.C. Ratio
Marigold					
Local	128.0	41200.00	153600.00	112400.00	1:3.72
HYV	168.6	48500.00	202320.00	153820.00	1:4.17
Chrysanthemum					
Local	182450.00	63430.00	273675.00	210245.00	1:4.31
HYV	217840.00	68950.00	326760.00	257810.00	1:4.70
Gladiolus					
Local	100140.00	124800.00	250350.00	125550.00	1:1.20
HYV	128520.00	139250.00	321300.00	182050.00	1:1.34
Tuberose					
Local	85230.00	67500.00	170460.00	102960.00	1:1.92
HYV	120000.00	85200.00	240000.00	154800.00	1:2.81

Sale price : Marigold 1200/- qtl., Chrysanthemum 1.5/- stick, Gladiolus 2.5/- spike and Tuberose 2.0/- spike.

pesticide, irrigation, fertilizers and extensive cultivation of flowers (replacing sugarcane farmers) also have the potential to prevent environmental pollution and save the ecosystem of these western Uttar Pradesh conditions.

Similarly, if we compare the productivity of varieties (grown by the there is wide gap in potential yield of the flowers resent developed varieties and with yield obtained at farmers field). The main reasons of low productivity in this region are use of obsolete varieties susceptible to pest and diseases, imbalanced fertilizer use, poor management of soil and available water resource and with conventional farming practices lacking in the utilisation of improved production technology etc. (1).

This can be realized by applying advanced, environmental friendly technology, which can be manage and allocate all resources efficiently for income stability. Floriculture has emerged as an important agribusiness, providing employment opportunities and entrepreneurship in both urban and rural areas. It has been found that commercial floriculture has higher potential per unit area than most of the field crops and therefore, a lucrative business.

FARMERS REACTION

The front line demonstration, on farm testing and practice farmers has revealed that the farmers of the area were highly impressed by the technologies. Also the farmers were thoroughly convinced that the improved practices like high yielding varieties and application of balanced fertilizer dose (right proportion, adequate quantity and right time of application) contributed a more efficient in realising higher yields.

CONCLUSION

It may be concluded that as per the agro- climatic conditions in Meerut, the technological intervention should be adopted for the technological viability, suitability and sustainability in context of more profit of farmers smart income. Technological and extension gap extended can be bridged by improved package of practices with emphasis on improved production technology including all cultural operations. Replacement of local variety with the high yielding variety (HYV) of flower crops would increase the production and net income of the farmers also.

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ASSOCIATION OF SOCIOMETRIC STATUS WITH DIFFERENT PERSONAL AND SOCIO-ECONOMIC VARIABLES OF 6-8 YEARS OLD CHILDREN

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ABSTRACT

In this research, Faizabad region of state Uttar Pradesh was selected as locales for studying the problem related to sociometric status. This region includes five districts namely-Faizabad, Barabanki, Sultanpur, Ambedkar Nagar and Gonda. Four Schools and hundred children from each district were selected. Hence a total of 500 primary school children were assessed for Association of sociometric status with different personal and socio-economic variables of 6-8 years old children. Result of this study shows that, sociometric is associated with family size, mother's occupation, father's occupation, mother's education, father's education and number of earning members. Whereas six values were not significant, hence null hypothesis for age, sex, birth order, number of siblings, family type and monthly income. These variables were accepted. Hence it may be calculated that sociometric status of 6-8 years old children were independent of their age, sex, birth order, number of siblings, family type and monthly income.

Keywords : *Sociometric Status, Association, Socio-Economic Variables.*

INTRODUCTION

In the present scenario human beings strive for popularity in different social groups, but all do not achieve the same degree of success. In any social group one comes across the popular people, rejected ones, isolated ones and some being in between. The modern educational practices aim at overall development of personality of the people because there are individual differences among children in their characteristics, behaviors and skills. To a large extent these individual differences are the outcomes of many factors. One such factor is the social and cultural group to which children belong.

Among the modern techniques of assessing and there by help in developing the personality of an individual, Sociometric techniques in the past three decades have increasingly been used as means of assessing peer relations among children. Sociometric techniques are defined as the measures of interpersonal attraction among the members of a specified group. It is an experimental methodology applicable to all social sciences. Etymologically, 'sociometry' has been derived from the Latin word 'socius' meaning 'social'

and the Latin 'metrum' or the Greek 'metron' meaning 'measure'. Thus, the term means 'social measurement'. To examine the social status of children, the technique sociometry can be applied on children, thus providing an evaluation of a child's peer relations from the perspective of peers themselves, rather than relying on outside or external adult source of information. Moreover, the sociometric measures provide a simple procedure for gathering information on a considerable number of children in a relatively short period of time (depending on the measures used).

REVIEW OF LITERATURE

Sociometric techniques are the measures of inter-personal attraction among the members of a specified group. When applied to children, it provides an evaluation of a child's peer relations from the perspective of peers themselves because, peer group influence speech, values, clothing habit, modes of behavior etc. Sociometric assessments also show relatively good temporal stability (4). A further advantage of the sociometric approach is that status is correlated with other indices of adjustment both concurrently and predictive (9). Differences in

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sociometric status of children can be the out-come of many factors including the social group, to which children belong, the opportunities of peer interaction and problem- solving, temperament of the children, exposure to the behavior of family members and home environment. Parenting style and disciplinary techniques used in the home are also the factors that affect children's peer relationship and directly or indirectly have impact/relation on sociometric status of children.

Research studies have revealed that rejected children are agonistic, aggressive, rebellious, inconsiderate of others, insensitive, dishonest and are poor in joining a peer group (Coie *et al.*, 1982).

Researchers have identified a variety of characteristics and behaviors that are associated with being accepted or rejected in a peer group. The peer report studies suggest that social acceptance (positive status) is related at all ages to helpfulness, rule conformity, friendliness and pro-social interaction. Social rejection (negative status) is related to disruptiveness and aggression at all ages.

Popular or well liked children seem to be those who are helpful to peers, follow the rules, co-operate in group situation and are generally competent. Rejected children more often seem to be off task. They are also more often involved in negative interactions with others, particularly, aggressive and argumentative interactions. There is sample evidence that teachers perceive rejected children as displaying two types of behavior- hyperactive and disruptive and aggressive. Rejected children appear to be anxious to be involved not shy.

(8) have reported that socio-personal variables like academic performance, parental and maternal educational level, occupational status of the family and family income are significantly correlated with sociometric status of the children as well as number of positive ratings. Acceptance and social preferences are positively correlated with successful peer group entry, popularity among class- mates, outgoing social behavior and positive conflicts resolution strategies.

In modern society, children are experiencing social interaction with peers at an early age and for longer time periods. Peer relationships play a significant role in the social development of children. Peer relationships have qualities that do not exist in

adult-child relationships (6). Children need to value each other's opinion for peer acceptance. They negotiate and compromise for conflicts resolution and learn give and take to have successful peer interactions. The development of these skills promotes social competence. Peers have significant pressure on children's behavior because they can modify behavior by acceptance or rejection.

MATERIAL AND METHODS

Sample: Five hundred 6 to 8 years old primary school children from Faizabad Region of State Uttar Pradesh participated in the present study.

Measures: The children were administered with Sociometric measures, to assess the Sociometric status of children. The nomination measure was used.

Nomination measure (Hymel, 1983) :

This is the traditional and most commonly used sociometric technique. Children were individually and separately asked to identify three peers according to the specified interpersonal criteria. Both positive and negative sociometric criteria were used (for example, "Name three classmates you like very much," versus, "Name three classmates you do not like at all"). In an attempt to simplify the task for 6-8 yrs old children, a modification of the procedure was used. In this procedure, the photographs of peers were used as the stimulus materials. Photographs of all children in the age range of 6-8 years were put on a display board. Children were required to select the photographs of peers, i.e., three for positive and three for negative nomination from the full group display. This procedure was presumably thought to avoid the memory problems with 6-8 years old children.

For scoring of the nomination data, procedure suggested by Hymel (1983) was used. Two different scores were obtained, depending on the sociometric criteria (positive or negative) used: acceptance and rejection scores. Positive nominations received from peers were used to compute acceptance scores, while negative nominations from peers were used to compute rejection scores.

The unweighted scoring system was used in which the child's score on the nomination measure is simply the total number of nominations received from peers (without weighting scores in terms of order of nomination). Acceptance and rejection scores were

considered to be separate indices of social status and were calculated and examined independently. On the basis of this method, the nominations received were further classified into six categories. These categories were a combination of the classifications as suggested by Hymel (1983) and Ladd (1983).

The classification is as follows :

Popular children : Who received large number of positive choices (high liking and low disliking scores).

Rejected Children : Who received large number of negative choices (High disliking and low liking scores).

Average children : Who received relatively few positive and negative choices?

Isolated children: Who failed to receive even a single choice, or no positive and very few negative, or no negative and very few positive choices? Physically an isolate is member of the group but he is not treated psychologically as such by other member, as no one interacts with him, neither accepts, or rejects.

Controversial children: Who received high liking and disliking scores?

A combination of acceptance and rejection scores was also used to create a single index of social status. Social preference score (acceptance minus rejection scores) was computed to assess the degree of likeability and unacceptability among children.

For both measures, the nomination and rating scale, scores were calculated and computed separately with the help of allotted scores.

RESULTS AND DISCUSSION

Demographic profile and association of sociometric status with different personal and socio-economic variables of children.

There were total 4016 children in 80 schools selected for the study. All the children were assessed for their sociometric status and personal & socio economic variables. Therefore, Children were categorized in the 3 sociometric status groups i.e. *Happy, Neutral & Sad* on the basis of peer rating. Neutral children were excluded from the sample. Rests of the children were taken for peer nomination. Peer Nomination were having 4 groups i.e. *Popular, Rejected, Average, Isolated, and Controversial*.

Details of these variables have been presented in the following tables. Figures in parentheses are in percentages.

Table 1. Sociometric Status at a glance.

Variables	Total N = 4016
Popular	1436 (35.76)
Rejected	1040 (25.90)
Average	1408 (35.06)
Isolated	80 (1.99)
Controversial	52 (1.29)

As evident from the above table 1 maximum percentage of children (35.76%) were popular followed by average (35.06%), rejected (25.90%), isolated (1.99%) and controversial (1.29%). The above findings are in congruence with (5) identified status groups of popular, rejected, neglected, controversial and average boys. Rejected or neglected boys were those who were engaged in inappropriate behaviour. They were engaged in physical aggression more than any other group. Popular boys refrained from aggression. Controversial boys were engaged in high frequencies of both prosocial and antisocial behaviours.

Table 2. Sociometric Status and Age.

Variables	6 yrs n=1204	7yrs n=1352	8yrs n=1460
Popular	436 (36.21)	492 (36.39)	508 (34.79)
Rejected	320 (26.58)	340 (25.15)	380 (26.03)
Average	412 (34.22)	476 (35.21)	520 (35.62)
Isolated	20 (1.66)	28 (2.07)	32 (2.19)
Controversial	16 (1.33)	16 (1.18)	20 (1.37)

Age wise distribution of sociometric status has been incorporated in Table 2. In case of 6 yrs old children, majority (36.21%) of them were popular followed by average (34.22%), rejected (26.58%), isolated (1.66%) and controversial (1.33%). Among 7 yrs children same trend was seen that, maximum percentages (36.39%) of respondents were popular followed by average (35.21%), rejected (25.15%), isolated (2.07%) and controversial (1.18%). Regarding 8 yrs respondents table further indicated that, maximum percentages (35.62%) of children were average followed by popular (34.79%), rejected (26.03%), isolated (2.19%) and controversial (1.37%).

Table 3. Sociometric Status and Sex

Variables	Male (N=2152)	Female (N=1864)
Popular	764 (35.50)	672 (36.05)
Rejected	564 (26.21)	476 (25.54)
Average	752 (34.94)	656 (35.19)
Isolated	44 (2.04)	36 (1.93)
Controversial	28 (1.30)	24 (1.29)

Table 3 indicated gender wise sociometric status. Regarding male respondents it was found that, majority (35.50%) belongs to popular category followed by average (34.94%), rejected (26.21%) isolated (2.04%) and controversial (1.30%). Same trend was seen in case of female respondents that, majority (36.05%) belonged to popular category followed by average (35.19%), rejected (25.54%), isolated (1.93%) and controversial (1.29%).

Table 4. Sociometric Status and Birth order.

Variables	2nd n=1064	3rd n=1412	4th n=1536
Popular	384 (35.96)	508 (35.98)	544 (35.42)
Rejected	312 (29.21)	360 (25.50)	368 (23.96)
Average	344 (32.21)	500 (35.41)	564 (36.72)
Isolated	16 (1.50)	28 (1.98)	36 (2.34)
Controversial	12 (1.12)	16 (1.13)	24 (1.56)

Table 4 presents the distribution of sociometric status of respondents on the basis of birth order. Maximum percentages (35.96%) of second born children were popular followed by average (32.21%), rejected (29.21%), isolated (1.50%) and controversial (1.12%). In case of third born children, same trend was observed that, majority of respondents were popular and average (35.98% & 35.41%) followed by rejected (25.50%), isolated (1.98%) and controversial (1.13%). Further it was seen in same table that, maximum (36.72%) percentage of fourth born children belonged to average category followed by popular (35.42%), isolated (2.34%) and controversial (1.56%).

Table 5. Sociometric Status and no. of siblings

Variables	1-3 n=1172	3-5 n=1944	5 &> n=900
Popular	404 (34.47)	684 (35.19)	348 (38.67)
Rejected	308 (26.28)	512 (26.34)	220 (24.44)
Average	420 (35.84)	672 (34.57)	316 (35.11)
Isolated	24 (2.05)	44 (2.26)	12 (1.33)
Controversial	16 (1.37)	32 (1.65)	4 (0.44)

Table 5 presents the distribution of sociometric status of respondents on the basis of number of siblings. Maximum percentages (35.84%) of average children were having 1-3 siblings followed by popular (34.47%), rejected (26.28%), isolated (2.05%) and controversial (1.37%). Further, maximum percentage (35.19%) of popular children was having 3-5 siblings followed by average (34.57%), rejected (26.34%), isolated (2.26%) and controversial (1.65%). In case of five and above siblings same trend was observed that, majority of (38.67%) of popular children was having 5 &> siblings followed by average (35.11%), rejected (24.44%), isolated (1.33%) and controversial (0.44%).

Table 6. Sociometric Status and Family Type

Variables	Nuclear n=2184	Joint N=1832
Popular	772 (35.35)	664 (36.24)
Rejected	568 (26.01)	472 (25.76)
Average	764 (34.98)	644 (35.15)
Isolated	48 (2.20)	32 (1.75)
Controversial	32 (1.47)	20 (1.09)

Table 6 indicated regarding sociometric status on the basis of family type. Result reveals that, maximum percentage (35.35%) of popular children belonged to nuclear family system followed by average (34.98%), rejected (26.01%), isolated (2.20%) and controversial (1.47%). Regarding joint family system, maximum percentages (36.24%) of popular children belonged to joint family system followed by average (35.15%), rejected (25.76%), isolated (1.75%) and controversial (1.09%).

Table 7. Sociometric Status and Family Size

Variables	Small (3-6) n=1368	Medium (6-9) N=1652	Large (9 &>) n=996
Popular	468 (34.21)	604 (36.56)	364 (36.55)
Rejected	364 (26.61)	412 (24.94)	264 (26.51)
Average	496 (36.26)	564 (34.14)	348 (34.94)
Isolated	24 (1.75)	48 (2.91)	8 (0.80)
Controversial	16 (1.17)	24 (1.45)	12 (1.20)

Table 7 depicted regarding sociometric status on the basis of family size. Result reveals that, maximum percentage (36.26%) of average children belonged to small family followed by popular (34.21%), rejected (26.61%), isolated (1.75%) and controversial (1.17%). Regarding medium family size, maximum percentages

(36.56%) of popular children were belonged to medium family followed by average (34.14%), rejected (24.94%), isolated (2.91%) and controversial (1.45%). Further same trend was observed in case of large family that, maximum percentages (36.55%) of popular children belonged to large family followed by average (34.94%), rejected (26.51%), controversial (1.20%) and isolated (0.80%).

Table 8. Sociometric Status and Mother's occupation.

Variables	House Wife n=2572	Labour N=1032	Service n=412
Popular	896 (34.84)	384 (37.21)	156 (37.86)
Rejected	668 (25.97)	272 (26.36)	100 (24.27)
Average	908 (35.30)	352 (34.11)	148 (35.92)
Isolated	68 (2.64)	8 (0.78)	4 (0.97)
Controversial	32 (1.24)	16 (1.55)	4 (0.97)

Table 8 presents the sociometric distribution of respondents on the basis of mother's occupation. Analysis unveils that, maximum percentages (35.30%) of average children's mothers were house wife followed by popular (34.84%), rejected (25.97%), isolated (2.64%) and controversial (1.24 %). Table further shows that, maximum percentages (37.21%) of popular children's mothers were labour followed by average (34.11%), rejected (26.36%), controversial (1.55 %) and isolated (0.78%). Further, maximum percentages (37.86%) of popular children's mothers were in service followed by average (35.92%), rejected (24.27%), controversial (0.97 %) and isolated (0.97%).

Table 9. Sociometric Status and Father's Occupation.

Variables	Ag. n=1040	Labour N=524	Business n=1084	Service n=1368
Popular	384 (36.92)	156 (29.77)	416 (38.38)	480 (35.09)
Rejected	260 (25.00)	148 (28.24)	288 (26.57)	344 (25.15)
Average	356 (34.23)	196 (37.40)	372 (34.32)	484 (35.38)
Isolated	32 (3.08)	8 (1.53)	4 (0.37)	36 (2.63)
Controversial	8 (0.77)	16 (3.05)	4 (0.37)	24 (1.75)

Analysis of table 9 unveils that; maximum percentages (36.92%) of popular children's fathers were doing agriculture followed by average (34.23%), rejected (25.00%), isolated (3.08%) and controversial (0.77 %). Table further shows that, maximum percentages (37.40%) of average children's fathers were labour followed by popular (29.77%), rejected (28.24%), controversial (3.05 %) and isolated (1.53%). Further,

maximum percentages (38.38%) of popular children's fathers were in business followed by average (34.32%), rejected (26.57%), controversial (0.37 %) and isolated (0.37%). Again it can be seen in same table that, maximum percentages (35.38%) of average children's fathers were in service followed by popular (35.09%), rejected (25.15%), isolated (2.63%) and controversial (1.75%).

Table 10. Sociometric Status and Mother's Education

Variables	Illiterate n=2532	Pri.-Se.Sec. n=468	Graduate/ PG n=1016
Popular	904 (35.70)	168 (35.90)	364 (35.83)
Rejected	648 (25.59)	116 (24.79)	276 (27.17)
Average	900 (35.55)	164 (35.04)	344 (33.86)
Isolated	56 (2.21)	4 (0.85)	20 (1.97)
Controversial	24 (0.95)	16 (3.42)	12 (1.18)

Education is one of the most important variables which influence the status, behaviour, attitude, belief and outlook towards life of respondents in the society.

The result pertaining to sociometric status on the basis of mother's education has been incorporated in Table 10. The table revealed that, 35.70 percent popular children were having illiterate mothers followed by average children (35.55%), rejected children (25.59%), isolated children (2.21%) and controversial children (0.95 %). Further it was depicted in same table that, 35.90 percent popular children were having educated mothers whose education was up to senior secondary level followed by average (35.04%), rejected (24.79%), controversial (3.42%) and isolated children (0.85 %). Further, 35.83 percent popular children were having graduate/PG mother followed by average children (33.86%), rejected children (27.17%), isolated children (1.97%) and controversial children (1.18 %).

Table 11. Sociometric Status and Fathers' Education

Variables	Illiterate n=2472	Pri.-Se.Sec. n=452	Graduate/ PG n=1092
Popular	884 (35.76)	156 (34.51)	396 (36.26)
Rejected	636 (25.73)	116 (25.66)	288 (26.37)
Average	880 (35.60)	148 (32.74)	380 (34.80)
Isolated	56 (2.27)	8 (1.77)	16 (1.47)
Controversial	16 (0.65)	24 (5.31)	12 (1.10)

The table 11revealed that, maximum percentages (35.76%) of popular children were having illiterate

father followed by average (35.60%), rejected (25.73%), isolated (2.27%) and controversial children (0.65 %). Further it was depicted in same table that, 32.74 percent average children were having fathers whose education was up to senior secondary level followed by popular children (34.51%), rejected children (25.66%), controversial children (5.31%) and isolated children (1.77%). Further, maximum percentages (36.26%) of popular children were having graduate/PG father followed by average (34.80%), rejected (26.37%), isolated (1.47%) and controversial children (1.10 %).

Table 12. Sociometric Status and No. of earning members

Variables	one n=3288	Two n=728
Popular	1196 (36.37)	240 (32.97)
Rejected	832 (25.30)	208 (28.57)
Average	1160 (35.28)	248 (34.07)
Isolated	64 (1.95)	16 (2.20)
Controversial	36 (1.09)	16 (2.20)

Result revealed that, 36.37 percent popular children were having one earning member in their family followed by average children (35.28%), rejected children (25.30%), isolated children (1.95%) and controversial children (1.09%). Further, 34.07 percent average children were having two earning member in their family followed by popular children (32.97%), rejected children (28.57%), isolated children (2.20%) and controversial children (2.20%) (Table 12)

Table 13. Sociometric Status and Monthly Income.

Variables	500-4500 N=2308	4500-8500 n=1248	8500 &> n=460
Popular	804 (34.84)	464 (37.18)	168 (36.52)
Rejected	600 (26.00)	320 (25.64)	120 (26.09)
Average	840 (36.40)	420 (33.65)	148 (32.17)
Isolated	40 (1.73)	24 (1.92)	16 (3.48)
Controversial	24 (1.04)	20 (1.60)	8 (1.74)

Table 13 revealed that, 36.40 percent average children were having 500-4500 rupees per month in their family followed by popular children (34.84%), rejected children (26.00%), isolated children (1.73%) and controversial children (1.04%). Further it was seen that, 37.18 percent popular children were having 4500-8500 rupees per month in their family followed by average children (33.65%), rejected children (25.64%), isolated children (1.92%) and controversial children (1.60%). Further, 36.52 percent popular

children were having 8500 & above rupees per month in their family followed by average children (32.17%), rejected children (26.09%), isolated children (3.48%) and controversial children (1.74%).

Table 14. Values between sociometric status and different personal and socio-economic variables under study.

Different Personal Variable	(²)	d.f	Significance at 5% level
Age	2.69	8	NS
Sex	0.34	4	NS
Birth Order	14.30	8	NS
No. of Siblings	13.75	8	NS
Family Type	2.34	4	NS
Family Size	18.26	8	S
Mother's Occupation	18.85	8	S
Father's Occupation	59.05	12	S
Mother's Education	23.95	8	S
Father's Education	68.48	8	S
No. of Earning Members	10.43	4	S
Monthly Income	13.02	8	NS

As evident from the table 14, Chi (²) values were calculated to test association of sociometric status and different personal and socio-economic variables with sociometric status-independent of association of attributes. Out of twelve (²) values six were significant at 0.5 level. Hence null hypothesis for the independence of association of attributes may be rejected. It may be calculated that sociometric is associated with family size, mother's occupation, father's occupation, mother's education, father's education and number of earning members. Whereas six values were not significant, hence null hypothesis for age, sex, birth order, number of siblings, family type and monthly income. These variables were accepted. Hence it may be calculated that sociometric status of 6-8 years old children were independent of their age, sex, birth order, number of siblings, family type and monthly income.

CONCLUSIONS

Result of this study shows that, sociometric is associated with family size, mother's occupation, father's occupation, mother's education, father's education and number of earning members. Whereas six values were not significant, hence null hypothesis for age, sex, birth order, number of siblings, family

type and monthly income. These variables were accepted. Hence it may be calculated that sociometric status of 6-8 years old children were independent of their age, sex, birth order, number of siblings, family type and monthly income.

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IMPACT OF ORGANIC NUTRIENTS ON YIELD AND GROWTH PARAMETERS OF TOMATO

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ABSTRACT

Today global food crisis is one of the major highlighted problems of the increasing population and is playing major role in applying high pressure on food production. To meet this, increasing demand of agricultural produce, farmers are using chemical fertilizers along with pesticides to such an extent that it is degrading the quality and productivity of the natural resources. Organic farming is the right tool for the sustainable agriculture in the changing environmental condition for backing to its original form. The study has been proposed to investigate the impact of organic and inorganic nutrient sources on growth, yield and post-harvest life of tomato. A field experiment was conducted to investigate the morphological performance, yield and shelf life of tomato variety Angoorlata under organic and inorganic nutrient sources. Organic manures exhibited a significant influence on morphological and shelf life of tomato fruit at different storage conditions viz., open at room temperature and at refrigerated conditions.

Keywords : Tomato, Organic Agriculture, Farmyard Manure, Vermicompost

INTRODUCTION

Tomato (*Lycopersicon lycopersicum* L.) is very important member of the nightshade family and one of the leading commercial vegetable crops grown globally. Tomato is consumed in diverse ways including raw in salads or cooked in sauces, soup, meat or fish dishes. It can be processed into purees, juices, ketchup, and drinks. Tomato requires nutrients such as N, P, K, Mg, Ca, Na and S for good production. These nutrients are specific in function and must be supplied to plant at the right time and in the right quantity (15). For improving plant growth and development, use of organic and inorganic or fertilizer is essential (7). Organic fertilizers are natural while inorganic fertilizers are synthetic and it has been reported that indiscriminate use of chemical fertilizers without addition of sufficient amount of organic matter in soil deteriorates the soil properties, the fruit quality and shelf life of the fruit (19).

It is also being reported that organically grown tomatoes have better shelf life as compared to inorganically grown tomato fruits (Patil et al. 2004). Several workers have suggested that higher amount of organic amendments particularly vermicompost, cow dung manure and biofertilizer along with reduced level of inorganic nitrogen can enhance the fruit yield,

quality and post-harvest life of tomato fruits (8). (11) reported that tomato fruits from organic farming accumulate more nutritional compounds, such as phenolics and vitamin C as a consequence of the stressing conditions associated with farming system. Organic fertilizers may act as an energy source for microorganisms in the soil, which can improve soil structure and plant growth. The present research work was initiated to study the effect of organic and inorganic regimes on the production of tomato variety Angoorlata.

MATERIAL AND METHODS

The present research work was conducted at Amity University Noida, Uttar Pradesh (28.530 N and 77.390 E) during the year 2018. The agro ecological region has hot, sub humid (dry) climate. The soil of the experimental site was sandy loam with low organic carbon content and alkaline in nature. The soil was free from chemical fertilizers and insecticide / pesticides. The Organic Institutional Farm has been maintained for the past ten years. The soil of the experimental site was sandy loam with low organic carbon content and alkaline in nature. The physico-chemical characteristics of the soil in the experimental field were – pH 7.8, EC, 0.528 ms cm⁻¹, organic carbon 0.58 % (12), available Nitrogen – 263.24 kg ha⁻¹ (16),

available Phosphorous - 25.9 kg ha⁻¹ (18) and available Potassium – 332.8 kg ha⁻¹ (14).

The experiment, comprising of three diverse nutritional ambient (T₁–Organic; T₂ – Inorganic, T₃ – Control (no fertilizers)) and tomato variety Angoorlata was conducted in a Randomized Block Design with three replications. Nursery was grown on raised bed and seedling was transplanted after 4 weeks when the seedlings were 9-12 cm in height having 4-7 compound leaves. The organic supplement comprised of Farmyard Manures, Vermicompost @ 15-20t/ha at the time of final ploughing and as Green Manure Dhaincha (*Sesbania aculeate* L.) crop was incorporated in the plot. Inorganic fertilizers; 100-125 kg N (Urea), 60-80 kg P₂O₅ (Single Super Phosphate) and 40-50 kg K₂O (Murate of Potash) was applied. 1/3 N, full P₂O₅ and K₂O was incorporated at the time of transplanting and remaining N after 45 days. The growth and yield parameters plant height at various stages, number of branches plant⁻¹, number of leaves plant⁻¹, number of flowers plant⁻¹, number of fruits plant⁻¹, fruit length (cm), fruit diameter(cm), weight of individual fruit(g), fruit yield plot⁻¹ fruit yield per hectare, shelf life (days) of the fruit at room temperature and at refrigerated condition were recorded.

Plant height was measured from the ten sample plants in centimeters from the ground level to the tip of the longest stem at 90 DAT (days after transplanting) and mean was calculated. Branches plant⁻¹ was recorded under each treatment at 60 days after transplanting from selected three plants and average was calculated. Flower plant⁻¹ was recorded under each treatment at 60 days after transplanting of selected plants.

Size of the fruit was measured with the help Vernier Caliper and expressed in centimeters (cm). Fruit weight was measured on a semi-analytical scale as whole fruits and individually weighed and results were expressed in grams (g). The yield in quintal per hectare was calculated by taking the total yield plant⁻¹ under each treatment and then converted into per hectare.

Shelf life :

Shelf life is calculated as the period of time between harvesting and period of start of rotting of fruits. Parameters measured were number of days for fruits to wrinkle and number of days to watery. The harvested ripe fruits were placed on a clean table in a store at

room temperature (24-30°C) for observing the changes critically on daily basis. Signs of wrinkleless were observed and the number of days it took to wrinkle. The number of days it took to watery was also noted for each treatment samples taken.

RESULTS AND DISCUSSION

Growth parameters :

Influence of organic and inorganic nutrients on growth related attributes of tomato are depicted in table 1. Maximum value (47.67 cm) for plant height at 90 DAS was recorded in organic treatment (T₁) with an increase of 32.13% increase over the control. A higher number of branches and leaves in the plants indicate better growth and development of the plants. The maximum number of branches plant⁻¹(24.67) and leaves plant⁻¹ (194) was recorded in organic treatment (T₁) with an increase of 32.13% and 23.04% over the control respectively. (Table 1 & Fig1.) Similar results were obtained by Brown (1995) who reported that the application of organic and inorganic fertilizer might have brought increase in the vegetative growth and induced more number of leaves in tomato plant. (10) observed that the application of organic manure along with compost improved soil water relationship, which affected bulk density and porosity of the soil, made available the moisture contents in proper proportion with required soil nutrients and hence promoted all growth parameters. These results are also in close resemblance with (4), who reported that organic fertilizers might contain high level of required nutrients which influenced the growth of plants.

A significant variation in the number of flower plant⁻¹ and number of fruits plant⁻¹ was observed due to effect of different nutrient treatment (Table 1). The highest number of flowers (60.33) and Fruits (7.33) plant⁻¹ was reported in organic treatment (T₁) with an increase of 58.76 % and 83.25 % over the control. The increment in the number of flower and fruits may be due to the climatic condition and influence of soil environmental factor that might have triggered the formation of flower thus by inducing hormonal activity. Similar findings were reported by (1) with the application of poultry and organic manures, with species of tomato plants. The results also coincides with (5) who reported that earliness in flowering of tomato may be due to the more important role played by manures as in contrast to synthetic fertilizers because manure contains full

Table 1: Effect of different nutrient sources on morphological, yield and shelf life parameters in tomato *Variety* Angoorlata

Treatment	Plant height (cm) 90 DAS	No. of Branches p ⁻¹	No. of leaves p ⁻¹	No. of flowers p ⁻¹	No. of Fruits p ⁻¹	Fruit length (cm)	Fruit diameter (cm)	Wt. of individual fruit (g)	yield plant ⁻¹ (kg)	Total yield (t/ha)	Shelf life (Days)	
											RT (OC)	RC (OC)
T ₁ (Organic Treatment)	47.67	24.67	194.00	60.33	7.33	3.05	2.27	12.03	0.78	27.27	7.67	13.33
T ₂ (Inorganic Treatment)	45.00	19.00	157.67	36.67	3.67	3.01	2.29	10.63	0.44	15.45	6.33	12.67
T ₃ (Control)	40.33	18.67	157.67	38.00	4.00	2.73	2.21	7.73	0.31	10.82	7.00	11.67
MEAN	44.33	20.78	169.78	45.00	5.00	2.93	2.26	10.13	0.51	17.85	7.00	12.56
SD	3.7151	3.3729	20.9751	13.2928	2.0246	0.1744	0.0416	2.1932	0.2424	8.4824	0.6700	0.8358

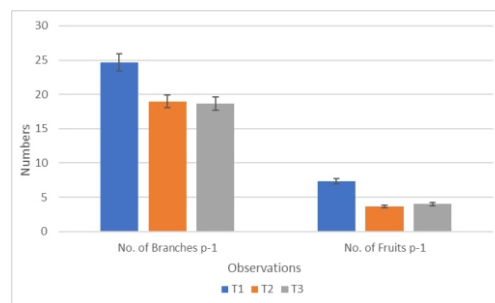
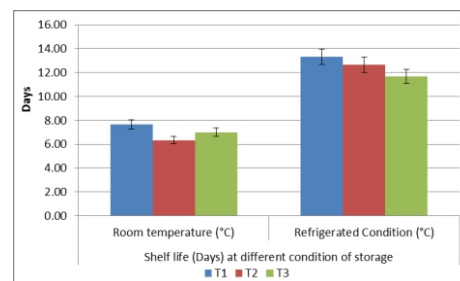
T₁ (Organic Treatment) T₂ (Inorganic Treatment) T₃ (Control)Figure 1 : Effect of different treatments on No. of Branches plant⁻¹ and Fruits plant⁻¹

Figure 2 : Effect of different treatments on Shelf life of tomato fruit at different storage conditions.

supplementation necessary for causing early flowering and inorganic regimes contain only NPK which may delay flowering in tomato plants. The number of fruits plant⁻¹ may increase due to the greater number of remained flowers on the plant and increased the chances to form more fruits by the plants treated with organic manures (3).

Fruit weight was measured on a semi-analytical scale as whole fruits and individually weighed and results expressed in grams (g), maximum fruit weight (12.03g) was reported in organic treatment (T₁) showing an increase of 55.62% over the control. The tomato fruit length was reported to be higher in organic treatment but in case of fruit diameter inorganic treatment showed better performance. (17) reported that farmyard manure was better than NPK as more fruit weight was recorded in tomato plants treated with organic manure as compared to inorganic fertilizer because organic manure has more water-holding capacity and provide continuous nutrients, which is in accordance with these result for more accumulation of weight in tomato plants treated with organic fertilizer.

Shelf Life

Fruits were stored at room temperature and were evaluated visually by visual evaluations. The average number of days it took tomato fruit to wrinkle was higher in organic nutrient manure application than in the inorganic nutrient manures. Maximum shelf life of

7.67 days and 13.3 days was recorded in tomato fruits stored at room condition and refrigerated conditions respectively (Table 1 & Fig 1). Hasanuzzaman (2) reported in a study that organic manures exhibited a significant influence on shelf life of tomato at different storage conditions viz., open at room temperature, polyethylene bag at room temperature and polyethylene bag in refrigerator. (9) reported an increase in the shelf life of tomato fruit with the application of vermicompost.

The study showed that use of organic fertilizer had better effects on growth and yield of tomato and also, organic farming is encouraged due to various advantages such as food safety, free from any chemical fertilizers and environment friendly.

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT IN RELATION TO VEGETATIVE PARAMETERS AND FRUITING BEHAVIOUR OF LEMON (*CITRUS LIMON* BURM) CV. PANT LEMON-1 IN SANDY LOAM SOIL UNDER WESTERN UTTAR PRADESH CONDITIONS

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ABSTRACT

A field experiment was carried out to study the effect of integrated nutrient management in relation to vegetative parameters and fruiting behaviour of lemon (*Citrus limon* Burm) cv. Pant Lemon-1 in sandy loam soil at Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut during summer season of 2011-12 and 2012-13. Result indicated that application of 75% NPK (315g N + 210g P + 315g K) + 10kg NC + 200g PSB + 200g Azotobacter found to be statistically significant and most beneficial & promotive in relation to maximum per cent increase in tree height (14.44 and 15.34 %), tree spread (16.20 and 17.68 %) and trunk diameter (11.21 and 13.55) during 2011-12 and 2012-13, respectively. Similarly, maximum fruit set (79.19 and 80.54 %) and fruit retention was recorded under 75% NPK (315g N + 210g P + 315g K) + 10kg NC + 200g PSB + 200g Azotobacter during 2011-12 and 2012-13, respectively. While maximum fruit drop (64.34 and 63.35 %) recorded under control treatment during 2011-12 and 2012-13, respectively. Maximum fruit set and fruit retention was observed under the spring flush, however more fruit drop in autumn flush.

Key Words : Pant Lemon-1, NPK, FYM, vermicompost, neem cake, PSB and azotobacter.

INTRODUCTION

Lemon (*Citrus limon* Burm) is one of the most important fruit crops belongs to family Rutaceae. Lemons are hardier than limes to both cold and heat. They have wide adaptability, since they can grow in humid and semi-humid regions, plains and area receiving high rainfall. Under Western Uttar Pradesh conditions, lemon has been found to be the most suitable citrus fruit due to its adaptability and high market demand throughout the year. Among several cultivars of lemon, Pant Lemon-1 is the most promising cultivar. It is a single plant selection from "Kagzi Kalan Lemon" (1). Lemons are primarily used as a fresh fruit. The main uses of fresh lemon are; making of lemonade, *Shikanji* and for a wide variety of culinary preparations like pies, cakes, dishes of vegetables, fish, meat and salads. It is extensively used for preparing lemon tea. Lemon is a good source of citric acid, which is used for pharmaceutical purposes and for aerated water. Extensive use of chemicals and

fertilizers with low doses of organic manures has resulted in deterioration of soil fertility and soil health as well. Moreover, the nutritional value of the crops will be affected seriously by the continuous use of synthetic fertilizer (10). Apart from the release of nutrient in slow manner, the application of organic fertilizers, which are made from animal excreta or other agricultural wastes is usually used to improve the structure and stability of the soil and in addition to enhancing the yield and quality of the crop plants (4). The use of bio-fertilizers in enhancing fruit quality and soil health has gained momentum in recent years. So, the scientific management of inorganic and organic fertilizers is very important for maintaining the soil productivity, to enhance fertilizer use efficiency and secure optimum vegetable production without harming the environment. Besides sustainable agricultural production, all round improvement in physical, chemical and biological make up of soils is the main aim of INM (3).

MATERIALS AND METHODS

The present studies were conducted at the Horticultural Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, 250110 (UP) during the two consecutive years i.e.; 2011-12 and 2012-13. The experiment was laid out in factorial randomized block design (FRBD) with three replications. The treatments involved in the study were 11 in numbers i.e. T₁ RDF (420g N + 280g P + 420g K) + 35kg FYM, T₂ 100% NPK (420g N + 280g P + 420g K) + 15kg VC, T₃ 75% NPK (315g N + 210g P + 315g K) + 20kg VC, T₄ 100% NPK (420g N + 280g P + 420g K) + 5kg NC, T₅ 75% NPK (315g N + 210g P + 315g K) + 10kg NC, T₆ 50% NPK (210g N + 140g P + 210g K) + 15kg VC + 10kg NC, T₇ 100% NPK (420g N + 280g P + 420g K) + 15kg VC + 200g PSB + 200g Azotobacter, T₈ 75% NPK (315g N + 210g P + 315g K) + 25kg VC + 200g PSB + 200g Azotobacter, T₉ 100% NPK (420g N + 280g P + 420g K) + 5kg NC + 200g PSB + 200g Azotobacter, T₁₀ 75% NPK (315g N + 210g P + 315g K) + 10kg NC + 200g PSB + 200g Azotobacter, T₁₁ 100% NPK (420g N + 280g P + 420g K) + 35kg FYM + 200g PSB + 200g Azotobacter per tree. The organic manure like FYM was incorporated in the lemon trees two weeks before fertilizers application, where as vermicompost, neem cake, PSB and azotobacter were mixed with soil prior to one week of fertilizers application. The fertilizers were applied separately in each tree in a ring made around the tree (60cm away from the tree trunk). The fertilizers were mixed thoroughly into 20 cm depth of soil according to treatment wise. Full dose of FYM, vermicompost, neem cake, P and K and half dose of N were applied in October and remaining half dose of N was applied in April-May during The experiment was conducted in lemon orchard during 2011-12 and 2012-13. Eleven year old uniform lemon trees were selected for the experimentation. All the trees were maintained under uniform cultural practices during the course of investigation. The sources of N, P and K were urea, single super phosphate and murate of potash, and organic sources i.e. FYM, vermicompost, neem cake, PSB and azotobacter.

RESULTS AND DISCUSSION

All the growth parameters were significantly influenced by integrated nutrient management under autumn and spring flush in two years of study of lemon. Results obtained from the present study

Table-1 : Effect of integrated nutrient management in relation to tree height, tree spread and trunk diameter of lemon (*Citrus limon* Burm) cv. Pant Lemon-1 in Sandy Loam soil.

Notation	Tree height (cm)						Tree spread (cm)						Trunk diameter (cm)					
	2011-12			2012-13			2011-12			2012-13			2011-12			2012-13		
	Initial	Final	% increa se	Initial	Final	% increa se	Initial	Final	% increa se	Initial	Final	% increa se	Initial	Final	% increa se	Initial	Final	% increa se
T ₁	236.00	241.67	2.40	245.80	254.40	3.50	350.33	376.00	7.33	385.40	416.66	8.11	42.000	43.167	2.78	44.27	45.53	2.84
T ₂	227.33	236.00	3.81	239.70	249.55	4.11	313.33	341.00	8.83	345.80	377.79	9.25	39.667	41.167	3.78	42.32	44.01	4.00
T ₃	255.33	268.67	5.22	271.50	288.09	6.11	300.00	331.33	10.44	350.30	388.27	10.84	37.167	39.700	6.82	41.02	44.10	7.52
T ₄	211.33	219.67	3.94	220.30	229.11	4.00	287.00	315.33	9.87	324.70	357.53	10.11	39.333	41.033	4.32	40.82	42.91	5.11
T ₅	233.00	248.67	6.72	252.80	271.05	7.22	325.00	360.00	10.77	377.90	420.49	11.27	36.833	39.433	7.06	41.50	44.75	7.82
T ₆	215.33	233.67	8.51	236.40	258.72	9.44	341.67	386.67	13.17	400.20	458.31	14.52	36.167	39.500	9.22	42.00	46.41	10.49
T ₇	217.67	242.33	11.33	250.40	282.38	12.77	314.33	356.33	13.36	365.20	419.25	14.80	37.167	40.833	9.86	41.82	46.60	11.44
T ₈	203.33	230.00	13.11	255.80	293.71	14.82	310.00	355.67	14.73	359.40	415.93	15.73	37.000	41.000	10.81	42.32	47.75	12.82
T ₉	201.33	226.33	12.42	247.80	280.01	13.00	340.00	387.67	14.02	410.20	472.96	15.30	41.167	45.400	10.28	46.35	52.21	12.65
T ₁₀	212.33	243.00	14.44	240.30	277.16	15.34	323.00	375.33	16.20	382.80	450.48	17.68	38.667	43.000	11.21	44.82	50.89	13.55
T ₁₁	224.67	247.33	10.09	250.30	277.83	11.00	295.00	334.00	13.22	339.80	387.75	14.11	36.167	39.667	9.68	40.35	44.53	10.35
SEm(±)	2.68	2.91		3.15	2.95		2.71	2.75		3.02	3.15		0.801	0.564		0.715	0.910	
CD at 5%	7.97	8.65		9.85	8.75		8.06	8.16		9.41	9.67		2.381	1.675		0.224	0.274	

Table-2 : Effect of integrated nutrient management in relation to fruit set, fruit drop and fruit retention of lemon (*Citrus limon* Burm) cv. Pant Lemon-1 in Sandy Loam Soil.

Notati on	Fruit set (%) under autumn and spring season				Fruit drop (%)under autumn and spring season								Fruit retention (%)							
	2012-13				2011-12				2012-13				2011-12				2012-13			
	Autum n flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean	Autu mn flush	Sprin g flush	Mean		
T ₁	55.40	65.62	60.51	56.20	66.11	61.16	70.44	58.23	64.34	69.25	57.44	63.35	30.35	41.42	35.89	31.47	42.38	36.93		
T ₂	67.81	70.54	69.18	68.34	71.30	69.82	69.49	56.89	63.19	68.10	56.24	62.17	32.52	44.61	38.57	33.52	45.14	39.33		
T ₃	69.38	71.87	70.62	70.20	72.44	71.32	67.84	50.89	59.37	66.44	49.53	57.99	35.70	46.54	41.12	37.44	47.38	42.41		
T ₄	68.47	70.97	69.72	69.50	71.59	70.55	68.36	52.28	60.32	67.88	51.60	59.74	34.62	45.58	40.10	35.22	46.18	40.70		
T ₅	70.65	73.03	71.84	71.20	73.89	72.55	66.51	50.45	58.48	66.04	48.32	57.18	37.41	48.00	42.70	38.22	48.98	43.60		
T ₆	73.53	75.24	74.39	74.44	76.11	75.28	68.01	49.64	58.83	67.37	48.34	57.86	37.72	49.40	43.56	39.00	51.14	45.07		
T ₇	74.70	76.60	75.65	75.10	77.35	76.23	62.52	47.20	54.86	61.52	45.32	53.42	40.73	52.63	46.68	41.72	54.18	47.95		
T ₈	75.78	79.42	77.60	76.34	81.14	78.74	59.43	44.35	51.89	58.33	42.88	50.61	44.05	55.99	50.02	45.02	57.28	51.15		
T ₉	75.40	78.20	76.80	76.15	80.20	78.18	61.48	45.38	53.43	60.70	44.80	52.75	43.00	53.36	48.18	44.02	55.13	49.58		
T ₁₀	77.84	80.53	79.19	78.72	82.35	80.54	56.11	42.71	49.41	54.44	40.79	47.62	44.73	58.48	51.61	45.47	60.23	52.85		
T ₁₁	74.39	76.38	75.38	75.49	77.40	76.45	63.65	48.16	55.91	63.00	47.52	55.26	40.59	51.75	46.17	41.12	52.18	46.65		
	Mean	71.21	74.40		71.97	75.44			64.90	49.65	63.92	48.44		38.31	49.80		39.29	50.93		
CD at 5%	Season	1.783			1.933				1.497		1.365			1.155			1.011			
	INM	4.181			4.534				3.511		3.2			2.708			2.37			
	Season x INM	N/A			N/A				N/A		N/A			N/A			N/A			

revealed that different treatments had significant effect on per cent increase in tree height, trunk diameter and tree spread (table-1 and table-2). The maximum per cent increase in tree height (14.44 and 15.34) were recorded under T₁₀ 75% NPK (315g N+ 210g P + 315g K) + 10kg NC + 200g PSB + 200g azotobacter, followed by T₈ 75% NPK (315g N + 210g P + 315g K) + 25kg VC + 200g PSB + 200g Azotobacter (13.11 and 14.82 %), while minimum percent increase in tree height (2.40 and 3.50 %) were recorded under T₁ (control) during 2011-12 and 2012-13, respectively. The findings of the present investigation indicated that 75% NPK (315g N+ 210gP+315g K) +10 kg NC+200g PSB + 200g azotobacter (T₁₀) gave the maximum per cent increase in trunk diameter (11.21 and 13.55 %) which was significantly higher than other treatments during the both years. Similarly, Maximum per cent increase in spread of the tree (16.20 and 17.68) was recorded with T₁₀ 75% NPK (315g N + 210g P + 315g K) + 10kg NC + 200g PSB + 200g azotobacter during 2011-12 and 2012-13, respectively. The use of neem seed cake performs the dual function of both fertilizer and pesticide, acts as a soil enricher, reduces the growth of soil pest and bacteria, provides macro nutrients essential for all plant growth, helps to increase the yield of plants in the long run, bio degradable and eco-friendly and excellent soil condition. It regulates microbial conversion of ammoniac nitrogen to nitrate and ensures continuous availability of nitrogen to the plants. Neem cake provides limonoids in soil to protect soil born pests and diseases in root zone of lemon tree. Application of organic manures may improve soil organic content in form of organic carbon, which decrease the harmful effect of inorganic fertilizers when use simultaneously. It also increases the earthworm activities in soils. Similar results were reported by (7), (8) and (5).

The fruit set basically depends on environmental factors such as temperature, relative humidity and pollinator's activity. The present study also revealed that season and treatments had significant effect on per cent fruit set and their interaction had also significant on per cent fruit set in both the years. Results obtained from present study that maximum fruit set was found in spring season as compare to autumn season during both the years. The highest mean value on per cent fruit set (79.19 and 80.54 %) with the INM dose T₁₀ 75% NPK (315g N + 210g P + 315g K) +10 kg NC + 200g PSB + 200g azotobacter) whereas, minimum fruit set per cent (60.51 and 61.16 %) was recorded under the

treatment T₁ (control) during 2011-12 and 2012-13, respectively. Similar results were also reported earlier by (7) and (9). Beside the environmental factors, this might be due to the better compatibility of another to stigma and less embryo abortion due to optimum micro and macro nutrient status of tree and good enzymatic activity by the application of organic, inorganic and bio-fertilizers.

The application of T₁₀ 75% NPK (315g N + 210g P + 315g K) +10 kg NC + 200g PSB + 200g azotobacter resulted in minimum fruit drop (49.41 and 40.79 %) followed by T₈ 75% NPK (315g N + 210g P + 315g K) + 25kg VC + 200g PSB + 200g Azotobacter (51.89 and 50.61 %), while maximum fruit drop (64.34 and 63.35 %) was reported in control (RDF) during both years of investigation. It may be due to various factors like lack of fertilization, embryo abortion and poor assimilation of internal nutrition (assimilate competition with growth of fruits), hormonal imbalances. Beside these, other soil and environmental conditions were also affecting the poor fruit set (6). Results obtained from the present study regarding fruit retention percentage showed that the maximum fruit retention was noticed in spring flush which was significantly higher over autumn flush. However, treatments and interaction between season and treatments also had significant effect on maximum per cent of fruit retention (51.61 and 52.85 %) with 75% NPK (315g N+ 210gP+315g K) +10 kg NC+200g PSB+200g azotobacter (T₁₀) followed by T₈ 75% NPK (315g N + 210g P + 315g K) + 25kg VC + 200g PSB + 200g Azotobacter (50.02 and 51.15 %), while maximum fruit drop (35.89 and 36.93 %) was reported under control treatment during 2011-12 and 2012-13, respectively. Application of neem cake performs better growth, higher fruit set in the present investigation. The findings of the present investigation are in complete agreement with the findings of (2).

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GENETIC VARIABILITY AND PATH COEFFICIENT ANALYSIS FOR SEED YIELD AND ITS RELATED ATTRIBUTES IN INDIAN MUSTARD (*BRASSICA JUNCEA* L. CZERN AND COSS.) UNDER LATE SOWN CONDITION

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ABSTRACT

Twenty five genotype of Indian mustard were undertaken to determine relationship among yield and its components using direct selection parameters like variability, heritability and genetic advance for 13 yield and its contributing characters. Analysis of variance for the design of the experiment indicated highly significant differences for all the characters. Higher phenotypic coefficient of variation (PCV) was recorded for number of secondary branches per plant followed by seed yield per plant, 1000-seed weight, length of main raceme, number of primary branches per plant, number of seeds per siliqua. High Heritability estimates were observed for days to 50% flowering (77.59%), length of main raceme (77.39%), 1000-seed weight (76.44%), plant height (75.67%), days to maturity (75.23%), number of secondary branches per plant (73.63%), number of siliquae per plant (71.64%), harvest index (70.63%), oil content (70.02%), biological yield per plant (69.09%), seed yield per plant (69.01%), number of primary branches per plant (68.98%), number of seeds per siliqua (67.60%).

The expected genetic advance as percent of mean was high for seed yield plant per plant, 1000-seed weight, number of siliquae per plant, number of secondary branches plant, plant height. The high heritability coupled with high genetic advance for seed yield plant per plant, 1000-seed weight, number of siliquae per plant, number of secondary branches plant, plant height would be helpful for indirect selection in improvement of seed yield. At phenotypic level seed yield per plant showed highly significant and positive association with harvest index, biological yield per plant, number of seeds per siliqua, number of primary branches per plant. The maximum coefficient of phenotypic variation was observed for number of secondary branches per plant.

Key words : *Variability, heritability, genetic advance, correlation and path coefficient analysis, indian mustard.*

Indian mustard is one of the most important oil seed crops of the country and it occupies considerable large acreage among the Brassica group of oil seed crops. At global level, rapeseed-mustard crops are grown in 53 countries spreading over the 6 continents, covering an area of 22.33 million hectare with an average production of 33.17 million tones and an average yield of 1468 kg/hectare ranging from 333 kg/hectare (Tazikistan) to 6667 kg/hectare (Algeria). The contribution of rapeseed-mustard to the total oilseed acreage and production in India was 23.7% and 26% respectively during the year 2014-15. India stands first both in acreage and production of rapeseed and mustard in Asia.

The average production of Indian mustard is low in the

country; this may be attributed to the lack of high yielding varieties, resistance to diseases and pests, high response to inputs and other management practices. Keeping in view these problems, it is of prime importance to evaluate the limiting factors contributing to growth and yield of Indian mustard. Creation of genetic variability and selection for important traits is a crucial activity that any plant breeder should apply to achieve better yield and other desirable agronomic characters. However, to carry out effective selection, the information on available genetic variation among Indian mustard genotypes, the nature of component traits on which selection would be effective and the influence of environmental factors on each trait need to be known. Information on the nature and magnitude of

variability and heritability in a population is one of the prerequisite for successful breeding programme in selecting genotypes with desirable characters. It is therefore, of great importance for breeder to know the heritability of the agronomical characters to improve the yield of the crop effectively.

Twenty five genotype of Indian Rapeseed-mustard group of crops play a very important role in the oil seeds economy of our country. India is the second largest rapeseed-mustard growing country in the world and ranks third next to Canada and China in production. Brassica are rich source of vitamins, minerals and contains many medicinal properties. They provide high amounts of vitamin C, soluble fiber and contain multiple nutrients with potent anti-cancer properties. The estimated area, production and productivity of rapeseed-mustard in the world was 31.68 million hectare, 59.07 million tones and 1864 kg/ha, respectively. In India the estimated area, production and productivity of rapeseed-mustard is 8.02 million hectare, 63.62 million tones and 1850 kg/ha, respectively. It is mainly cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Haryana, West Bengal, Assam, Bihar and Punjab. In Uttar Pradesh rapeseed-mustard are cultivated with an area, production and productivity of 6.62 million hectare, 8.36 million tones and 1263 kg/hectare, respectively (2).

MATERIALS AND METHODS

A field experiment was conducted in Randomized Block Design at Research Farm Oilseeds, C.S.A.U, Kanpur during 2014-2015. The experimental material comprised of twenty five diverse genotypes of Indian mustard. These genotypes obtained from Oilseeds seed section, C.S.A.U, Kanpur. These lines were grown in single row plot of 5 meter length. Spacing between row to row and plant to plant 45 cm and 15 cm. maintain by thinning. On the basis of five randomly selected plants, data were recorded on days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, length of main raceme, number of siliquae per plant, number of seeds per silique, 1000-seed weight (g), biological yield per plant (g), harvest index (%), oil content (%) and seed yield per plant (g).

Analysis of variation (ANOVA) for Randomized Block Design for all attributes was done statistical software.

Analysis of variance and the genetic parameters were computed by following standard statistical procedure. The mean data were subjected analysis of variance as per standard procedure outlined by (11). The phenotypic coefficient of variation (PCV), Genotypic Coefficient of Variation (GCV) and heritability in broad sense were calculated using the formula suggested by Burton and de Vane (1953). Genetic advance was calculated by the method suggested by (6). The genotypic and phenotypic correlation coefficients were estimated according to the formula given by (1). The partitioning of genotypic correlation coefficient of traits into direct and indirect effects of the components on yield as suggested by Wright (1921) and illustrated by (4).

RESULTS AND DISCUSSIONS

The analysis of variance exhibit highly significant difference among genotypes for all the characters indicating the presence of adequate amount of genetic variability among the genotypes (Table-1). For any sound breeding programme, it is essential to have a large variation in the material at the hand of breeder. The characters of economic important are generally quantitative in nature and exhibited a considerable degree of interaction with the with the environment. The phenotypic coefficient of variation (PCV) were invariably slightly higher than their corresponding Genotypic Coefficient of Variation (GCV) due to environment influence (Table-2). The higher estimates of phenotypic coefficient of variation (PCV), and genotypic coefficient of variation (GCV) were observed for number of secondary branches per plant followed by 1000-seed weight, length of main raceme, number of primary branches per plant, seed yield per plant, number of seeds per silique. Days to 50% flowering, harvest index, number of siliquae per plant, plant height, days to maturity, biological yield per plant, oil content showed moderate value of coefficient of variation.

In general the phenotypic coefficient of variation was higher than genotypic coefficient of variation which indicated that environment played a considerable role in expression of these traits. Relatively smaller values of environmental coefficients of variation (ECV) for these traits suggested that their phenotypic expression is less influenced by environments. Highest genetic variability was observed in Indian mustard for secondary branches per

Table-1 : Analysis of variance for 13 characters in 25 late sown Indian mustard genotypes.

Source of Variation	d.f.	Days 50% flowering	Days to maturity	Plant height (cm)	No. of primary branch / plant	No. of secondary branch / plant
Replication	2	0.413	2.093	0.842	0.270	11.773
Treatment	24	135.842**	108.194**	346.837**	1.805**	22.880**
Error	48	3.218	10.871	29.318	0.808	3.773

Contd..

Length of main raceme (cm)	No. of siliquae / plant	No. of seeds / siliqua	1000-seed Weight (g)	Biological yield / plant(g)	Harvest index (%)	Oil Content (%)	Seed yield / plant(g)
4.367	1.773	2.333	0.0044	2.192	3.940	0.158	0.653
176.137**	1198.420**	2.641	0.752**	6.475**	6.949**	2.622**	2.472**
5.208	316.731	1.527	0.0443	2.841	2.263	0.963	1.101

*Significant at p=0.05 **Significant at p=0.01

Table-2: Estimates of mean, coefficients of variation (PCV and GCV), heritability and genetic advance for 13 quantitative characters in 25 late sown Indian mustard genotypes.

Character	Mean	Coefficient of variability		Heritability (%)	Genetic advance as percent of mean
		GCV (%)	PCV (%)		
Days to 50% flowering	75.3733	8.82	9.13	77.59	9.72
Days to maturity	128.066	4.44	5.13	75.23	5.35
Plant height (cm)	168.418	6.10	6.90	75.67	24.03
Number of primary branches/plant	7.866	14.32	13.57	68.98	10.45
Number of secondary branches/Plant	17.946	18.96	17.74	73.63	25.24
Length of main Raceme (cm)	53.733	17.04	17.67	77.39	16.15
Number of siliquae / plant	317.173	5.40	7.79	71.64	28.39
Number of seeds / siliqua	13.186	14.61	13.45	67.60	14.25
1000-seed Weight (g)	3.5103	18.54	18.08	76.44	36.15
Biological yield / plant (g)	51.840	2.12	3.88	69.09	25.12
Harvest index (cm)	22.745	5.49	8.59	70.63	19.26
Oil content (%)	39.039	1.90	3.154	70.02	11.25
Seed yield/plant (g)	11.800	18.72	16.57	69.01	39.51

plant followed by seed yield per plant, 1000-seed weight, length of main raceme and number of primary branches per plant as reported by (7, 14, 16).

Knowledge of heritability of a character is important as it indicates the possibility and extent to which improvement is possible through selection (Robinson et al. (1949). The efficiency of selection depends upon the magnitude of heritability of traits, because it measures the transmissibility of characters from parents to off-spring. Through the estimates of heritability in biometrical studies are influenced by method of estimation, generation of study, sample size

and environment even though it helps the breeders during selection. The present study revealed that estimates of broad sense heritability (Table-2) were ranged from 67.60% (number of seeds per siliquae) to 77.59% (days to 50% flowering) for all the traits studied. High heritability for different traits under study viz., days to 50% flowering (77.59%), length of main raceme (77.39%), 1000-seed weight (76.44%), plant height (75.67%), days to maturity (75.23%), number of secondary branches per plant (73.63%), number of siliquae per plant (71.64%), harvest index (70.63%), oil content (70.02%), biological yield per plant (69.09%), seed yield per plant (69.01%), number

Table-3: Genotypic and phenotypic correlation coefficient between yield and its component characters in 25 late sown Indian mustard genotypes.

Character	Days 50% flowering	Days to maturity	Plant height (cm)	No. of primary branch / plant	No. of secondary branch / plant	Length of main raceme (cm)	No. of siliquae / plant	No. of seeds / siliqua	1000-seed Weight (g)	Biological Yield plant (g)	Harvest index (%)	Oil Content (%)	Seed yield / plant (g)
Days 50% flowering	1.0000	0.8125**	0.8931**	0.4124**	0.5586**	0.0161	0.0597	0.1483**	-0.2007**	0.0999	-0.1507**	0.0143	-0.1078
Days to maturity	0.6820**	1.0000	0.6678**	0.4451**	0.2708**	-0.0673	-0.5147**	0.3354**	-0.3236*	0.0079	-0.1773**	0.1785**	-0.2003**
Plant height (cm)	0.7657**	0.5584**	1.0000	0.4426**	0.6520**	-0.0870	0.0374	0.3402**	-0.2794**	0.0014	-0.1095	-0.1526**	-0.1409*
No. of primary branch / plant	0.1918**	0.2460*	0.2135**	1.0000	0.5882**	0.1892**	0.0887	0.8053**	-0.4165**	0.4870**	-0.0295	-0.3992**	0.1254*
No. of secondary branch / plant	0.4260**	0.2460*	0.4432**	0.3722**	1.0000	0.2086**	0.2490**	0.3467**	-0.1694**	0.1216**	-0.3404**	-0.2404**	-0.2820**
Length of main raceme (cm)	0.0150	-0.0469	-0.0534	0.1040	0.1494**	1.0000	0.3355**	0.0165	0.0844	0.1199**	-0.0581	-0.0820	0.0076
No. of siliquae / plant	0.0356	-0.2347*	0.1062	0.1010	0.2301**	0.2268**	1.0000	-0.4987**	0.0871	0.0211	-0.1310*	-0.0467	-0.0716
No. of seeds / siliqua	0.0568	0.1066	0.0696	0.3290**	0.0237	-0.0097	0.0056	1.0000	0.0189	0.4510**	0.5374**	-0.3107**	0.7347**
1000-seed Weight (g)	-0.1888**	-0.2420*	-0.2122**	-0.1315*	-0.1442*	0.0941	0.0635	0.0137*	1.0000	0.0883	0.0148	-0.1658**	0.0254
Biological Yield / plant (g)	0.0272	0.0800	0.1012	0.0820	-0.0445	0.782**	0.0374	0.0910	0.0751	1.0000	0.1927**	-0.0857	0.5384**
Harvest index (%)	-0.0901	-0.0406	-0.0216	-0.0480	-0.1404*	-0.0479	-0.1237*	-0.0345	-0.0564	0.1836**	1.0000	-0.0857	1.0176**
Oil Content (%)	-0.0683	-0.0068	-0.1240*	0.0017	-0.1927**	-0.0526	-0.1351*	0.0525	-0.0536	-0.2389*	-0.0200	1.0000	-0.3521**
Seed yield / plant (g)	-0.0750	0.0187	0.0520	-0.0108	-0.1437*	-0.0002	-0.1147*	-0.0336	0.0204	0.5312**	0.8736**	-0.1032	1.0000

*Significant at p=0.05

**Significant at p=0.01

of primary branches per plant (68.98%), number of seeds per silique (67.60%).

High genetic advance in per cent of mean (>20%) was recorded for seed yield plant per plant (39.51), 1000-seed weight (36.15), number of siliques per plant (28.39%), number of secondary branches plant (25.24), plant height (24.03%), indicating that direct selection for these traits would be effective for the improvement. Moderate estimates of genetic advance in per cent of mean (10-20%) were recorded for length of main raceme (19.07%), days to 50% flowering (16.94%) and days to maturity (13.01%). The character having high heritability with high genetic advance generally indicates that heritability is more due to the additive gene effect and advocated the use of high estimates of heritability along with high magnitude of genetic advance for genetic improvement in any trait through selection. High heritability does not always ensure an increased genetic advance. Heritability estimates together with genetic advance are generally regarded to be more useful in predicting the grain through selection (6). High heritability coupled with high genetic advance in per cent of mean were observed for seed yield plant per plant, 1000-seed weight, number of siliques per plant, number of secondary branches plant, plant height. The estimates of genetic variability and genetic advance in per cent of mean for most of the characters under study are in accordance with earlier reports (14, 15, 16).

Thus it may be concluded that there is sufficient genetic variability for most of the economic traits studied in the above genetic material and a combination of various traits contributes to seed yield. In this study it is find that Seed yield plant, 1000-seed weight, length of main raceme, number of primary and secondary branches plant showed maximum potential for effectiveness of selection, because these traits show high PCV, GCV, heritability and genetic advance. Seed yield per plant showed highly significant and positive association with harvest index, number of seeds per silique and biological yield per plant while significant and positive correlation with number of number of primary branches per plant. Similar findings were also reported by Srivastava and Singh (2002), (5, 8, 9). Path coefficient analysis revealed that biological yield per plant and harvest index directly influenced seed yield at genotypic and phenotypic levels. These characters also had positive

association with seed yield per plant (Table-3). This indicated that direct selection based on biological yield per plant and harvest index would result in an appreciable improvement of seed yield. (9) found that biological yield and harvest index had high, positive and direct effects on seed yield.

In the present study, days to maturity, plant height, number of secondary branches per plant, length of main raceme, number of siliques per plant and 1000-seed weight via biological yield per plant exerted substantial indirect effect on seed yield at genotypic and phenotypic levels, while number of primary branches per plant, length of main raceme, number of seeds per silique and 1000-seed weight via biological yield per plant exerted substantial indirect effect on seed yield at genotypic and phenotypic levels. These findings were earlier reported by (5, 9, 13). This would help us in designing the selection methodology which can further be utilized in the breeding programme for improvement of seed yield in Indian Mustard.

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LOCATION ASSESSMENT OF WILT CAUSING PATHOGEN *FUSARIUMOXYSPOURUM* F. SP. CICERI IN SEEDS OF CHICKPEA VARIETIES

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ABSTRACT

Gram is a type of plant of pulse crops which is having the seed in a pod, that's containing two or three peasin a single pod. Gram belong to the order Fabales and family Fabaceae is an herbaceous annual, having branching close to the ground with semi-erect to semi-spreading habit. This crop (chickpea) is subjected to attack by a number of fungal, viral, bacterial and nematode diseases. Inadequate information is available on the *Fusarium* wilt of gram as regards to seed-borne nature. In present studies total ten varieties seed, in which five susceptible viz. Radhey, JG-62, Pusa-372, Pusa-329 and ICP-1454 and five resistant viz., Avarodhi, KWR-108, KGD-1168, JG-315 and JG-130 (resistant to disease under field condition) were taken. The test pathogen was detected in the all-susceptible varieties of chickpea seeds ranging from 11-26 %. The average recovery percentage from sodium hypochlorite (NaOCl) and mercuric chloride (HgCl₂) pre-treated seeds were 13.6 and 5.6 percent. These were some differences in the recovery of seed infection in the varieties. It was found minimum in Pusa-329 (11%) and maximum in JG-62 (26%) followed by ICP-1454 (24%), Radhey (16%) and Pusa-372 (14%) respectively. Test pathogen was not presented in resistant varieties seeds except only in Avarodhi (5%) variety. Other remaining resistant varieties like KWR-108, KGD-1168, JG-315 and JG-130 did not carry seed infection of the test pathogen.

Keywords : Gram, resistant, susceptible, wilt.

INTRODUCTION

In India chickpea (*Cicer arietinum* L.) variously known as Gram or Bengal gram. Manly two types of chickpea are grown, first one is brown seeded type called as "Desi" and second one is white seeded called as a "Kabuli". Occurrence of chickpea wilt was first described in India by (8). According to (13) chickpea is the third most important pulse crop in the world after dry beans (*Phaseolus vulgaris* L.) and dry peas (*Pisum sativum* L.). It has white flower with blue, pink or violet veins. Its center of origin is considered to be in the tract lying between Caucasus and Himalayas from where it has spread to different countries including India. Pulse crops play an important role in Indian agriculture, besides being rich in protein. Sprouted seeds are recommended for breakfast. Exudation of leaves locally called "Amb" contains malic and oxalic acids, which possess medicinal value for bronchitis, cholera, constipation, diarrhea, digestive disorders,

snake-bites, warts and blood purification. It's also prescribed for intestinal disorders. The availability of pulses per capita is 27 gm./day. In India, chickpea is sown in the month of mid-October to mid-November in unirrigated areas and in the month of December for recommended under irrigated areas. It's harvested after 100 to 150 days as according to the varieties maturity characters. In India total area under chickpea cultivation is 9.90 million hectares with annual production of 9.60 million tones and average productivity of chickpea is 960 kg/ha. Whereas the total area and production of chickpea in Uttar Pradesh is 4.45 lakh hectare and 2.98 lakh tones, respectively, having productivity of 669 kg/ha (7).

Chickpea seeds are taken fresh as green vegetables or roasted as snack food, sweet and condiments by human. In animal feed is another use of chickpea in many developing countries. Its husks, green or dried stems and leaves are used for cattle feed; chickpea whole seeds may be milled directly for feed. Leaves are

said to yield an indigo like dye. In human it's also consumed as whole seed in the form of fried and boiled for to full fill the protein deficiency. Fresh and disease free young plant and its green pods are eaten like spinach or are used as vegetable. The grains are also used as vegetable (Chhole). Seeds are ground and the flour can be used as soup, dhal and for making to the bread, prepared with pepper, salt and lemon it is served as a side dish. Gram flour is mixed with wheat flour to improve the protein content of wheat flour and it's used in making chapatti (Roti). The flour of dehusked gram called 'Besan' which is widely used for making to the Pakodas, Kadhi, Namkeens and several snacks foods. A little proportion of canned chickpea is also used in Turkey and Latin America to produce fermented food.

Pulses are grown 60 per cent in Rabi and 40 per cent in Kharif. One hundred-gram chickpea seeds contain about 9.8 per cent Moisture, 21.1 g Protein, 5.3 g Fat, 61.0 g Carbohydrates and 3.9 g Fiber in addition to Vitamins. They sustain the productivity of the cropping system. Their ability to use atmospheric nitrogen through Biological nitrogen fixation (BNF) is economically sounder and environmentally acceptable.

According to (13) were reported that the foliage of *F. oxysporum* f.sp. *ciceri* infected plant turns yellow before wilting and the xylem tissue shows light brown discoloration. According to (2) found the wilt fungus in the hilum of chickpea seeds. It was eradicated by seed treatment with *Benlate* T (Benomyl + Thiram). According to (9) they were reported that the chickpea wilt causes complete loss in grain yield if the disease occurs in the vegetative and reproductive stages of the crop and when seed harvested from wilted plants they were lighter than those collected from healthy chickpea plants. According to (14) they were showed the fungus to be in the hilum of the infected seed in the form of chlamydospores like structures. According to (3) they were founded that infected seeds play an important role in the long-distance dispersal of the pathogen and its introduction into *F. oxysporum* f. sp. *ciceri* free soils and geographic areas also. According to (4) they were reported that, *Fusarium* wilt is one of the major diseases of chickpea and they were found that at national level the yield losses up to the tune of 60 per cent. According to the (1) they were stated that *F. oxysporum* f. sp. *ciceri* infects chickpea at seedling as well as at flowering and pod forming stage, with more incidence at flowering and pod filling stage if the crop

is subjected to sudden temperature rise and water stress. It is more prevalent in lower latitudes (0-30°N) where growing season is relatively dryer and warmer than in the higher latitudes (30-40°N). According to (6) they were reported that *F. oxysporum* f. sp. *ciceri* is the seed borne in nature and found that its mycelium was presented in the hilum region of the infected seeds which was collected from wilt affected plants of chickpea when it was isolated on Potato dextrose agar (PDA). According to (5) they were reported that *F. oxysporum* f. sp. *ciceri* is the most destructive and wide spread fungal disease of chickpea. It has drastic effect on yield causing cent per cent loss under favorable conditions.

This crop (chickpea) is subjected to attack by a number of fungal, viral, bacterial and nematode diseases. Inadequate information is available on the *Fusarium* wilt of gram as regards to seed borne nature. Out of these maladies, wilt causes considerable loss to gram in India every year. It is a complex problem and various pathogens as well as physiological factors are implicated to cause wilt of gram, which lead to variation in disease syndrome, although often there is overlapping of symptoms. However, the typical vascular wilt in chickpea caused by *F. oxysporum* f. sp. *ciceri* is the outstanding problem in Uttar Pradesh.

Test Pathogen : *Fusarium oxysporum* is a saprophyte or a heterotroph in nature they can easily obtain their food from organic matter through decomposing method. They are filamentous and belong to the Class Ascomycetes and Family Hypocreaceae. They are typically produce microconidia and macroconidia as well as mycelia and chlamydospores that serve as propagules in infected chickpea plant. Test pathogen lifecycle can be divided into three stages like dormant, parasitic and saprophytic stages. *F. oxysporum* has many Formae speciales (special forms) that exist as plant pathogens, which are clearly differentiated according to host range, causing storage, root, stem and fruit rot, as well as vascular wilt. Healthy plant is infected by *F. oxysporum* when that pathogen is already presented in that soil where that plant was grows. Test pathogen proceeds to infect the host through its sporangial germ tube or through mycelium by invading the plants roots. If any wound are found in the roots or at the formation point of lateral roots the fungus were inserted into this. Once inside the plant, it travels from root to the stem several inches above in the ground level. Some species of test pathogen can be

taking much height after getting the entry in plant by virulence condition. As its growth, the mycelium branched and produces microconidia, which are carried upward within the vessel by way of the plants sap stream. They are easily isolated from tap root, lateral roots and collar region, main stem, lateral branches and pod hulls also according to (12).

Wilt : Chickpea wilt caused by *F. oxysporum* f. sp. *ciceri*. Its symptoms can be seen on the seedlings as well as at the maturity stage of the diseased plants. It starts out looking like vein clearing on the younger leaves and drooping of the older lower leaves, followed by stunting and pale yellowing of the lower plant leaves and ultimately dry up. Yellow dry leaves are defoliated; marginal necrosis of infected leaves is also seen. Reddish to black discoloration of the xylem vessels are seen inside the infected plant near by ground stem as a line or dots in cross section. Roots of wilted plants turn black and decompose in later stage. Sometime if stem are grown under much wet condition than white, pink or orange fungal growth are seen outside of the affected stems, to root or stem decay. After that infected plant has dead.

Identification of test pathogen : To find out the presence of test pathogen in seeds from all ten varieties of chickpea was done under the Stereo binocular microscope (SBM). It's based on the measurements of different morphological structures. Observations of the following morphological characters of the fungus were noted.

Colony characteristic : Colonies were white initially, radiating are early stage of growth with wine- red pigmentation visible from the bottom side of the without too disturbing of seeds place. In some strains discrete orange colour are seen due to presence of some mass of hyphae at middle point of the growth. It plays the role of a silent assassin in the pathogenic strains of the fungus can be survive for up to 20 years as in dormant or unfavorable condition.

Mycelium characteristics : Color, branching pattern and width of the hyphae was studied during this study. Mycelium seen profusely branched, creeping, hyaline, cylindrical, septate and measuring 3.20 -4.6 µm in width.

Sporodochia : The test fungus produces white to light orange sporodochia on PDA. When conidiophores are often clustered to form sporodochia and produce large

pasty masses of spores. Three types of asexual spores are found.

1. Microconidia-The microconidia were hyaline, oval to cylindrical in shape and straight to slightly curved and measuring 2.5 – 3.5 x 5-11 µm in size. They are smaller than macroconidia in size having only one or two celled and they are frequently produced by the fungus under any conditions.

2. Macroconidia-The macroconidia were sparse and produces on the branched conidiophores. They were hyaline, three to several celled, fusiform to sickle shaped (curved toward of the ends), mostly with an elongated apical cell and pedicellate basal cell. Its measuring is 3.0 – 4.5 x 20 -55 µm in size noted.

3. Chlamydospores-The chlamydospores were usually intercalary and one produced singly or in pairs. globes to sub-globes, thick-walled and smooth surfaced spores. Chlamydospores are seen like swelling is often on the hyphae and measuring 7.0- 8 x 3.5 – 5.0 µm in size. They can remain dormant in soil for long periods and infect other host under favorable condition.

MATERIALS AND METHODS

In present studies, total ten varieties seed, in which five susceptible viz. Radhey, JG-62, ICP-1454, Pusa-372 and Pusa-329 and five resistant viz., Avarodhi, KWR-108, KGD-1168, JG-315 and JG-130 (resistant to wilt disease under field condition) were taken from Indian institute of pulses research (IIPR) Kanpur (Uttar Pradesh) India and pulse research farm of Economic botany legume (EBL) section of Chandra Shekhar Azad University of Agricultural and Technology (CSAUA&T), Kanpur (Uttar Pradesh) India. All seeds brought to the laboratory of department of botany, Meerut Collage Meerut (UP) for the examined of the location of Wilt causing pathogen *Fusarium oxysporum* f. sp. *ciceri* in seeds. Two methods was used first one is Standard blotter method (SBM) and second one is Agar plat method (APM). The study of seed infection, pattern and growth habit of test pathogen was examined under in-vitro conditions. All fungus colonies were separately observed on seed in-situ through using of Standard blotter method (SBM) according to proposed by International seed testing association (10). According to suggestion of (11) these observations were also recorded by use to agar plate method for the re-confirmation of those

Table-1 : Per cent seed infection of *F. oxysporum* f. sp. *ciceri* in chickpea cultivars in Standard blotter method and Agar plate method.

Sl. No.	Sample	Standard blotter method			Agar plate method		
		Untreated	Pre-treatment with		Untreated	Pre-treatment with	
			NaOCl	HgCl ₂		NaOCl	HgCl ₂
Susceptible cultivars							
1.	JG-62	26	19	8	24	17	7
2.	ICP-1454	24	16	7	20	13	5
3.	Radhey	16	13	5	13	8	5
4.	Pusa-372	14	11	5	12	9	4
5.	Pusa-329	11	9	3	11	7	2
	Average	18.2	13.6	5.6	16.0	11.4	4.6
Resistant cultivars							
6.	Avarodhi	5	2	0	3	0	0
7.	KWR-108	0	0	0	0	0	0
8.	KGD-1168	0	0	0	0	0	0
9.	JG-315	0	0	0	0	0	0
10.	JG-130	0	0	0	0	0	0
	Average	1.0	0.4	0.0	0.6	0.0	0.0

**I****II****Images : Standard blotter method (Image-I) had an edge over agar plate method (Image-II).**

results, which is obtained during standard blotter method test. Growth habit of test pathogen in-situ method such technique was follow as given below.

1. Standard blotter method (SBM) : Standard blotter method was used for the detection of seed borne fungi of chickpea. Three hundred seeds of each variety was randomly select from properly homogenize samples, each sample was mixed and divide by precision divider (Gamet type) and then each sample further divided into three lots, each lot contain one hundred seeds. First lot of one hundred seed remains as untreated (control). Second lot was pre-treat with 1% Sodium hypochlorite (NaOCl) for 10 minutes and third lot pre-treat with 0.1% Mercuric chloride (HgCl₂) solution for 1 minute. This experiment was conducted during in the year of 2019-2020 in a Completely randomized design (CRD) with ten replications were use from each lot untreated

as control & pretreated with (NaOCl and HgCl₂) of each ten variety of chickpea. Each replication was contained 10 seeds. Selected 10 seeds were arranged as 9 seeds in the outer ring and 1 seed in the center place on three pre-soaked moist layers of sterilize blotter paper from sterile distill water; kept in 90 mm diameter polypropylene/glass petri-plates. These plates were incubated at 25 ± 20°C under alternating cycle of 12 hours Near Ultra Violet (NUV) light and 12 hour darkness for seven days. On eighth day, the seed was examined under Stereo-binocular microscope (SBM) at the range on (6.4 x 40 x) for the presence of *F. oxysporum* f.sp. *ciceri*. The numbers of seed bearing colonies of the test pathogen was count, record and interpret as percent infection of the test pathogen.

2. Agar plate method (APM) : Agar plate method is preferred mostly in plant pathological studies as it provides nutrients rich substrate for the development of fungal mycelial growth and sporulation of the pathogen on seed, its use mostly for slow growing fungi. In this method, Potato dextrose agar medium was used in the place of blotter paper in a capsule of chloramphenicol 500 mg was added in each flask containing 200 ml of PDA medium before pouring in petri-plates in order to check the any bacterial contamination. One hundred fifty seeds were randomly select from properly homogenize samples; each sample (variety) was further divided, with help of precision

divider (Gamet type) into three lots, each lots contain 50 seeds. First lot of 50 seed remains as untreated (control). Second lot was pre-treat with 1% Sodium hypochlorite (NaOCl) for 10 minutes and third lot pre-treat with 0.1% Mercuric chloride (HgCl₂) solution for 1 minute. This experiment was conducted during in the year of 2019-2020; in a completely randomized design (CRD) with ten replications was used from each lot (Untreated & Pretreated with NaOCl and HgCl₂) of each variety. Each replication was contained 5 seeds. Selected 5 seeds were arranged as 4 seeds in the outer ring and 1 seed in the center place on 90 mm PDA petri plate. Then the plates were incubated for 7 days and next day, the growth of the fungus on seed was examined by naked eye and for specific identification of the test pathogen, Stereo-binocular microscope and Compound microscopes (CM) were use. The numbers of seed bearing colonies of *F. oxysporum* f. sp. *ciceri* were counts, records and interpret in per cent infection of the test pathogen.

RESULTS

The data on per cent seeds infection of *Fusarium oxysporum* f. sp. *ciceri* in different chickpea cultivars in Standard blotter method and Agar plate methods are presented in Table-1. The results in Table-1 show that the average recovery percentage from Sodium hypochlorite (NaOCl) and Mercuric chloride (HgCl₂) pretreated seeds were 13.6 and 5.6 percent. These were some deference's in the recovery of seed infection in the varieties. It was founded minimum in Pusa-329 (11%) and maximum in JG-62 (26%) followed by ICP 1454 (24%), Radhey (16%) and Pusa-372 (14%), respectively. Test pathogen (*Fusarium oxysporum* f. sp. *ciceri*) was not founded in the resistant varieties, except only Avarodhi (5%) variety. Other remaining resistant varieties viz., KWR-108, KGD-1168, JG-315 and JG-130 did not carry seed infection of the test pathogen.

DISCUSSION

Standard blotter methods had an edge over Agar plate method. So far, as the detection of the pathogen was concerned. In present study, out of ten seed samples, collated from susceptible & resistant cultivars was tested for the presence of the pathogen on seed by using standard blotter method & agar plate method, the test pathogen (*F. oxysporum* f. sp. *ciceri*) was detected in the all susceptible varieties of chickpea ranging from

11-26 per cent. It's also present in only one resistant variety namely Avarodhi except others varieties, during in this test. The pre-treatment of the seeds of all ten varieties with the Sodium hypochlorite and Mercuric chloride, reduced the recovery of the test pathogen from the infected seeds of chickpea cultivars.

SUMMARY

Total ten varieties seed, in which five susceptible viz. Radhey, JG-62, ICP-1454, Pusa-372 and Pusa-329 and five resistant viz., Avarodhi, KWR-108, KGD-1168, JG-315 and JG-130 were taken. Presence of the test pathogen in the seeds of all ten varieties of chickpea was done under the Stereo binocular microscope (SBM). It's based on the measurements of different morphological structures. Observations of the following morphological characters of the fungus were noted.

The average recovery percentage from Sodium hypochlorite (NaOCl) and Mercuric chloride (HgCl₂) pretreated seeds were 13.6 and 5.6 percent it was founded minimum in Pusa-329 (11%) and maximum in JG-62 (26%). Test pathogen (*Fusarium oxysporum* f. sp. *ciceri*) was not presented in resistant varieties, except variety Avarodhi (5%). Other remaining resistant varieties viz., KWR-108, KGD-1168, JG-315 and JG-130 did not carry seed infection of the test pathogen. Standard blotter methods had an edge over Agar plate method in the detection of the pathogen from the infection/ infested seed. Pre-treatment of the seeds with both Sodium hypochlorite (NaOCl) and Mercuric chloride (HgCl₂) both was capable to reduce the recovery of the test pathogen (*F. oxysporum*) from the seed.

DECLARATIONS

This article does not contain any studies with human participants or animals performed by any of the authors.

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SOIL MICROBES : A KEY PLAYER ON SOIL HEALTH AND CROP PRODUCTION UNDER CHANGING CLIMATE

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ABSTRACT

Climate is one of the main drivers of organism growth and species distributions; thus, a changing climate has the potential to alter the composition of plant and soil communities and the interactions between them. Soil microorganisms represent a fundamental role in soil health and sustainability. Microbial population density and diversity are stirred by the level of organic matter indirectly by providing energy for soil micro-organisms, improving soil moisture, soil structure and stability, plant nutrient availability and forbid soil-borne disease incidence. Crop production and soil management practices designed to hold soil microorganisms i.e. minimum tillage, composting, cover cropping, eliminating fertilizer and pesticide use and maintaining biodiversity, will inevitably lead to soil improvements and stability. The need for replenishing organic matter in the soil after harvesting is thus of great importance. In ecological farming systems, organic matter is maintained by mixed farming, rotations, recycling, compost and farm yard and green manures and bought-in organic sources. Including legumes and cover crops in the rotation should help balanced soil fertility, disease management, and avoid leaching nutrients and soil pollution. Crop and soil management practices designed to support soil microorganisms have been shown to lead to improvements in soil structure and stability. Although the great diversity of soil microorganisms is now well appreciated, studies over the past twenty years have established that several other soil organisms, apart from mycorrhizal fungi, not only play an active role in suppressing pathogens but also mediate the activity of a range of beneficial organisms. Apart from farming in ways that support indigenous microbes, the use of effective exotic cultures of beneficial microorganisms as soil and compost amendments, root dips, feed additives or sprays to supplement or reinforce the indigenous micro-flora are being considered.

Keywords : Soil microorganisms; health; sustainability; mycorrhizal; fungi.

BACKGROUND OF STUDY

Did you know that only 40 to 60% of the fertilizer we apply actually goes to the plant, the remaining is lost to run off into our waterways, volatilization to the air or is tied up in the soil. This is why soil health is such an imperative piece of plant health. Functional soil is a soil embedded with organic matter and soil microbes that work together to hold onto nutrients in the soil and convert nutrients locked in the soil. Beneficial soil microbes form symbiotic relationships with the plant. In fact, the plant will exert as much as 30-40% of its energy to the root zone to make food for microbes. In return those microbes not only protect the plant from stress, but also feed the plant by converting and holding nutrients in the soil (32). The microbial world is the largest unknown reservoir of multifariousness on

earth. They comprise of the prevalent living mass on the planet earth (50). To advance the sustainability of existing agricultural system and to provide a higher quality to our agricultural merchandise, beneficial microbes are used (1). The responsible use of native microorganisms to get monetary, social, and environmental asset is inherently striking and determines a magnificent evolution of research from traditional technologies to modern techniques to provide a capable system to protect environment and new methods of environmental monitoring (14). Very few soil microbes have been extensively used as plant growth-promoting agents including *Rhizobia*, *Azospirillum*, *mycorrhizal fungi*, *Actinomycetes*, *Arthrobacter* and PGPR (*P. fluorescens*) and bioagents (38, 48, 66). Soil microbial gathering is multiplex and dynamic and varies in composition among dissimilar

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levels and compartments, which represents a real challenge in soil ecology. These microbes are known for their ability to fix atmospheric nitrogen in association with plants forming nodules in roots. They belong to the family Rhizobiaceae, are symbiotic, and can fix nitrogen 50–100 kg/ha in association with pods only (6).

DISTRIBUTION OF MICROORGANISMS WITHIN THE SOIL PROFILE

The abundance and biomass of most soil organisms is highest in the top 10 cm of soil and declines with depth in parallel with organic matter content and prey availability. Approximately 65% of the total microbial biomass is found in the top 25 cm of the soil profile. Below that depth, microbial densities typically decline by one to three orders of magnitude. Abundances of G⁻ bacteria, fungi, and protozoa are typically highest at the soil surface, whereas G⁺ bacteria, Actinobacteria, and archaea tend to increase in proportional abundance with increasing depth (20). In forest soils, the litter layer is dominated by fungi, with fungal biomass being up to three times higher than that of bacterial biomass (9). The relative importance of bacteria increases in the organic and mineral soil horizons. Hyphal density of and root colonization by mycorrhizal fungi decrease substantially below 20 cm. Microbial grazers (e.g., protozoa, collembolan) also decrease with depth, often more rapidly than either their bacterial or fungal prey. *Collembolan* (hexapod group, 6 abdominal segments; segment 1 ventral tube has glue peg/piston with adhesive and water balance properties) numbers peak at 1–5 cm below the soil surface and drop to almost none below 10 cm. Although generally low, the numbers and activities of soil organisms at depth vary spatially depending on gradients in texture, pH, temperature, water availability, and organic matter content.

Top soil is rich in soil organic matter – dark spongy material formed from decomposed plant and animal tissue. Soil organic matter is critically important: It helps soils hold onto water and nutrients and supports soil microbes that recycle nutrients. Loss of soil organic matter has made many farms increasingly reliant on fertilizers, pesticides and herbicides. Much recent research has focused on adding organic material back to soils to restore them. This is an important strategy, but it is evidently believed that we also should aim to enhance the microbes that are responsible for

soil formation. It was demonstrated in a 2015 study (published by Kaitlyn, 2018) that adding efficient microbes to soils can enhance the percentage of plant carbon that is transformed into soil. New research suggests that by fostering an efficient and active soil microbiome, we can accelerate soil regeneration far beyond typical rates seen in nature.

Natural soils are thriving with life. They contain an incredible diversity of microscopic bacteria, actinomycetes, fungi, viruses and other organisms as well. One g of soil can contain 107-109 prokaryotes

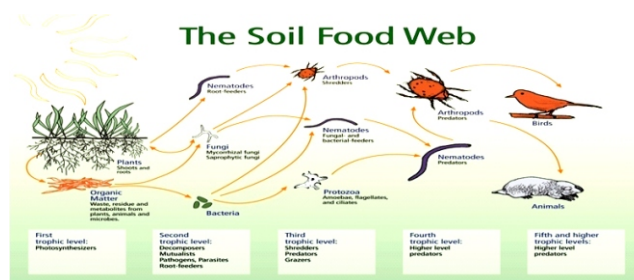


Fig. 1 : Microbes perform critical functions in soil food webs, such as decomposing organic materials, cycling nutrients and improving soil structure (39).

with 10000 of different species.

These microbes interact closely with each other, forming complex networks. They communicate with chemical signals (quorum sensing or quenching). They work together to break down complex organic materials, including dead plants and animals. They often work in teams to complete biochemical processes, such as transforming nitrogen from an inert gas to plant-usable forms, other nutrients like P, K, S, and micronutrients, and recycling them from dead plant materials back into dissolved forms.

In healthy soils, organic matter is protected from decomposition inside clumps of soil called aggregates. But tilling crushes aggregates, unlocking their carbon and allowing microbes and soil fauna to attack it. This creates a temporary feast for soil microbes, but eventually they deplete their food supply and die off. Without a healthy microbial community, nutrients are no longer recycled, opportunistic pests can invade and farmers rely increasingly on chemicals to replace biological soil functions.

REVIVING AGRICULTURAL SOILS

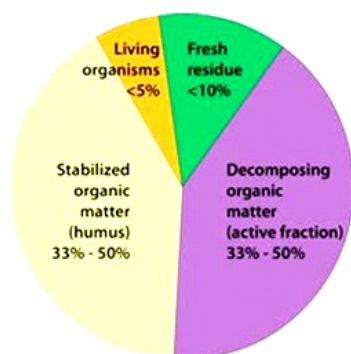


Fig. 2 : Components of soil organic matter.

Soil degradation is a critical problem because it threatens our ability to produce enough healthy food for a growing human population and contributes to climate change. In response, large companies, nonprofits, scientists and government agencies are working together to restore soil health.

The first step to improving soil health is to stop the bleeding. Instead of leaving fields barren in between crops, which leads to erosion, farmers are increasingly planting cover crops such as rye grass, oats and alfalfa. They also are replacing intensive tilling with no-till practices to prevent the breakdown of soil structure.

Soil organic matter contains over 50% carbon. Globally, soils contain more carbon than plants and the atmosphere combined. Losing carbon-rich organic matter from soils releases carbon dioxide, a greenhouse gas, which can accelerate climate warming. But by regenerating our soils, we can sequester more carbon underground and slow climate warming.

In addition to protecting soil, cover crops take carbon out of the atmosphere as they grow and funnel it into the soil. Unlike cash crops that are harvested and removed from the soil, cover crops are left to decompose and contribute to soil formation.

Increasing the supply of plant carbon in this way is an important first step in rebuilding soil carbon. But new research suggests that it may be insufficient.

A NEW PARADIGM OF SOIL FORMATION

We used to think that soil organic matter was formed from leftover bits of plants that were difficult to degrade. Over time, we thought that these plant particles became chemically transformed into what was called humus – dark, long-lasting material left

over when dead plants and animals decay. This view suggested that the key to building soils was getting a lot of dead plant material into the ground.

Recently, however, technological advances have transformed our understanding of soil formation. There is now strong evidence that the most persistent forms of soil carbon are formed primarily from dead microbial bodies rather than from leftover plant parts. The vast majority of old soil carbon appears to have undergone microbial decomposition. While plants are the original source of carbon for soils, microbes control its fate by using it as food, thus ensuring that at least some of it will remain in the soil.

FEEDING THE SOIL BY FEEDING BENEFICIAL MICROBES

Microbes can take a simple compound like sugar and transform it into the thousands of complex molecules found in soils. When microbes break plant matter down, they use some of the material they consume for building new biomass that is, to fuel their own growth and exhale the rest as carbon dioxide. The efficiency with which they create new biomass varies widely. Some microbes are like weeds: They grow quickly in food-rich environments, but are sloppy eaters and waste much of what they consume. Others are slow-growing but hardy, waste little and are able to survive times of starvation or stress.

To maximize the proportion of plant carbon that is transformed into soil organic matter, we should aim to support and enhance soil microbiomes that quickly and efficiently transform dead plant materials into soil organic matter. Healthy soils should also contain microbiomes that help prevent disease, cycle nutrients and help reduce plant stress.

A more holistic concept of farming in terms of agro-ecology has begun to challenge the traditional reduction approach to the study of agriculture. As a result we have become more aware of the importance of microorganisms in such processes as soil formation, plant nutrition, and the suppression of plant pathogens, pests and weeds. Moreover, it has become clear that many farming practices – intensive tillage, pesticide use, fertiliser use and mono-cropping in particular – are directly or indirectly harmful to soil microbes and therefore to the processes mediated by them. It is of concern that since much industrialized agriculture now relies heavily on manufactured inputs rather than using

natural resources, the sustainability of agriculture is threatened and a move towards resource conserving agriculture is essential. Farming practices must be designed to optimize soil microbial life as part of a wider strategy aimed at conserving and replenishing natural resources. The practical application of this technology and the role of naturally occurring populations of microorganisms in agro-ecosystems form the basis of this article.

Soil microbial biomass is composed of eukaryotic (fungi, yeasts, protozoa and algae), and prokaryotic (eubacteria, actinomycetes and archaea) organisms, whose populations vary from soil to soil (55). Soil microbial biomass is dictated by a variety of soil and environmental parameters including soil texture and structure, pH, air/moisture content, and soil temperature (15, 35). Now it is well obvious that one of the prime factors that determine soil microbial status is the type and amount of organic material that enters the soil ecosystem. The vast majority of soil microorganisms are heterotrophic and require organic materials as both carbon and energy sources (55). Management practices in particular, the manipulation of the quality and quantity of organic inputs might, therefore, be predicted to modify soil microbial populations, the soil food web (trophic levels), and the biological processes involved in nutrient transformation (59).

Microorganisms play a fundamental role in soil creation and stability through the binding of soil aggregates by hyphae and by the secretion of exudates (4). There are many examples of the ways in which soil beneficial microbial systems (microbial inoculants) help ecosystem health and stability.

Microbial inoculants based on these microorganisms can be divided into different categories depending on their use.

Biofertilizers are substances which contain microorganisms in living/dormant cells which, when applied to seed, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant, and promote growth by increasing the supply or availability of nutrients to the host plant.

Three major groups of microorganisms are considered beneficial to plant nutrition: nitrogen-fixing bacteria (diazotrophs), P and/or other nutrients solubilizing/mobilizing micro-

organisms including arbuscular mycorrhizal fungi (AMF- *Gigaspora*, *Funneliformis* or *Rhizophagus* (*Glomus*), and *Laccaria*), plant growth-promoting rhizobacteria (PGPR).

Another category of PGPM-containing products is that of phytoestrogens / plant biostimulants which are generally containing auxin-producing bacteria, inducing root elongation.

The widely accepted definition of plant biostimulants (17) is : substance(s) and/or micro-organisms whose function when applied to plants or the soil rhizosphere stimulates the natural processes to enhance/benefit nutrient uptake and efficiency, tolerance to abiotic stress, and crop quality. Typically, biostimulants do not have a direct action against pests.

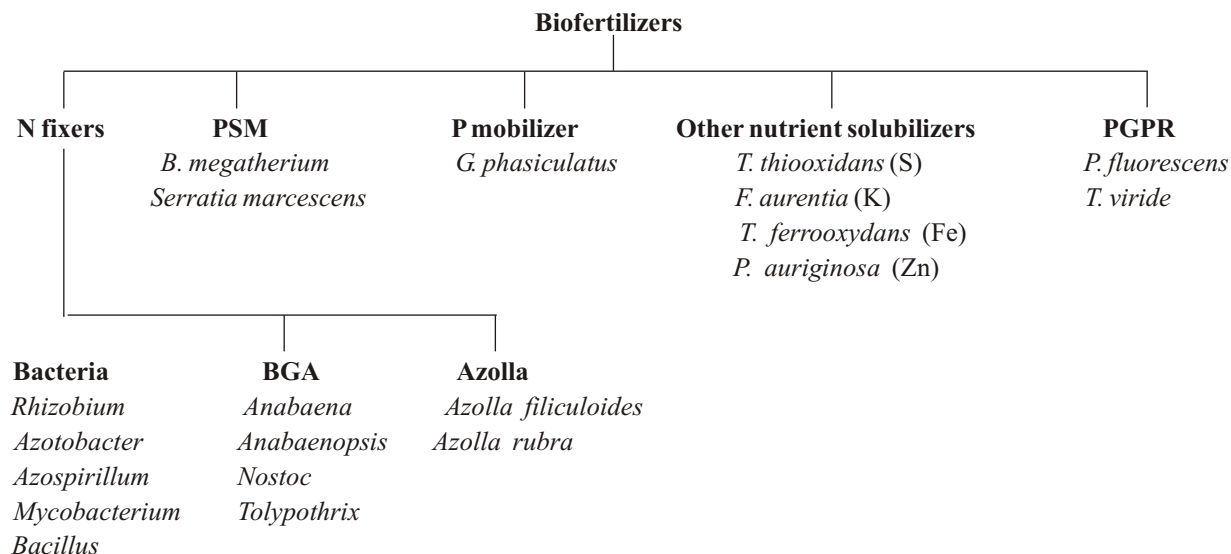
In addition to these bacteria, *Frankia*, *Rhizobium* sp. and cyanobacteria undergo symbiosis by getting established inside the plant tissues and may or may not develop special symbiotic structures. The classical examples of symbiotic association developed by *Rhizobium* sp. are found in about 13,000 or more leguminous plants, both cultivated and non-cultivated herbs, shrub and trees. Among leguminosae, the largest number of plants is in papilionoidae. Moreover, species of *Anabaena*, *Nostoc*, *Tolypothrix*, etc. develop symbiotic association with fungi (symbiotic structure is lichen), bryophytes, pteridophytes, gymnosperms and angiosperms and fulfill the requirement of nitrogen deficiency. However, actinorrhizic nodules are developed by *Frankia*, a member of Actinomycetes, on roots of about 170 species of woody dicot non-leguminous plants from 15 genera belonging to temperate trees like *Alnus*, *Myrica*, *Casuarina*, etc. (25). Nodules; are of two types : (i) *Alnus* type where nodules show dichotomous branching to form a coralloid root, and (ii) *Myrica/Casuarina* type in which case the apex of each nodule produces a normal but negative geotropic root. The function of nodules is to facilitate gas diffusion to the nitrogen fixing endophyte in the nodule under low O₂ tension (11).

NON-SYMBIOTIC NITROGEN FIXATION

Microorganisms which pass independent life and fix atmospheric nitrogen are known as free living diazotrophs. There are two groups of such microorganisms : bacteria and cyanobacteria (blue-green algae). Based on the mode of nutrition (carbon, nitrogen and oxygen and requirement of reducing

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CLASSIFICATION OF BIOFERTILIZERS



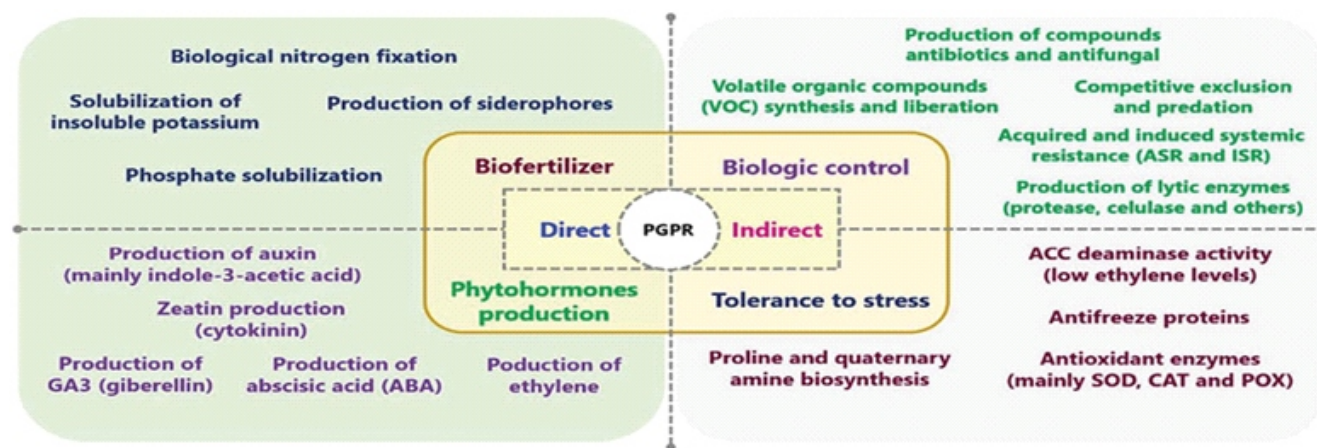
SYMBIOTIC N₂ FIXATION

Table 1 : A short list of symbiotic species and their corresponding hosts.

Symbiotic species	Host plants	Cross inoculation group
Bacteria : <i>Rhizobium</i>		
<i>Bradyrhizobium japonicum</i>	<i>Glycine max</i> (soybean)	Soybean group
<i>Rhizobium fredii</i>	<i>Glycine max</i> (soybean)	
<i>R. leguminosarum</i>	<i>Pisum sativum</i> (peas)	Pea group
	<i>Vicia faba</i> (broad bean)	
	<i>Lathyrus</i> (Khesari)	
	<i>Lens</i>	
<i>R. phaseoli</i>	<i>Phaseolus vulgaris</i> (common bean)	Bean group
<i>R. meliloti</i>	<i>Medicago sativa</i> (alfalfa-hathi ghas)	Alfalfa group
	<i>Melilotus</i> sp. (sweet clovers)	
	<i>Trigonella foenumgraecum</i> (fenugreek-methi)	
<i>R. trifolii</i>	<i>Trifolium</i> sp. (clovers)	Clover group
<i>R. lupini</i>	<i>Lupinus</i> , <i>Ornithopus</i>	Lupin group
“Cowpea rhizobia” group or <i>Rhizobium</i> sp.	<i>Vigna unguiculata</i> (cowpea),	Cowpea group
	<i>Arachis hypogaea</i> (peanut),	
	<i>Vigna subterranea</i> (Bambara groundnut)	
	<i>Leucaena</i> sp., <i>Albizia</i> sp.,	
	<i>Crotalaria</i>	
	<i>Pueraria</i>	
<i>Azorhizobium caulinodans</i>	<i>Sesbania</i> sp. <i>Sesbania rostrata</i> (stem nodulating)	

Table 2 : Major groups of rhizobia.

Genus	Characteristics	Closest relatives
<i>Rhizobium</i>	Grow fast on culture media, and genes of nitrogen fixation and nodulation reside on Sym-plasmid except for <i>R. loti</i>	<i>Agrobacterium</i> (Crown-gall inducing bacteria)
<i>Bradyrhizobium</i>	Grow slowly on culture media, and genes of nitrogen fixation and nodulation reside on chromosome	<i>Rhodopseudomonas palustris</i> (photosynthetic bacteria)
<i>Azorhizobium</i>	Grow slowly on culture media, and genes of nitrogen fixation and nodulation reside on chromosome. Capable of free-living nitrogen fixation. Isolated from the stem nodules of <i>Sesbania rostrata</i>	<i>Aquabacter spiritensis</i>

**Fig. 3 :** Direct and indirect mechanisms mediated by plant growth-promoting rhizobacteria (PGPR) with beneficial effects on host plants (16, 15).

groups) bacteria are divided into (i) aerobic bacteria (*Azonomas*, *Azotobacter*, *Beijerinckia*, *Mycobacterium*, *Methylomonas*), (ii) facultative anaerobic bacteria (*Bacillus*, *Enterobacter*, *Klebsiella*, etc.), (iii) anaerobic bacteria (*Clostridium*, *Desulfovibrio*, etc.) and (iv) photosynthetic bacteria (*Rhodomicrobium*, *Rhodopseudomonas*, *Rhodospirillum*, *Chromatium*, *Chlorobium*, etc.). Among cyanobacteria, both heterocystous and non-heterocystous forms fix atmospheric nitrogen, for example, *Anabaena*, *Anabaenopsis*, *Aulosira*, *Calothrix*, *Cylindrospermum*, *Gloeocapsa*, *Lyngbya*, *Nostoc*, *Oscillatoria*, *Plectonema*, *Scytonema*, *Stegonema*, *Tolypothrix*, *Trichodesmium*, etc. (2).

P solubilization / mobilization

Strategies for mobilizing soil P, namely acidification of the soil, the release of organic acid anions (e.g. citrate, oxalate, gluconate), protonation and the release of enzymes acid and alkaline phosphatases and phytase (64, 65), chelation of cations and competing with phosphate for adsorption sites in the soil.

K solubilization

The mechanisms for KSMs to solubilization of K are by: (i) lowering the pH, or (ii) by enhancing chelation of the cations bound to K, and (iii) acidolysis of the surrounding area of microorganism. The lowering in pH of the medium suggests the release of organic acids and protons by the K-solubilizing microorganisms (43, 62, 69). Such acidolysis by organic acids produced by the rhizospheric microorganisms can either directly dissolve the mineral K as a result of slow releases of exchangeable K, readily available exchangeable K or can chelate both Si and Al ions associated with K minerals (49). Thus, the synthesis and discharge of organic acids (eg. tartrate) by the microorganisms into the surrounding environment acidify the microbe's cells and their surrounding environment that ultimately lead to the release of K ions from the mineral K by protonation and acidification (24). Of the different organic acids involved in the solubilization of insoluble K, tartaric, succinic, citric, gluconic, α-ketogluconic and oxalic acids are the most prominent acids released by microbial strains

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Table 3 : Application of VAM inoculum in agriculture, horticulture and forestry.

Crop	VAM Fungus	Outcome
Banana	<i>Acaulospora sp</i>	Improved growth & nutritional status
Mulberry	<i>Glomus sp</i>	Reduced P requirements, Improved growth
Douglas fir	<i>Laccaria bicolor</i>	60% increased in wood volume
Cyclamen	<i>Glomus sp</i>	Increased survival in nursery
Acacia	<i>Terminalia sp</i>	Improved growth & survival
Douglas fir	<i>Melanogaster sp</i> <i>Rhizopogon sp</i>	Improved growth
Black spruce	<i>Paxillus sp</i>	Protection against <i>Cylindrocladium</i> root rot

Table 4 : Plant probiotic bacteria used to enhance the quality of fruit and horticultural crops.

Bacterial strain	Fruit or horticultural crop	Crop effects caused
<i>Phyllobacterium sp.</i> PEPV15	<i>Fragraria x ananassa</i>	Enhancement of vitamin C
<i>Pseudomonas</i> BA-8, <i>Bacillus</i> OSU-142 and <i>Bacillus</i> M-3	<i>Fragraria x ananassa</i>	Enhancement of vitamin C
<i>Paenibacillus polymyxa</i>	<i>Fragraria x ananassa</i>	Enhancement of vitamin C
<i>Pseudomonas sp.</i> 19Fv1T	<i>Lycopersicon esculentum</i>	Enhancement of vitamin C
<i>Bacillus megaterium</i> and <i>Bacillus amyloliquefaciens</i>	<i>Lycopersicon esculentum</i>	Enhancement of vitamin C
<i>Bacillus amyloliquefaciens</i> FZB2 and <i>B. amyloliquefaciens</i> FZB42	<i>Lycopersicon esculentum</i>	Enhancement of vitamin C
<i>Pseudomonas sp.</i> 5Vm1k and AMF	<i>Fragaria x ananassa</i>	Enhancement of vitamin B and C
<i>Pseudomonas putida</i> 41, <i>Azotobacter chroococcum</i> 5, <i>Azospirillum lipoferum</i> OF and AMF	<i>Lycopersicon esculentum</i>	Inreased antioxdant activity
<i>Bacillus licheniformis</i>	<i>Lycopersicon esculentum</i>	Improved total flavonoids content
<i>Pseudomonas putida</i> 41, <i>Azotobacter chroococcum</i> 5, <i>Azospirillum lipoferum</i> OF	<i>Ocimum basilicum</i>	Inreased antioxdant activity
<i>Pseudomonas sp.</i> , <i>Bacillus lentus</i> and <i>Azospirillum brasilens</i> .	<i>Ocimum basilicum</i>	Inreased antioxdant activity and chlorophyll leaf content
<i>Rhizobium leguminosarum</i> PETP01	<i>Capsicum annum</i>	Inreased antioxdant activity
<i>Pseudomonas fluorescens</i> N21.4	<i>Rubus sp.</i>	Inreased flavonoids concentration
<i>Rhizobium sp.</i> PEPV12	<i>Spinacia oleracea</i> .	Inreased chlorophyll content
<i>Paenibacillus polymyxa</i> RC14	<i>Brassica oleracea var capitata</i> cv Yalova 1.	N,P,K,S,Fe and Cu content increase
<i>Bacillus subtilis</i> BA-142, <i>Bacillus megaeorium</i> -GCsub group A.MFD-2, <i>Acinetobacter baumannii</i> CD-1 and <i>Pantoea agglomerans</i> FF	<i>Lycopersicon esculentum L.</i> and <i>Cucumis sativus L.</i>	N,P,Mg, Ca, Na, K, Cu, Mn,Fe and Zn content increase in both fruit
<i>Bacillus subtilis</i> EY2, <i>Bacillus atrophaeus</i> EY6, <i>Bacillus spharicus</i> GC subgroup B EY30, <i>Staphylococcus kloosii</i> , and <i>Kocuriaery thromyxa</i> EY43	<i>Fragaria x ananassa</i>	N,P,Mg, Ca, Mg, S, Cu, Mn and Fe
<i>Pseudomonas fluorescens</i> and <i>Bradyrhizobium sp.</i>	<i>Origanum majorana</i>	Increased the amount of essential oils
<i>Bacillus megaeorium</i> , <i>Pantoea agglomerans</i> and <i>Bacillus subtilis</i>	<i>Brassica oleracea</i>	Inreased chlorophyll plant content
<i>Pseudomonas fluorescens</i> N21.4	<i>Rubus sp. var Lochness</i>	Increased and stabilize total flavonoid content during different season

Table 5 : Benefits in use of biofertilizers.

S.N.	Biofertilizer	Crop inoculated	Nutrient saved (kg ha ⁻¹)	Crop yield increased (%)
1.	<i>Rhizobium</i>	Pulses and oil seeds	20-30 N	10-20
2.	<i>Azospirillum</i>	Cereals and Vegetables	20-30 N	15-20
3.	<i>Azotobacter</i>	All crops (non-leguminous)	10-15 N	7-12
4.	<i>Azolla</i>	Paddy	25-50 N	10-15
5.	Blue green algae	Paddy	20-30 N	10-15
6.	VA mycorrhiza	All crops	-	15-20
7.	P-solubilizing bacteria (<i>Bacillus</i> , <i>Pseudomonas</i> , etc)	Legumes, cereals and vegetables	15-30 P ₂ O ₅	15-20

PGPR

Mechanisms of action

Direct mechanisms

- 1. Biofertilizer :** Biological nitrogen fixation, P and K solubilization,
- Siderophores production, and
- Phytohormones production (IAA, Cytokinin, GA, ABA, Ethylene)

Indirect mechanisms

- Biological control
 - Antibiotics, bacteriocins and antifungal
 - Volatile organic compounds
 - Competitive exclusion and predation
 - Acquired and induced systemic resistance (ASR and ISR)
 - Lytic enzymes (protease, cellulase and others)
- Bioremediation (Plant-Microbe-Metal Interactions)
 - Metal mobilization
 - Metal immobilization
 - Metal transformation
 - Metal transport and distribution
- Tolerance to stress
 - ACC deaminase activity
 - Antifreeze proteins
 - Proline and quaternary amines (osmolytes)
 - Antioxidant enzymes (SOD, CAT and POX)

Mycorrhizal microorganisms

Mycorrhizal fungi can be broadly categorised into two groups: vesicular arbuscular mycorrhizas (VAM or AM) and ecto-mycorrhizas (EM), which vary widely in structure and function (27). VAM fungi are ubiquitous in the soil and can form symbiosis with most terrestrial plants including major crops, cereals, vegetables and horticultural plants. Soil microbial populations are immersed in a framework of interactions known to affect the soil quality (27). The former are microscopic obligate symbionts that can only be cultured with a host plant and constitute the largest proportion of fungal biomass in the soil. VAM produce structures known as arbuscules and vesicles within the root cell that are involved in the nutrient transfer process. This symbiosis confers benefits directly to the host plants through the acquisition of phosphate and other mineral nutrients from the soil by the fungus while the fungus receives a carbon source (primarily glucose) from the host and store in the fungal mycelia as trehalose. In addition, the symbiosis may also enhance the plants resistance to biotic and abiotic stresses. Ectomy- corrhizas (EM), regularly produce large above-ground fruiting bodies (like mushroom and toadstool) as well as a hyphal net around the plant root. Vesicles and arbuscules are absent and hyphal penetration of the root is limited. EM fungi are amenable to axenic culture. Potential inoculums can also be produced in the field from mycelium.

Mycorrhizal fungi are also believed to control root pathogens by one or more of : (1) improving nutrient acquisition by host plant; (2) excluding pathogens at root infection sites and within the rhizosphere; (3) inducing anatomical and structural changes in the root thereby creating physical barriers to pathogen entry; (4) producing substances antagonistic to root pathogens; and (5) activation of plant defence

mechanisms. The role of mycorrhizal fungi, as well as other microorganisms, in stimulating induced resistance to soil-borne plant pathogens in a range of crops has received much attention over the past 25 years (Azcon-Aguilar & Barea, 1996) and it is worth considering its significance to organic farming. Interactions between plants, mycorrhizal fungi and soil bacteria are not random but appear to occur in an ordered manner between compatible species. The presence in the soil of given mycorrhizal species can influence the persistence and activities of native bacteria and vice versa (3).

In addition, the positive interaction between composting and VAM inoculation that led to increased growth of tree seedlings was related to the ability of the mycorrhiza to enhance plant nutrient uptake from the compost. The possibilities for exploiting these types of synergism have been investigated in many cases (58). Heavy metal pollution of soils (along with severe compaction) is common on metalliferous mine spoils and on modern brown-field sites following industrial activities. Polluted soils such as these are slow to support new vegetation and so remain prone to further damage from erosion. One of the ways in which plants benefit from ecto-mycorrhizal infection in nature is through an increased tolerance to heavy metals in the soil. Mycorrhizal fungi confer protection to the plant against uptake of heavy metals by adsorption on hyphae and through various forms of fungal metabolism (22).

Organic agriculture and microorganisms

Soil management practices that change the soil carbon content also influence the size and structure of the soil biomass. Application of organic amendments and/or cover crops increases carbon availability to microorganisms (51) found that, after more than 40 years, microbial biomass C was higher in organic than in conventionally managed dairy farm soils. Carbon released from crop residues contributes to increasing soil microbial activity and so increases the likelihood of competition effects in the soil. The placement of the residue in soil can lead to the displacement of a pathogen from its preferred niche, diminishing the pathogen's ability to survive (8, 30). Therefore, soil microbial biomass changes as a consequence of switching to organic land management (55). Application of organic matter and all treatments that increase the total microbial activity in the soil might

enhance the general suppression of pathogens by increasing competition for nutrients. Crop rotation may also yield microbial benefits beyond those normally associated with pathogen host range and saprophytic survival. Rotation is most successful in limiting the impact of biotrophic pathogens that require living host tissues, or those pathogens with low saprophytic survival capability (7).

Agricultural practices can have major short- or long-term impacts on mycorrhizal fungi, as well as on other soil microorganisms. (52) studied the effectiveness of VAM spores from organically and conventionally managed soils and found that white clover only benefited from mycorrhizal infection in a low-fertility (organically managed) soil. Furthermore, inocula from organic soils were more effective in both achieving mycorrhizal infection and in allowing more efficient P uptake by the crop. Application of composts may enhance beneficial soil microorganisms. As the active microbial biomass increases, the capacity to utilize carbon, nutrients and energy in the soil is increased and thus these resources might be limited for soil-borne pathogens (60).

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ROLE OF SELF HELP GROUPS (SHGS) IN EMPOWERMENT OF WOMEN-ITS CHALLENGES

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ABSTRACT

The lack of knowledge resources, lack of communication, and linkages with the other agencies are cause of large gap in adoption of new technologies in crop production, dairy farming, post harvest management. To provide critical skills and technologies, the KVK organized Women Self Help Group. SHG is a small volunteer association of poor/lower middle class people preferably from the same socio economic background. Self Help Groups is one of the driving forces on the chain of socio-economic development; the study was more expanded to four villages Self Help Groups (SHGs), a voluntarily form by the locality of Haidernagar, Jalalpur, Mukandpur, Lakhan villages of Muzaffarnagar District. With the help of simple random sampling technique, 100 members of the groups are selected, of which all data and require information is collected, the study showcase the roles of SHGs on alleviation of poverty and its sustainability.

Key words : Socio-Economic, SHGs, Alleviation and Sustainability

INTRODUCTION

According to National Bank for Agriculture and Rural Development (NABARD), "Self Help Groups (SHGs) is a small voluntary group of poor people usually belong to same socio economic background to meet necessary means of saving and financial support to its group members, they get their assistance from NGO's, commercial bank, institutions and from other places (Khati, F.S and Indra, M, 2011). The Self Help Group (SHG) bank linkage programmers in the past two decades have become a well-known tool for development agencies and even for corporate house (Reddy, A,A and Malik, D.P, 2011). A Self-Help Group (SHG) is comprised of 10-20 members (women or men) who work for themselves to build their economy and make their livelihood comfortable. The aim of self-help group is to provide a platform for banking with poor and down trodden which is reliable business. It provides livelihood opportunities for village women through micro-credit with the existing banks in the area. Formation of self- help group (SHGs) is an effective medium that can guarantee all-round development of women particularly in rural area (Babajide Abiola and Taiwo Joseph, 2011). The impact of Self Help Groups (SHGs) noteworthy in

terms of self-worth like self confidence cum capacity building by providing self-employment opportunities to meet the economic crisis. It also improve the assessment making capacity in terms of various social, political, economic, help and educational dealings and mobilize women to fight against various types of exploitation against them in family and society at large (Ministry of Health and Family Welfare, 1988 and Gupta, N. S, 1988).

REVIEW OF LITERATURE

Study on Self Help Groups in village Haidrnagar, Jalalpur, Mukandpur, Lakhan of District Muzaffarnagar showed that Self Help Groups play significant roles in socio-economic development in the District. (2) stated that the SHGs of Andhra Pradesh were expertise in diversification of the resources by undertaking allied farming activities. The mode of Fund raiser and timely repayment of loan are also main discussion in this paper

Diagnosis of problem : Poverty is pouring out in all square of socio-economic crisis in the society, livelihood are the major concern of every stakeholder. The present study is emphasis on role of Self Help Groups, and its contribution on reduction of poverty, creation of opportunity and challenges for the weaker

section. The rural poor are more vulnerable in politically and economically. Therefore, the study wants to show hope, and sustainability development of the society.

Scope of the study : The present study covers four villages from Muzaffarnagar districts namely, Haidernagar Jalalpur ,Mukandpur, Lakhan village in the state of Uttar Pradesh. Besides, the study also involves intensive and extensive survey, particularly expanding to four villages from 1st April 2011 to 1st August, 2019

Objectives of the study

1. To study the socio economic profile of the Self Help Group
2. To study the relationship between the income generation and the reduction of poverty.
3. To find out the problems face by Self Help Group and means of solution
4. Change in decision making power of rural women.

Delimitation of the study :

1. The present study covered four villages from Muzaffarnagar districts namely, Haidernagar Jalalpur, Mukandpur, Lakhan in the state of Uttar Pradesh, the whole study were strictly depend only on the data collected from these four villages.
2. There is a potential for a sampling bias due to simple random sampling method, the sample population may not be representative.

RESEARCH METHODOLOGY

In this stage an attempt is been made to study the role of Self Help Group possible option for their livelihood, samples of 100 (10 x 10) on 10 groups of respondents from four villages Haidernagar and Mukandpur, in the state of Uttar Pradesh is selected for the study. With the help of Simple Random Sampling Technique Primary data has been collected in the month of August 2019 by setting structure questionnaire and personal interview. The collected information was shown with the help of tables and was further analysed calculating percentage. Secondary data were collected from various sources like books,journal and website. Finally conclusion were drawn and suggested for the development.

In the above Table 1.1 shows that there are altogether 10 numbers of Self Help Groups (SHGs) and the

groups was establish on 2000 to 2014, having members ranging from 12 to 20 each. Since all the members have major role played in allied agriculture activities, they used to have the group meeting on every 5th of the month.

In the above table 1.2 shows the distribution of age groups of the members, its reveals that 52 numbers of respondents of the study are under of ages of 18-25 years , followed by 44 members under 25-35 years and above 45 years categories have 22 members in the groups.

The table 1.3 clearly reveals that 42 of the respondents are study up-to lower primary and below; followed by 34 of the members are under the categories of middle primary and below; out of the respondents 39 numbers of the respondents are studies up-to HSLC and there only 1 member in a group which have education qualification up to post graduation.

In the above table 1.4 showcase the marital status of the members, out of the total 100 (94%) of the respondents are married and there are only 8(6%) numbers of the respondents are yet too married.

Since the groups are the villages based Self Help Groups (SHGs) all the provision of training are being conducted together, the table 1.5 reveals that each member of the groups have Participated 2-5 times of training which is conducted in the Krishi Vigyan Kendra of their District, Trainings emphasis not only on the agriculture practices, micro-finance but also involved on maintenance of record which is find difficult for the local members. Therefore, all the groups are still finding necessary to conduct more training in the locality.

In the above table 1.6 showcases the saving habit of the groups. There are altogether 10 numbers of the groups, out of which. 8 numbers of the groups are contributing Rs 200 per month as a capital formation to utilize in their agriculture and allied practices and business purposed. Followed by 2 members of the groups' subscript Rs 500 per month.

In the table 1.7 found that cent percent of the groups used their personal media of Family Members, friends and Neighbors respectively., since the Groups is initiated in remote local levels.

From the table 1.8 reveals that 9 Self Help Groups with 90% required the promotion since the groups were well aware their duties and responsibility which have

Table 1 : Name of the SHGs and its Commencement.

(N = 10 SHGs, X = 100)

Name of Self Help Group	Date of commencement	Number of member	No of meeting to be held in a month
Saraswati WSHG	2000	15	5th of every month
Saraswati WSHG	2008	20	5th of every month
Mahalaxmi WSHG	2010	12	5th of every month
Mahalaxmi WSHG	2011	13	5th of every month
Ekta WSHG	2013	16	5th of every month
Asha WSHG	2013	16	5th of every month
Vaishno WSHG	2013	16	5th of every month
Vaishnavi WSHG	2013	18	5th of every month
National WSHG	2013	13	5th of every month
Durga WSHG	2014	18	5th of every month
Total		137	

Source : Field Survey.

Table 2 : Age group of SHGs members,

(N = 10, X =137)

Name of Self Help Group	18-25 years	25-35 years	35-45 years	Above 45 years
Saraswati WSHG	8	4	2	1
Saraswati WSHG	11	5	4	0
Mahalaxmi WSHG	6	4	1	1
Mahalaxmi WSHG	3	5	3	2
Ekta WSHG	4	5	4	3
Asha WSHG	2	5	5	4
Vaishno WSHG	6	4	5	1
Vaishnavi WSHG	4	3	6	5
National WSHG	2	4	5	2
Durga WSHG	6	5	4	3
Total	52	44	39	22

Source : Field Survey.

been comprehensively in the local level only and only a group were not fully aware this in turn lead confusion in the duties and responsibility.

In the table 1.9 showcase the problem and challenges faced by the groups during the studies out of the 10 groups it is bad shape that 7 Self Help Groups with 70% have financial which will lead retardation on their growth perspective, 3 (30%) Self Help groups have others challenges like human resources, others etc., it also reveal that 3 (30%) groups are comparatively stable in their position.

The table 10 showcase the range of groups earning annually in the study areas, 8 groups with 80% in the studies areas earn at the range of Rs 10000-20000

annually. Rest 2 (20%) groups earn at the range of Rs 20000 above annually.

Source: Field Survey

In the above table 1.11 shows the utilization of income earns in the studies area, cent percent of the respondents were utilizing their income on Education, Health and Food. It also further revealed that all the members of the groups were not in a position to make saving and construction expenses out of their earning ,only 3groups were able to make savings for future.

Findings :

It is found that all the Self Help Groups of Haidernagar Jalalpur, Mukandpur, Lakhana village

Table 3 : Distribution of Members Education Qualification.

(N = 10, X = 137)

Name of the Groups	Lower primary (LP)	Middle of primary (MP)	HSLC	Higher Secondary	Graduation	Post-Graduation
Saraswati WSHG	5	1	6	2	3	0
Saraswati WSHG	8	4	3	3	2	0
Mahalaxmi WSHG	4	1	4	3	0	0
Mahalaxmi WSHG	3	4	3	1	2	0
Ekta WSHG	5	4	4	2	0	1
Asha WSHG	4	3	4	2	3	0
Vaishno WSHG	3	4	4	2	3	0
Vaishnavi WSHG	4	3	4	3	2	0
National WSHG	1	5	4	1	2	0
Durga WSHG	5	5	3	4	1	0
Total	42	34	39	23	18	1

Source : Field Survey.**Table 4 : Marital status of groups, August, 2017.**

(N = 10, X = 137)

Marital Status	No. of members	Percentage
Married	129	94
Unmarried	08	6
Total	137	100

Source : Field Survey**Table 5 : Provision of Training and its requirement.**

(N =10, X = 137)

Name of the groups	No. of training underwent	No got training	Want training
Saraswati WSHG	3	-	Yes
Saraswati WSHG	3	-	Yes
Mahalaxmi WSHG	4	-	Yes
Mahalaxmi WSHG	2	-	Yes
Ekta WSHG	3	-	Yes
Asha WSHG	5	-	Yes
Vaishno WSHG	2	-	Yes
Vaishnavi WSHG	2	-	Yes
National WSHG	4	-	Yes
Durga WSHG	5	-	Yes

Source : Field Survey

were establish in 2000 to 2014 and held meeting on every 5th of every month

Out of the total of 100 members, 52 numbers of respondents of the study are under the age of 18-25 years, followed by 44 members under 25-35 years and above 45 years categories have 22 members in the groups

It is revealed that cent per cent of the members are female in the groups.

It is found that 42 of the respondents have studied up-to lower primary and below; followed by 34 of the members are under the categories of middle primary and below; out of the respondents 39 numbers of the respondents are studies up-to

Table 6 : Amount deposited by the members.

(N = 10, X = 137)

Name of the groups	Rs 100 per month	Rs 200 per month	Rs 500 per month
Saraswati WSHG	-	Yes	-
Saraswati WSHG	-	Yes	-
Mahalaxmi WSHG	-	Yes	-
Mahalaxmi WSHG	-	Yes	-
Ekta WSHG	-	Yes	-
Asha WSHG	-	Yes	-
Vaishno WSHG	-	-	Yes
Vaishnavi WSHG	-	-	Yes
National WSHG	-	Yes	-
Durga WSHG	-	Yes	-

Source : Field Survey

Table 7 : Source of media used by the groups.

(N = 10, X = 137)

Name of the groups	Family member	Friend	Neighbour
Saraswati WSHG	Yes	Yes	Yes
Saraswati WSHG	Yes	Yes	Yes
Mahalaxmi WSHG	Yes	Yes	Yes
Mahalaxmi WSHG	Yes	Yes	Yes
Ekta WSHG	Yes	Yes	Yes
Asha WSHG	Yes	Yes	Yes
Vaishno WSHG	Yes	Yes	Yes
Vaishnavi WSHG	Yes	Yes	Yes
National WSHG	Yes	Yes	Yes
Durga WSHG	Yes	Yes	Yes
Total	10	10	10

Source : Field Survey.

Table 8 : Self Help Group requirement of promotion.

(N = 10, X = 137)

Promotion	Numbers of Groups	Percentage
Required	9	90
Not Required	-	-
Confused	1	10
Total	10	100

Source : From Field Survey

HSLC and there only 1 member in a group which have education qualification up to post graduation.

Out of the total, 100 respondents . marital status of the members, 92 (94%) of the respondents are married and there are only 8(6%) numbers of the respondents are yet too married.

Cent per cent of the members have participated in the trainings (3to 5 times)which was organized at KVK and still wants for it.

It is found that out of 10 groups 8 numbers of the groups are contributing Rs 200 per month as a capital formation to utilize in their agriculture and allied practices and business purpose. followed by

Table 9 : Problem and challenges faced by the groups.

(N = 10, X = 137)

Challenges	Problem faced by SHGs	Percentage
Financial Problem	7	70
Other Problem	3	30
No Problem	0	0
Total	10	100

Source : Field Survey**Table 10 : Annually income earned from the groups.**

(N = 10, X = 137)

Name of the groups	Rs5000-10000	10000-20000	20000 and above
Saraswati WSHG	-	Yes	-
Saraswati WSHG	-	Yes	-
Mahalaxmi WSHG	-	Yes	-
Mahalaxmi WSHG	-	Yes	-
Ekta WSHG	-	Yes	-
Asha WSHG	-	Yes	-
Vaishno WSHG	-	-	Yes
Vaishnavi WSHG	-	-	Yes
National WSHG	-	Yes	-
Durga WSHG	-	Yes	-
Total	10	10	10

Source : Field Survey.**Table 11 : Utilization of income by the group's members.**

(N = 10, X = 137)

Name of the Groups	Education	Health	Fooding	Saving	Construction
Saraswati WSHG	Yes	Yes	Yes	Yes	-
Saraswati WSHG	Yes	Yes	Yes	-	-
Mahalaxmi WSHG	Yes	Yes	Yes	-	-
Mahalaxmi WSHG	Yes	Yes	Yes	-	-
Ekta WSHG	Yes	Yes	Yes	-	-
Asha WSHG	Yes	Yes	Yes	-	-
Vaishno WSHG	Yes	Yes	Yes	-	-
Vaishnavi WSHG	Yes	Yes	Yes	Yes	-
National WSHG	Yes	Yes	Yes	-	-
Durga WSHG	Yes	Yes	Yes	Yes	-
Total	10	10	10	03	00

2 members of the groups subscript Rs 500 per month.

It is found that cent percent of the groups used their personal media of Family Members, friends and Neighbors respectively, since the Groups is initiated in remote local levels.

It is found that 9 Self Help Groups with 90%

required the promotion since the groups were well aware their duties and responsibility which have been comprehensively in the local level only and only a group were not fully aware this in turn lead confusion in the duties and responsibility.

Out of the total, the problem and challenges faced by the groups during the studies out of the 10 groups it is bad shape that 7 Self Help Groups

with 70% have financial problems which will lead retardation on their growth perspective, 3 (30%) Self Help groups have others challenges like human resources, others etc.

It is the range of groups earning annually in the study areas, 8 groups with 80% in the studies areas earn at the range of Rs 10000-20000 annually. Rest 2 (20%) group earn at the range of Rs 20000 above annually

It is found that the utilization of income earns in the studies area, cent percent of the respondents were utilizing their income on Education, Health and Food. It also further reveals that all the members of the groups were not in a position to make saving and construction expenses out of their earning, only 3groups were able to make savings for future.

CONCLUSION

Self Help Groups play the significant roles for economic development right from the village levels and beyond, it has the chain of developmental perspective. Grass root level of micro-finance compounded the sustainability where the members and the villager in particular thrive to maintain the livelihood; these in return create the economic growth

for the nation. Therefore, pro-active role of government will bring the better economic environment in all square of development, it needs the better lower credit rate and subsidies are major concern to fulfil the purpose of the self Help Groups. Alleviation of poverty and the role of Self Help groups show the strongly positive correlation.

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VEGETABLES CULTIVATION UNDER PROTECTED CONDITIONS

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ABSTRACT

In addition, the biotic stresses also do not allow successful production of vegetables like capsicum, cucumber, tomato, chilli, okra/bhindi, cauliflower, cabbage, leafy vegetables etc. in the fields mainly during rainy and winter season. In spite of the great importance of vegetable crops, it faces a lot of restraints like temperature stress, photostress, moisture stress and weeds growth, nutrients deficiency in the soil, excessive wind velocity and atmospheric CO₂. Some possible ways to reduce green house gas emissions are suggested and some sustainable adaptation strategies are indicated. We expand our survey of the existing research to the entire production system, including greenhouse structure, energy, electricity, growing media, and fertilizers. Different protected cultivation structures having different temperature, humidity, UV radiation ranges and also having different cost involvement in construction of structure which may results the production of vegetables with distinct advantage of good quality fruits, productivity and favorable market price to the growers/farmers. These limitations can be alleviated by adopting a unique, specialized hi-technology is called as protected cultivation.

Intense heat and high incidence of UV rays in dry months reduce the quality of leafy vegetables in open which otherwise very good in protected structures. Protected cultivation has great scope to achieve self-sufficiency in vegetable sector even with less area. The shade net house is ideal for cultivation of vegetable during dry period in the tropical islands when extreme sunshine and heat are limiting factor to vegetable production. These structures are constructed using a UV stabilized agro-shade net (35%–70% shade) materials for creating partial shade condition inside the structure to favour the growth and development of partial shade requiring crops or to protect crop from scorching heat during hot/summer months. The partial shade effect helps in fast and better growth of leafy vegetables besides reducing the evapo-transpiration loss of water. Low cost shade net for high value leafy vegetables like coriander, palak, fenugreek and insect free brinjal crop. Consequently more pesticides are being used for protecting the crops which deteriorate the vegetable quality by the presence of residues. This also creates environmental concern as the limited soil and fresh water bodies are get contaminated. The net house can be used for year round cultivation of crops such as Capsicum, tomato, okra, cauliflower, cabbage, brinjal, beans, parthenocarpic cucumber and other cucurbits with reduced incidence of insect-pest and diseases and consequent low chemical residues on the produces. The cost can be reduced drastically by the use of local wood materials like bamboo/wooden poles. Vegetable growers can substantially increase their income by protected cultivation of vegetables in off-season as the vegetables produced during their normal season generally do not fetch good returns due to large availability of these vegetable in the markets. Off-season cultivation of cucurbits under low plastic tunnels is one of the most profitable technologies under northern plains of India. Protected cultivation enables us to grow vegetables in the off-season and also to extend the vegetable growing seasons for a much longer period than is possible under open field conditions. Though certain breakthroughs in vegetable cultivation in adverse climates using protected devices have been registered, more extensive research and generation of awareness are required to tap potential of protected cultivation of vegetable crops and also increase the area under protected devices.

Keywords : Protected conditions, vegetable cultivation, shade net/green houses types and benefits

INTRODUCTION

India is the second largest producer of vegetable crops in the world next only to China. However, its vegetable production is much less than the requirement if balanced diet is provided to every individual. There are different ways and means to achieve this target, e.g.,

bringing additional area under vegetable crops using hybrid seeds, use of improved agro-techniques and another potential approach is perfection and promotion of protected cultivation of vegetables. Vegetables are recognized as health food globally and play important role in overcoming micronutrient deficiencies and providing opportunities of higher farm income. The worldwide production of vegetables has tremendously

gone up during the last two decades and the value of global trade in vegetables now exceeds that of cereals. The worldwide production of vegetables has doubled over the past quarter century and the value of global trade in vegetables now exceeds that of cereals. Vegetables are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are the major causes of low yields and will be further magnified by climate change. India is the second largest producer of vegetables in the world, next to China. India has witnessed increase in horticulture production over the last few years. Significant progress has been made in area expansion resulting in higher production. Over the last decade, the area under horticulture grew by 2.6% per annum and annual production increased by 4.8%. During 2017-18, production of horticulture crops was 311.71 M.T. from an area of 25.43 M.H. (*Horticultural Statistics at a Glance 2018*). The production of vegetables has increased from 101.2 M.T. to 184.40 M.T. since 2004-05 to 2017-18. It is the second-largest producer of vegetable producer, accounting for 8.6% of the world vegetable production (according to FAO). Another potential approach is perfection and promotion of protected cultivation of vegetables. In natural season local vegetables flood the markets substantially bringing down the prices. In the absence of storage infrastructure and vegetable processing industry in the country, off-season vegetables farming is the only viable option that can add value to the farmer produce. Vegetables can be cultivated in off-season, with the induction of an artificial technique like greenhouse technology, in which temperature and moisture is controlled for specific growth of vegetables.

Protected Cultivation

Protected cultivation practices can be defined as a cropping technique wherein the micro environment surrounding the plant body is controlled partially/ fully as per plant need during their period of growth to maximize the yield and resource saving. Greenhouse is the most practical method of achieving the objectives of protected agriculture, where natural environment is modified by the use of sound engineering principles to achieve optimum plant growth and yield (more produce per unit area) with increased input use efficiency. Protected cultivation of vegetables offers distinct advantages of quality, productivity and favourable market price to the growers. Vegetable

growers can substantially increase their income by protected cultivation of vegetables in off-season as the vegetables produced during their normal season generally do not fetch good returns due to large availability of these vegetable in the markets. Off-season cultivation of cucurbits under low plastic tunnels is one of the most profitable technologies under northern plains of India. Walk-in tunnels are also suitable and effective to raise off-season nursery and off-season vegetable cultivation due to their low initial cost. Insect proof net houses/green houses can be used for virus-free cultivation of tomato, chilli, capsicum, cucumber, leafy vegetables and other vegetables mainly during the rainy season. These low cost structures are also suitable for growing chemicals-free green vegetables. The green house is generally covered by transparent or translucent material such as glass or plastic. The green house covered with simple plastic sheet is termed as poly house. The green house generally reflects back about 43% of the net solar radiation incident upon it allowing the transmittance of the “photo-synthetically active solar radiation” in the range of 400-700 Nm wave length. The sunlight admitted to the protected environment is absorbed by the crops, floor, and other objects. These objects in turn emit long wave thermal radiation in the infra red region for which the glazing material has lower transparency. As a result the solar energy remains trapped in the protected environment, thus raising its temperature. Growing of cucumber using cost effective plastic greenhouses provides an alternative for raising crop in the period of scarcity in Himachal Pradesh. New features added to these structures have cut down the requirement of water and energy in such cultivation through novel means like micro irrigation- cum-fertilization and rainwater harvesting. The gardeners planted cucumbers in carts that were wheeled into the sunlight by day and brought indoors by night to protect them from the elements. This was an innovative form of the greenhouse. In the 16th century, European explorers brought back exotic plants acquired in the course of their travels. Many were tropical plants that could not survive the cold European climates. The result was the creation of greenhouses that would progress from the Italian “botanical gardens” to wooden structures to the more stable cast iron frames, and eventually to glasshouses. Later, with the advent of plastics during the World War II a new phase in the greenhouse technology emerged. At present nearly 90

Table-1 : Area under Greenhouse(s) in different Countries.

Sr. No.	Country	Greenhouse Area (Hectare)
1.	China	2,760,000
2.	South Korea	57,444
3.	Spain	52,170
4.	Japan	49,049
5.	Turkey	33,515
6.	Italy	26,500
7.	Israel	18000
8.	Mexico	11,759
9.	Netherlands	10370
10.	France	9,620
11.	United states	8425
12.	India	5730

per cent of the new greenhouses are being constructed by utilizing ultra violet (UV) stabilized polythene sheets as the glazing material. There are more than 55 countries now in the world where cultivation of crops is undertaken on a commercial scale under cover and it is continuously growing at a fast rate internationally. China is the largest users of greenhouses. The development of greenhouse technology in China has been faster than in any other country in the world. With a modest beginning in late seventies, the area under greenhouses in China has increased tremendously. The world scenario of greenhouse production is given in Table-1.

India's first exposure to truly hi-tech protected farming of vegetables and other high-value horticultural produce came through the Indo-Israel project on greenhouse cultivation, initiated at the New Delhi-based Indian Agricultural Research Institute (IARI) in 1998, shortly after the establishment of diplomatic ties with that country. However, the Israeli experts left India in 2003 at the end of this five-year project, IARI continued to maintain the facility, calling it the Centre for Protected Cultivation Technology (CPCT). It has, in the past 10 years, managed to refine and upscale the system to reduce costs, besides designing greenhouse structures to suit local conditions. During last decade this area must have increased by 10 per cent if not more. The states that have consistently expanded the area under protected cultivation for the period of 2007-2012 are Andhra Pradesh, Gujarat, Maharashtra, Haryana, Punjab, Tamil Nadu and West Bengal. Maharashtra and Gujarat had a cumulative area of 5,730.23 hectares and

4,720.72 hectares respectively under the protected cultivation till 2012. In Europe, Spain is leading in protected agriculture with 51,000 ha mostly under low cost poly houses. In Asia, China has the largest area under protected cultivation, 2.5 million ha under poly house/greenhouse. Protected vegetable production is important component of protected agriculture. Protected vegetable production is practiced throughout the world irrespective of altitude of the place since several hundred years.

Benefits of Protected Vegetable

Cultivation Protected vegetable production can reduce the amount of water and chemicals used in production of high value vegetables compared to open field conditions. The comparative advantages are :

Income in the off-season increased by 48%, but pesticide use also increased by 56%.

Adverse climate for production of vegetables can be overcome by different systems of protected production.

We assess the impact of training in off-season tomato production.

Propensity score estimators were used to correct for program placement bias.

Safe pest management needs emphasis to avoid adverse health outcomes.

Production of vegetables through the year.

Multiple cropping on the same piece of land is possible.

Off season production of vegetables to get better return to growers.

Production of high quality and healthy seedlings of vegetables for transplanting in open field supporting early crop, strong and resistant crop stands.

Use of protected vegetable cultivation can increase production as well as productivity per unit of land, water, energy and labour. It supports the production of high quality and clean products.

It makes cultivation of vegetables possible in areas where it is not possible in open conditions such as high altitudes deserts.

It makes vertical cultivation of vegetables possible using technologies like hydroponics, aeroponics etc and use of vertical beds for production.

Disease free seed production of costly vegetables becomes easy under protected structures. 10. The

potential of polyhouse production technology to meet the demand of producing good nutrition and healthy foods and quality vegetables free from pesticides can be fully exploited. 11. Controlled environmental conditions are used for early raising of nurseries, off-season production of vegetables, there seed production and protecting the valuable germplasm

Vegetable crops can be grown under adverse weather conditions round the year and off-season.

Management and control of insect-pests, diseases and weeds is easier.

Stock plants maintenance, cultivating of grafted plantlets and micro propagated plant limitations:-

Hand pollination in cross pollinated vegetables like cucurbits or development of their parthenocarpic cucumber.

Costly, short life and non-availability of cladding materials.

Lack of appropriate tools and machinery.

Structure cost initially looks unaffordable. Farmers with zero risk affordability do not come forward to adopt it.

Strategies

Increase the awareness of the farmers of international standards and technology transfer in the field of Integrated Crop Management (ICM), Integrated Pest Management (IPM) and Good Agricultural Practices (Gap, Global Gap and HACCP).

Stimulate the production of non-traditional crops (cauliflower, leek, paprika, carrots and lettuce) and other production methods (organic crops, greenhouses).

Increase the acreage with vegetables for prioritized vegetables (long bean, okra, hot pepper, eggplant, tannia leaves, bitter gourd), the precise crops to be determined after a detailed market survey.

Create a board for all stakeholders in vegetables production and marketing

Components of Green House

Protected cultivation has two major components of technology. One is the infrastructure involving frames, cladding materials, irrigation system, tools, implements, other engineering inputs and another is crop production technology. Infrastructural inputs ensure optimal light, air temperature, water and plant

growth requirements. This optimal aspect of climatic parameters involves simple to most advanced engineering inputs such as automation, etc. to regulate several parameters such as ventilation which is one of the most important components in a successful greenhouse production. A major problem with conventional designs of greenhouses is the concentration of heat within the covered structures, which needs to be either expelled or neutralised through energy-intensive cooling facilities. This problem has been overcome by designing naturally ventilated greenhouses where the temperature can be maintained at the desirable level without consuming any energy. Importance of cladding materials in protected cultivation can hardly be overemphasized. Their quality and cost are important besides certification. Micro irrigation and fertigation involves a lot of science and technology, demanding research for continuous improvement. It is the engineering aspect of the protected structure which provides plants optimal conditions to grow normally. Another aspect of protected cultivation is crop production technology which involves development of high-yielding varieties and hybrids of crops suitable for protected cultivation.

Common types of greenhouses being used in India

1. Greenhouses with fan and pad cooling system
2. Plastic greenhouses with natural ventilation
3. Solar greenhouses (Leh design)
4. Plastic low tunnels
5. Walk-in tunnels (Dry temperate areas in HP)
6. Net houses and Anti-insect cages
7. Underground trenches (Leh and Ladakh region)

Causes for Green House Failure / Damage. The main factors are :

- (a) The profile used in the GH frame, trusses and other member too light which deformed
- (b) strong Winds
- (c) Cladding material some time appeared to be stronger than structure
- (d) Poly film tearing because of rough and sharp edge of the frame
- (e) The foundation not sufficiently secured against uplift forces

Subsidy

Along with the application, they have to file their land records. Then the people from that particular department will visit their place to see the land, available infrastructure, water availability, and climatic condition. On that basis, they will sanction the permit to construct a greenhouse in whichever area of the land they want to use for the construction. Maximum limit is 4000 sq m. An individual farmer can apply up to 4000 sq m under Horticulture Mission, and 1000 sq m under Agricultural Department. After seeing the feasibility report, the department sanctions the greenhouse along with subsidy. National Horticulture Board (NHB) is a body of Government of India which provides 50% subsidy on a project cost 36/112 lakhs maximum ceiling per farmer/beneficiary.

CONCLUSION

The greenhouse technology is still in its preliminary stage in India and concerted efforts are required from all concerned agencies to bring it at par with the global standards. Economically viable and technologically feasible greenhouse technology suitable for the Indian agro-climatic and geographical conditions is needed at the earliest. Globalization coupled with economic liberalization will help in achieving the desired results. Efforts should be made to synthesize energy conservation principle along with environmental safety on a broader perspective. The future needs for improving this technology are :

Standardizing proper design of construction of polyhouses including cost effective and indigenously available cladding and glazing material.

Computerized Control System maximize returns it includes time base/volume base/sensor based irrigation system, opening and closing of ventilators and side wall roll up curtains, CO₂ Generator, Climate Control, Temperature, Humidity, Heat Radiation, Control of EC, pH, ppm level of elements in irrigation water etc. as required to the plant.

Developing cost effective agro-techniques for growing of different vegetable crops in the different types of polyhouses and lowering energy

costs of the green house environment management.

Major research activities on growing of vegetables under protected covers should be launched by ICAR and SAU's.

Import of planting materials, structural designs and production technologies which are not relevant under Indian conditions should be stopped and in turn emphasis should be given to develop own F1 hybrid varieties so that seed are made available to the growers in time and at cheaper rates.

Government initiatives/efforts in popularizing the greenhouse technology among the farming community of the country are to be strengthened.

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KNOWLEDGE LEVEL AND KNOWLEDGE GAPS AMONG-ST THE MUSTARD GROWERS (B.F. & NB.F.) REGARDING RECOMMENDED MUSTARD PRODUCTION TECHNOLOGY

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ABSTRACT

The present investigation was conducted in Bharatpur Region of Rajasthan state India during the years 2014-15, 16-17. Bharatpur Region was purposively selected for the present investigation due to the following reasons: Rajasthan is rank first amongst all the states of India in terms of both area and production of rapeseeds-mustard. Rajasthan state comprises of tenth regions. In Rajasthan, the rapeseeds and mustard crop is most popular oilseeds crops cultivated in Jaipur, Alwar, Bharatpur, Dholpur, Karouli, Sawai-madhopur, Sriganganagar, Jhunjhunu and Sikar Districts. In this state, its grown on area of 25,32,330 hectares with an annual production of 32,57,987 tonnes and productivity of 1287 kg/ha. in the years 2015-16. Rapeseed-mustard is the most important oilseeds crops grown in rabi season in Bharatpur Region of Rajasthan. Bharatpur Region occupies first rank in area, production and productivity of rapeseed and mustard crop amongst the oilseeds crops in tenth regions of Rajasthan. It's mostly grown in five selected Districts of Bharatpur Division of Rajasthan. This region has covered 7,49,597 hectares of land. Whereas, an annual production of rapeseed and mustard crop is 10,07,502 tonnes which is very high 1344 kg/ha. as compared to average national productivity in years 2015-16. DRMR:-Directorate of Rapeseed-Mustard Research station is located in near at Sewar, Bharatpur Region of Rajasthan in India. Therefore, DRMR, Sewar under Bharatpur Region was purposively selected. Front Line Demonstrations (FLDs) are being laid out regularly by the DRMR Scientists on the various farmer's field to demonstrate the production potential of rapeseeds-mustard technologies. All the recommended Practices were provided to the selected farmers. An exhaustive list of mustard growers from each selected KVKs was prepared, in this way 25, beneficiary farmers and 25, non-beneficiary farmers were selected from the list available at the each KVKs head quarter. Thus, total 50 mustard growers were selected from each KVK by used the simple random sampling technique. Thus, these obtained lists, the 125, beneficiary farmers and 125, non-beneficiary farmers were selected regarding Recommended Mustard Production Technology in Bharatpur division. Thus, total sample sizes were consisted of 250 mustard growers from the present research study by using simple random sampling technique through proportionate. Responses were recorded in quantitative form through pre-structured interview schedule technique on the total 250 selected respondents. The present study was undertaken in Bharatpur Region of Rajasthan State, to find out that the level of knowledge amongst the mustard growers on a sample size of 250 respondents. The study highlights that the maximum number, half of the respondents were found the total majority of farmers 124 (49.60 %), the majority 64 of beneficiary farmers (51.20 %) and the majority 60 of non-beneficiary farmers (48.00 %) were having from medium level of knowledge groups category. Further reported that the highest level of knowledge exists in package of practices likes "Weed management", "Soil & field preparation" hence, it were ranked first and second. Further recorded that the medium level of knowledge in package of practices likes "Time of sowing", "Physiological aspects/practices", "Seed rate & recommended spacing", "Harvesting/threshing & storage", "Irrigation management" and "Fertilizer application" were ranked Third, Fourth, Fifth, Sixth, Seven and Eight in ranks order. Further observed that the significant association for Education level, social participation, extension participation, Source of information utilized, Economic motivation, and Irrigation potentiality had positively and significantly associated with the knowledge level. On the other hand, non-significant association for age, size of land holding and risk orientation had negatively and non-significantly associated with the knowledge level. It

indicates that the beneficiary farmers had higher knowledge level as compared to non-beneficiary farmers amongst both the category of farmers regarding recommended mustard production technology.

Keywords: *Impact, KVK's, training, FLD's, DRMR Scientists, Knowledge, Rapeseed-Mustard, Oilseeds Crops, Mustard Growers, (B.F. & NB.F.) Recommended Mustard Production Technology.*

INTRODUCTION

The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. The Indian Council of Agricultural Research (ICAR) institutes, state agricultural universities (SAU) and Krishi Vigyan Kendras (KVK) were set up for meeting the emerging research and education challenges. The ICAR is the apex body mandated for coordinating, guiding and managing research and education in Agriculture, Horticulture, Fisheries and Animal sciences in the Country. For implementing its research policies and programmes, the ICAR has developed a strong network of 109 institutes, 78 all-India coordinated projects and 690 KVKs spread across the Country. There are 71 State Agriculture, Veterinary, Horticulture and Fishery Universities and 4 General Universities with agriculture faculty.

Agricultural Extension Division is one of the Subject Matter Divisions where the major activities are of Assessment and Demonstration of Technology/Products through a network of 690 Krishi Vigyan Kendras (KVKs). The Division of Agricultural Extension, ICAR, New Delhi is headed by Deputy Director General (Agricultural Extension) supported by 2 Assistant Director Generals. Krishi Vigyan Kendra (KVK) is an agricultural extension center in India. The name means "farm science center". Usually associated with a local agricultural university, these centers serve as the ultimate link between the Indian Council of Agricultural Research and farmers, and aim to apply agricultural research in a practical, localized setting. All KVKs fall under the jurisdiction of one of the 11 Agricultural Technology Application Research Institutes (ATARIs) throughout India.

Indian Council of Agricultural Research has developed a strong network of Krishi Vigyan Kendras (KVKs) in the country to disseminate agricultural technologies and an innovation which is one of the vital first line extension systems. As more and more KVKs are coming up, the KVK scientist has the great

responsibility of creating the centre of excellence in the field of effective technology transfer. Because of its participatory approach, KVKs are getting more popularity among the rural masses especially through organized need based vocational training in the field of agriculture and allied sectors. Under the demonstration strategy, it organized front line demonstration in various crops to generate production data and feedback information. The aim of front line demonstration in general is to raise production, conduct field day, farmer's interaction and exhibition at demonstration site. The KVKs in India has emerged as a distinct organization and its advantage was greeted with great expectation especially on technology transfer front to set a pace of growth of farm productivity and thereby ensuring regeneration of entire farming community (8).

The Krishi Vigyan Kendra (KVKs)-Agriculture Science Centre's, New agricultural technologies dissemination through KVKs with FLDs and OFTs by the KVK's Staffs and DRMR Scientists were adopted by the mustard growers to a considerable extent which may be due to better and adequate infrastructure training and demonstration facilities. The krishi Vigyan Kendra (KVKs) provides a strong training support for bringing about production breakthrough in agriculture. Krishi Vigyan Kendras are functional in carrying out extension activities in accordance with government programme schedule and providing training support to raise the skill of the farmers which will help them to increase their farm productivity. Frontline demonstration (FLDs) is the long-term educational activity conducted by agricultural scientists in a systematic manner on farmers' field to show the worth of new practice/technology. It indicates FLDs and OFTs is proven extension intervention to demonstrate the production potential of improved technologies on farmers' field. (19)

Indian Council of Agricultural Research (ICAR) had established Krishi Vigyan Kendras (KVKs)-'Agriculture Science Centers' all over the India, is an institutional innovation for application of agricultural technologies at the farmer's field with the help of a multi-disciplinary team. The first KVK of the country

was established in 1974 at erstwhile Pondicherry and initial mandate of KVKs was confined only to impart training. Krishi Vigyan Kendras (1974) actually originated as one of the four first line extension systems of ICAR that included National Demonstration (1964), Operational Research Projects (1974-75), and Lab to Land Programme (1979). As long as the need for close interaction between farmers, extensionists and researchers in the participatory diagnosis of problems and location specific recommendations, emphasizing joint action and education rather than prescription has been increasingly felt, the Krishi Vigyan Kendra (KVK) network started spread enormously in the country. The immense policy reforms in the KVK mandates and its activities were brought about only after a thorough realization of the importance of micro-economic situation perspectives of technology suitability and its adoption. With a decision of establishing KVKs in all the rural districts of the country in Xth five-year plans, the KVK revised mandate. There is a wide network of 690 KVKs in the country (ICAR, 2018). Therefore, the main mandate of the KVK is to plan and carry out on-farm trials (OFTs) to verify, test, validate and refine location 31 specific technologies developed by the National Agricultural Research System (NARS). The purpose is to have an appropriate technology which may be economically profitable, ecologically sustainable, technically feasible and culturally compatible. Another vital activity of KVK is to conduct the frontline demonstrations (FLDs) on flagship technologies developed by NARS on farmer's field. The frontline demonstration is a long-term educational activity conducted by the KVK scientists in a systematic manner on farmers' field under his close supervision to show the worthiness of technology. Besides, KVK are building capacity of different stakeholders on niche areas of agricultural and allied sciences, at district level. (15)

The Indian Council of Agricultural Research (ICAR) has established Krishi Vigyan Kendras (KVKs) all over the country for transferring agricultural technology on the farmer's field with the help of a multi-disciplinary team called Subject Matter Specialists (SMS). KVKs are playing strategic role in technology back stopping, knowledge management and advisory to the different stake holders like farmers, farm-women, rural youths and extension personnel. The emphasis is given to provide critical knowledge and skills to the participants to enhance the agricultural

productivity and also become economically self-reliant through gainful-employment. The mandate of KVK is to plan and carry out on-farm research trials to verify, test, validate and refine location specific technologies developed by the National Agricultural Research System (NARS). The main purpose is to have an appropriate technology which may be economically profitable, ecologically sustainable, technically feasible and culturally compatible. Another important activity of KVK is to demonstrate the flagship technologies developed by NARS on farmer's field to enhance productivity and profitability of principle crops grown in the district. Therefore, KVK should know that to what extent the productivity of these crops are in round due to demonstrations, to what extent demonstrations helped for horizontal spread of technologies in their operational area and extent to what the new technologies are adopted by the farmers. (12).

The Krishi Vigyan Kendras of Bharatpur Region are engaged in promoting scientific agriculture in the area for more than a decade. It is therefore important to know as to how far KVK has been able to promote knowledge level and extent of adoption with regard to recommended mustard production technology in respective area. Rapeseeds-mustard being major crops of rabi season in Bharatpur Region on adoption regarding recommended mustard production technology give sufficient evidence of success achieve by KVK.

Rapeseed-mustard is second most important oil seeds crop after groundnut and known as queen of oilseeds crop due to unparallel productivity among oil seed crops. The availability of suitable high yielding varieties as well as excellent knowledge about production technology are ascribed as main reasons for high productivity of mustard crop in Bharatpur Region during the year (2010-11).

DRMR : The Indian Council of Agricultural Research (ICAR) established the National Research Centre on Rapeseed-Mustard (NRCRM) on October 20, 1993, to carry out basic, strategic and applied research on rapeseed-mustard. Besides, generating basic knowledge and material, it also engages in developing ecologically sound and economically viable agro production and protection technologies. The Centre has also the responsibility to plan, coordinate and execute the research programmes through wide network of 22 main and sub-centres across the country,

to augment the production and productivity of rapeseed-mustard. In February 2009, the ICAR re-designated NRCRM as the Directorate of Rapeseed Mustard Research (DRMR). The DRMR functions as a fulcrum to support the production system research for rapeseed (Brown sarson, yellow sarson, toria, taramira, gobhi sarson) and mustard (black mustard, Ethiopian mustard and Indian mustard) group of crops through research, service and support units.

Thus, the results of such study will be useful for State Department of Agriculture, Marketing Departments, State Agricultural Universities, Agricultural Research Stations, Krishi Vigyan Kendras as well as to the beneficiary farmers and non-beneficiary farmers to decide appropriate strategies and to make programmes for better production and to develop an economic environment for rapeseeds-mustard crops. Keeping in view of the above facts in consideration, the present research study was undertaken to entitled “Impact of Krishi Vigyan Kendras on Adoption of Recommended Mustard Production Technology by the Mustard Growers in Bharatpur Region of Rajasthan State, India. To assess the object to find out the Knowledge Level Amongst the Mustard Growers (B.F. & NB.F.) Regarding Recommended Mustard Production Technology.

RESEARCH METHODOLOGY

A. Selection of Krishi Vigyan Kendras :

The present investigation was conducted in five selected Krishi Vigyan Kendras from Bharatpur Region of Rajasthan. Each Krishi Vigyan Kendra is located at each district head quarter. KVK Navgaon (Alwar), KVK Kumher (Bharatpur) and KVK Unella (Dholpur) are working under Directorate of Extension Education, Jobner. However, the administrative control of Sri Karan Narendra Agricultural University, Jobner, District-Jaipur, Rajasthan. KVK Kermoda (Sawai-madhopur) and KVK Hindoaun (Karoli) are working under Directorate of Extension Education, Kota. However, the administrative control of Agricultural University, Kota, Rajasthan. KVK Navgaon (Alwar), KVK Kumher (Bharatpur), KVK Unella (Dholpur) and KVK Hindoaun (Karoli) Districts come under Agro Climatic Zone III b of Rajasthan *i.e.* Flood Prone Eastern Plain Zone (III b). KVK Kermoda (Sawai-madhopur) District is situated in Agro-Climatic Zone V of Rajasthan.

Keeping the above facts in view, the present

investigation an attempt has been made to measure the “Impact of Krishi Vigyan Kendras on Adoption of Recommended Mustard Production Technology by the Mustard Growers in Bharatpur Region of Rajasthan”. Thus present research study has been conducted with the beneficiary farmers and non-beneficiary farmers regarding recommended mustard production technology in Bharatpur division. At present time, total numbers of 42 KVKs are going on operation in all the tenth regions of Rajasthan State. This research work has been carried out, within five listed below KVKs purposively selected for the present research study from Bharatpur Region of Rajasthan *viz.*, Alwar, Bharatpur, Dholpur, Karoli & Sawai-madhopur Districts of Rajasthan.

Bharatpur Region was purposively selected for the present investigation due to the following reasons:

(I) Rajasthan is rank first amongst all the states of India in terms of both area and production of rapeseeds-mustard. Rajasthan state comprises of tenth regions *viz.*, Jaipur, Sikar, Bharatpur, Bikaner, Sri-ganganagar, Jodhpur, Jalore, Kota, Udaipur and Bhilwara. In Rajasthan State, the rapeseeds and mustard crop is most popular oilseeds crops cultivated in Jaipur, Alwar, Bharatpur, Dholpur, Karoli, Sawai-madhopur, Sriganganagar, Jhunjhunu and Sikar Districts. In this state, its grown on area of 25,32,330 hectares with an annual production of 32,57,987 tonnes and productivity of 1287 kg/ha in the years 2015-16.

(II) Rapeseeds-mustard is the most important oilseeds crops grown in rabi season in Bharatpur Region of Rajasthan. Bharatpur Region occupies first rank in area, production and productivity of rapeseeds and mustard crop amongst the oilseeds crops in tenth regions of Rajasthan. It's mostly grown in five selected Districts of Bharatpur Division of Rajasthan. This region has covered 7,49,597 hectares of land. Whereas, an annual production of rapeseeds and mustard crop is 10,07,502 tonnes which is very high 1344 kg/ha as compared to average national productivity 2015-16. (1).

(III) DRMR : Directorate of Rapeseeds-Mustard Research station is located in near at Sewar, Bharatpur Region of Rajasthan in India. Therefore, DRMR, Sewar under Bharatpur Region was purposively selected. Front Line Demonstrations (FLDs) are being laid out regularly by the DRMR Scientists on the farmer's field to demonstrate the production potential

of rapeseeds-mustard technologies. Thus research study area was easily accessible to the investigator, he is bonafide resident of this region.

(IV) Limitation of time, money and available resources for this research study.

B. Selection of the respondents/farmers

25, beneficiary farmers were selected from the list available at the each KVKs head quarter. Similarly, 25, non-beneficiary farmers were selected from the list available at the each KVKs head quarter. Thus, total numbers 50 mustard growers were selected from each KVK by the simple random sampling technique. In this way all five KVKs were included in the present investigation.

25, beneficiary farmers who are getting benefits from the KVK were randomly selected from each of the selected KVKs. Similarly, equal numbers of the non-beneficiary farmers who are not getting benefits from the KVK were randomly selected from each of the selected KVKs.

From these obtained lists, 125, beneficiary farmers and 125, non-beneficiary farmers were selected, in this way total 250 sample sizes for the present research study by using simple random sampling technique through proportionate. Thus, total sample sizes were consisted of 250 mustard growers from present research study.

On the basis of specific objectives formed for the present research study, a suitable tool was developed. The data were collected through personal interview method by interview schedule. Collected data were classified, tabulated, and statistically analyzed which led to the following salient findings. In order to test the validity of results various hypotheses were formulated

Table A. Selection of Krishi Vigyan Kendras and Rapeseeds-Mustard Growers from Bharatpur Region of Rajasthan.

Selected Division	Selected KVKs	No. of Rapeseeds-Mustard Growers	
Bharatpur Region	Alwar	25	25
	Bharatpur	25	25
	Dholpur	25	25
	Karoli	25	25
	Sawai-madhopur	25	25
Total	5 KVKs	125	125

and appropriate statistical tests were applied. The statistical tests applied were S.D., 'z' test, 't' test and rank correlation. The levels of significance for acceptance or rejection of hypotheses were 5 percent and 1 percent level of significant.

RESULTS AND DISCUSSION

Knowledge level of the (B. F. & NB. F.) about package of practices regarding recommended mustard production technology.

It is assumed that the knowledge of farmer's to large degree depends upon the extent of exposure given to him about package of practices wise production technology of rapeseed-mustard cultivation in the present study area.

The Front Line Demonstration conducted on rapeseed-mustard crops from DRMR, scientists and K.V.Ks, subject matter specialists i.e., Alwer, Bharatpur, Dholpur, Karoli and Sawai madhopur Districts. These organizations and institutions are supposed to have imparted knowledge level about package of practices with regard to recommended mustard production technology to the respondents where the FLD's were conducted on his farm. In this section, efforts were made to assess the level of knowledge amongst the beneficiary farmers as well as the non-beneficiary farmers regarding recommended mustard production technology.

1. Distribution of the (B. F. & NB. F.) according to their knowledge level regarding recommended mustard production technology.

The knowledge scores obtained from the respondents were divided into three knowledge categories in the form of frequency as well as percentage about package of practices with regard to recommended mustard production technology was assessed. Thus, the farmers were divided into three levels of knowledge groups on the basis of mean and standard deviation and knowledge scores obtained by them. The data related to the level of knowledge of both the categories of farmers i.e., beneficiary farmer's and non-beneficiary farmer's indicates that the knowledge of farmers about package of practices regarding recommended mustard production technology has a wide gap. In order to place the respondents into appropriate categories knowledge scores were distributed as reported in table 1.

The data indicates in table 1 shows that the total majority of farmers 124 (49.60 %) had from medium

Table 1. Distribution of the (B. F. & NB. F.) according to their knowledge level with regard to recommended mustard production technology.

S. No.	Knowledge level	Beneficiary (N=125)		Non-beneficiary (N=125)		Total (N=250)	
		F	%	F	%	F	%
1.	Low (below 68.95 score)	28	22.40	25	20.00	53	21.20
2.	Medium (from 70 to 78 score)	64	51.20	60	48.00	124	49.60
3.	High (above 78.25 score)	33	26.40	40	32.00	73	29.20
	Total	125	100.00	125	100.00	250	100.00

Mean = 73.60 S.D. = 4.65 F = Frequency; % = Percentage

Table 2. Knowledge and Knowledge gaps among-st the (B. F. & NB. F.) with regard to package of practices wise recommended mustard production technology.

S. No.	Package of practices	Beneficiary (N=125)		Non-Beneficiary (N=125)		Total (N=250)	
		MPS	KG	MPS	KG	MPS	KG
1.	HYVs varieties	60.42	39.58	58.06	41.94	59.24	40.76
2.	Soil and field preparation	89.60	10.40	79.20	20.80	84.40	15.60
3.	Soil treatment	63.08	36.92	57.14	42.86	60.11	39.89
4.	Seed treatment	60.00	40.00	57.60	42.40	58.80	41.20
5.	Time of sowing	88.89	11.11	77.78	22.22	81.25	18.75
6.	Seed rate and recommended spacing	84.16	15.84	80.00	20.00	82.08	17.92
7.	Fertilizer application	71.81	28.19	61.11	38.89	66.46	33.54
8.	Irrigation management	80.00	20.00	60.00	40.00	70.00	30.00
9.	Weed management	90.00	10.00	84.40	15.60	87.20	12.80
10.	Plant protection measures	67.55	32.45	62.50	37.50	65.02	34.98
11.	Physiological aspects/practices	88.80	11.20	77.78	22.22	83.29	16.71
12.	Harvesting/threshing and storage	80.00	20.00	60.00	40.00	70.00	30.00
	Over all	77.03	22.97	67.96	32.04	72.32	27.68

MPS = Mean Per cent Scores

KG = Knowledge Gap's

rs = Rank correlation;

**Significant at 1% level

level (from 70 to 78 scores) knowledge category regarding recommended mustard production technology. Further reported that the total majority of farmers 73 (29.20 %) had from high level (above 78.25 scores) knowledge category. Further observed that the total majority of farmers 53 (21.20 %) had from low level (below 68.95 score) knowledge category regarding recommended mustard production technology.

The data reported in table 1 shows that the majority 64 of the beneficiary farmers (51.20 %) were having from medium level of knowledge groups with regard to recommended mustard production technology. Further reported that the majority 33 of the beneficiary farmers (26.40 %) were having from high level of knowledge groups. Further observed that the majority 28 of the

beneficiary farmers (22.40 %) were having from low level of knowledge groups regarding recommended mustard production technology.

Further data recorded in table 1 shows that the majority 60 of the non-beneficiary farmers (48.00 %) were having from medium level of knowledge groups with regard to recommended mustard production technology. Further reported that the majority 40 of the non-beneficiary farmers (32.00 %) were having from high level of knowledge groups. Further observed that the majority 25 of the non-beneficiary farmers (20.00 %) were having from low level of knowledge groups regarding recommended mustard production technology.

These findings of the present study are similar in

Table 3. Comparison between knowledge level of the (B. F. & NB. F.) with package of practices regarding recommended mustard production technology.

S. No.	Package of practices	Beneficiary (N=125)		Non-Beneficiary (N=125)		'Z' value
		Mean +	S.D.	Mean +	S.D.	
1.	HYV's varieties	12.68	1.13	12.19	1.08	3.55*
2.	Soil and field preparation	2.69	0.24	2.38	0.21	10.88*
3.	Soil treatment	4.42	0.39	4.00	0.36	8.85*
4.	Seed treatment	2.88	0.81	2.00	0.18	1.60*
5.	Time of sowing	8.00	0.51	7.00	0.39	17.24**
6.	Seed rate and recommended spacing	4.21	0.14	4.00	0.36	6.08*
7.	Fertilizer application	12.21	1.08	11.00	0.98	9.26*
8.	Irrigation management	2.00	0.18	1.60	0.14	19.60**
9.	Weed management	7.37	0.66	6.75	0.13	10.33*
10.	Plant protection measures	10.81	0.96	10.00	0.89	6.91*
11.	Physiological aspects /practices	8.00	0.71	7.00	0.62	10.53*
12.	Harvesting/threshing and storage	1.60	0.14	1.20	0.11	25.10**
	Over all					

*Significant at 5% level of significance

**Significant at 1% level of significance

compliance with the findings of (3, 4, 5, 6, 7, 10, 11, 13, 14, 16, 18, 19, 20, 21, 22).

2. Knowledge level and Knowledge gaps among-st the (B. F. & NB. F.) with regard to package of practices wise recommended mustard production technology.

The knowledge level of the beneficiary farmers and non-beneficiary farmers with regard to package of practices wise recommended mustard production technology were measured in terms of mean percent score and knowledge gaps. As many as 12 packages of practices regarding recommended mustard production technology included in the research study to assess the level of knowledge. In order to find out the mean percent scores and knowledge gaps of each major practice were calculated. Thereafter, the knowledge gaps were assessed under each package of practices regarding recommended mustard production technology.

It is clear from table 2 present that the level of knowledge needs to be introduced to the beneficiary farmers and the non-beneficiary farmers with regard to package of practices wise recommended mustard production technology. Further observed that the level of knowledge under each practice is presented in the table and level of information needs to be introduced

for the beneficiary farmers and the non-beneficiary farmers regarding recommended mustard production technology are also shown in the table 2.

The data reported in table 2 shows that the overall level of knowledge with 72.32 MPS were found. The highest level of knowledge amongst the total majority of farmers about "Weed management" with 87.20 MPS; hence, it was rank first. Further highest level of knowledge followed towards "Soil and field preparation" with 84.40 MPS was rank second. Further reported that the medium level of knowledge among the total majority of farmers reported in package of practices likes "Physiological aspects/practices" with 83.29 MPS, "Seed rate and recommended spacing" with 82.08 MPS, "Time of sowing" with 81.25 MPS and "Harvesting/threshing and storage" with 70.00 MPS were ranked Third, Fourth, Fifth and Sixth in ranks order. Further recorded that the medium level of knowledge among the total majority of farmers in package of practices likes "Irrigation management" with 70.00 MPS and "Fertilizer application" with 66.46 MPS were ranked Seven and Eight in ranks order. Further observed that the lowest level of knowledge among the total majority of farmers observed in package of practices likes "Plant protection measures" with 65.02 MPS, "Soil treatment" with 60.11 MPS, "HYV's varieties" with

59.24 MPS and “Seed treatment” with 58.80 MPS were ranked Ninth, Tenth, Eleventh and Twelfth in ranks order amongst the total majority of farmers regarding recommended mustard production technology.

Further data recorded in table 2 indicates that in case of overall level of knowledge gaps (27.68 %) were found. Further reported that the highest level of knowledge gaps among the total majority of farmers were reported in package of practices likes “Seed treatment” (41.20 %), “HYVs varieties” (40.76 %), “Soil treatment” (39.89 %) and “Plant protection measures” (34.98 %). Further recorded that the medium level of knowledge gaps were recorded in package of practices likes “Fertilizer application” (33.54 %), “Irrigation management” (30.00 %), “Harvesting/ threshing and storage” (30.00 %) and “Time of sowing” (18.75%). Further observed that the lowest level of knowledge gaps were observed in package of practices likes “Seed rate and recommended spacing” (17.92%), “Physiological aspects/practices” (16.71%), “Soil and field preparation” (15.60%), and “Weed management” (12.80%), amongst the total majority of farmers regarding recommended mustard production technology respectively.

The data reported in table 2. shows that the overall level of knowledge with 73.03 MPS were found amongst the beneficiary farmers. This highest level of knowledge among the beneficiary farmers about “Weed management” with 90.00 MPS; hence, it was rank first. Further highest level of knowledge among the beneficiary farmers followed towards “Soil and field preparation” with 89.60 MPS was rank second. Further reported that the medium level of knowledge among the beneficiary farmers reported in package of practices likes “Time of sowing” with 88.89 MPS, “Physiological aspects/practices” with 88.80 MPS, “Seed rate and recommended spacing” with 84.16 MPS and “Harvesting/threshing and storage” with 80.00 MPS were ranked Third, Fourth, Fifth and Sixth in ranks order. Further recorded that the medium level of knowledge among the beneficiary farmers reveals in package of practices like “Irrigation management” with 80.00 MPS and “Fertilizer application” with 71.81 MPS were ranked Seven and Eight in ranks order. Further observed that the lowest level of knowledge among the beneficiary farmers were observed in package of practices likes “Plant protection measures” with 67.55 MPS, “Soil treatment” with 63.08 MPS, “HYVs varieties” with 60.42 MPS and “Seed

treatment” with 60.00 MPS were ranked Ninth, Tenth, Eleventh and Twelfth in ranks order amongst the beneficiary farmers regarding recommended mustard production technology respectively.

Further data recorded in table 2 indicates that in case of overall level of knowledge gaps (22.97 %) were found amongst the beneficiary farmers. This highest level of knowledge gaps among the beneficiary farmers were found in package of practices likes “Seed treatment” (40.00 %), “HYVs varieties” (39.58 %), “Soil treatment” (36.92 %) and “Plant protection measures” (32.45 %). Further reported that the medium level of knowledge gaps were reported in package of practices likes “Fertilizer application” (28.19 %), “Irrigation management” (20.00 %), “Harvesting/threshing and storage” (20.00 %) and “Seed rate and recommended spacing” (15.84 %). Further observed that the lowest level of knowledge gaps were observed in package of practices likes “Physiological aspects/practices” (11.20 %), “Time of sowing” (11.11 %) “Soil and field preparation” (10.40 %), and “Weed management” (10.00 %), amongst the beneficiary farmers regarding recommended mustard production technology.

The data reported in table 2 shows that the overall level of knowledge with 67.96 MPS were found amongst the non-beneficiary farmers. This highest level of knowledge among the non-beneficiary farmers about “Weed management” with 84.40 MPS; hence, it was rank first. Further highest level of knowledge among the non-beneficiary farmers followed towards “Seed rate and recommended spacing” with 80.00 MPS was rank second. Further reported that the medium level of knowledge among the non-beneficiary farmers reported in package of practices likes “Soil and field preparation” with 79.20 MPS, “Physiological aspects/practices” with 77.78 MPS, “Time of sowing” with 77.78 MPS and “Plant protection measures” with 62.50 MPS were ranked Third, Fourth, Fifth and Sixth in ranks order. Further recorded that the medium level of knowledge among the non-beneficiary farmers reveals in package of practices like “Fertilizer application” with 61.11 MPS “Irrigation management” with 60.00 MPS and “Harvesting/threshing and storage” with 60.00 MPS were ranked Seven, Eight and Ninth in ranks order. Further observed that the lowest level of knowledge among the non-beneficiary farmers were observed in the package of practices likes “HYV’s varieties” with 58.06 MPS and “Seed treatment” with 57.60 MPS “Soil treatment” with 57.14 MPS were ranked Tenth, Eleventh and Twelfth in ranks

order amongst the non-beneficiary farmers regarding recommended mustard production technology.

Further data recorded in table 2 indicates that in case of overall level of knowledge gaps (32.04 %) were found amongst the non-beneficiary farmers. Further reported that the highest level of knowledge gaps among the non-beneficiary farmers were reported in package of practices likes “Soil treatment” (42.86 %), “Seed treatment” (42.40 %), “HYVs varieties” (41.94 %) and “Irrigation management” (40.00 %). Further recorded that the medium level of knowledge gaps were recorded in package of practices likes “Harvesting/threshing and storage” (40.00 %), “Fertilizer application” (38.89 %), “Plant protection measures” (37.50 %) and “Time of sowing” (22.22 %). Further observed that the lowest level of knowledge gaps were observed in package of practices likes “Physiological aspects/practices” (22.22%), “Soil and field preparation” (20.80 %), “Seed rate and recommended spacing” (20.00%) and “Weed management” (15.60 %) amongst the non-beneficiary farmers regarding recommended mustard production technology respectively.

3. Comparison between knowledge level of the (B. F. & NB. F.) with package of practices regarding recommended mustard production technology.

The significant difference between the level of knowledge was analyzed with the help of ‘Z’ test. The obtained results have been presented in this table 3.

H₀ There is no significant difference between level of knowledge among the beneficiary farmers and non-beneficiary farmers with regard to recommended mustard production technology.

H₁ There is a significant difference between level of knowledge among the beneficiary farmers and non-beneficiary farmers with regard to recommended mustard production technology.

The data recorded in this table 3 shows that the calculated ‘Z’ value was higher than it tabulated value significance at 5 per cent level of probability with level of knowledge amongst the beneficiary farmers and the non-beneficiary farmer’s in all 12 packages of practices regarding recommended mustard production technology. Thus rejection of null hypothesis and acceptance of alternative hypothesis leading to conclusion that there were significant difference between level of knowledge amongst the beneficiary farmers and the non-beneficiary farmers with regard to all 12 packages of practices wise recommended

mustard production technology. In other words, there was significant difference between level of knowledge amongst the beneficiary farmers and the non-beneficiary farmers regarding recommended mustard production technology.

Discussion : This finding reveals that the higher level of knowledge amongst the beneficiary in comparison to the non-beneficiary farmers with regard to recommended mustard production technology. It may be because of the reason that the FLD’s were conducted on the field of the beneficiary farmers from both the organizations and institutions likes as DRMR, Scientists and SMSs of K.V.Ks. These research centers have also provided necessary guidance, literature and training to the beneficiary from both the organizations and institutions likes as DRMR, Sewar (Bharatpur) and K.V.Ks. Alwer, Bharatpur, Dholpur, Karoli and Sawai madhopur. On the other hand, the FLD’s were not-conducted on the non-beneficiary farmers field and they may be not provided any type of guidance, literature and training from both the organizations and institutions likes DRMR, Scientists and SMSs of K.V.K. as such as they were deprived of technical knowledge. This might have resulted in higher level of knowledge access among the beneficiary than that the non-beneficiary farmers.

CONCLUSION

Knowledge level and knowledge gaps among-st the mustard growers (B. F. & NB. F.) regarding recommended mustard production technology.

1. This study was undertaken in Bharatpur Region of Rajasthan State, to find out that the level of knowledge amongst the mustard growers on a sample size of 250 respondents (125, beneficiary farmers and 125, non-beneficiary farmers) from both the category of mustard growers regarding recommended mustard production technology. The study highlights that the maximum number, half of the respondents were found the total majority of farmers 124 (49.60 %), the majority 64 of beneficiary farmers (51.20 %) and the majority 60 of non-beneficiary farmers (48.00 %) were having from medium level of knowledge groups category. Further reported that the total majority of farmers 73 (29.20 %), the majority 33 of beneficiary farmers (26.40 %) and the majority 40 of non-beneficiary farmers (32.00 %) were having from high level of knowledge groups category. Further observed that the total majority of farmers 53 (21.20

%), the majority 28 of beneficiary farmers (22.40 %) and majority 25 of non-beneficiary farmers (20.00 %) were having from low level of knowledge groups category with regard to recommended mustard production technology.

2. Finding data reported from the research study that the overall knowledge level with 72.32 MPS followed overall level of knowledge gaps (27.68 %) were found among the total majority of farmers. Further reported that the overall knowledge level with 77.03 MPS while, overall level of knowledge gaps (22.97 %) were found among the beneficiary farmers. Further observed that the overall knowledge level with 67.96 MPS whereas, overall level of knowledge gaps (32.04 %) were found among the non-beneficiary farmers with regard to recommended mustard production technology.

3. The data high light in table 2. Indicated that the highest level of knowledge exists in package of practices likes “Weed management”, “Soil and field preparation” hence, it were ranked first and second. Further reported that the medium level of knowledge in package of practices likes “Time of sowing”, “Physiological aspects/practices”, “Seed rate and recommended spacing” were ranked Third, Fourth and Fifth in ranks order. Further recorded that the medium level of knowledge in package of practices likes “Harvesting/threshing and storage”, “Irrigation management” and “Fertilizer application” were ranked Sixth, Seven and Eight in ranks order. Further observed that the lowest level of knowledge in package of practices likes “Plant protection measures”, “Soil treatment”, “HYVs varieties” and “Seed treatment” were ranked Ninth, Tenth, Eleventh and Twelfth in ranks order. On the other hand, Further reported that the highest level of knowledge gaps exists in package of practices likes “Seed treatment”, “HYVs varieties”, “Soil treatment” and “Plant protection measures”. Further recorded that the medium level of knowledge gaps in package of practices likes “Fertilizer application”, “Irrigation management”, “Harvesting/threshing & storage” and “Seed rate & recommended spacing”. Further observed that the lowest level of knowledge gaps in package of practices likes “Physiological aspects/practices”, “Time of sowing”, “Soil & field preparation” and “Weed management” amongst both the category of farmers regarding recommended mustard production technology.

4. This finding reveals that the calculated ‘Z’ value was

higher than it tabulated value significance at 5 per cent level of probability with level of knowledge amongst the beneficiary farmers and the non-beneficiary farmers in all 12 packages of practices regarding recommended mustard production technology. Thus rejection of null hypothesis and acceptance of alternative hypothesis leading to conclusion that there were significant difference between level of knowledge amongst the beneficiary farmer’s and the non-beneficiary farmers with regard to all 12 packages of practices wise recommended mustard production technology.

5. Thus, this is proved evidently, significant difference between beneficiary farmers and non-beneficiary farmers with respect to knowledge level regarding recommended mustard production technology. It indicates that the beneficiary farmers had higher knowledge level as compared to non-beneficiary farmers. Significant association for Education level, social participation, extension participation, Source of information utilized, Economic motivation, and Irrigation potentiality had positively and significantly associated with the knowledge level. On the other hand, non-significant association for age, size of land holding and risk orientation had negatively and non-significantly associated with the knowledge level amongst both the category of farmers regarding recommended mustard production technology. It may be because of the reason that the FLDs were conducted on the field of the beneficiary farmers from both the organizations and institutions likes as DRMR, Scientists and SMSs of K.V.K. These research centers have also provided necessary guidance, literature and training to the beneficiary farmers from both the organizations and institutions likes as DRMR, Sewar, Bharatpur and K.V.Ks., Alwer, Bharatpur, Dholpur, Karoli and Sawai madhopur.

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YIELD PERFORMANCE UNDER TWO IRRIGATION REGIMES IN A SET OF DOUBLED HAPLOIDS DERIVED FROM WHEAT PARENTS DIFFERING IN ADAPTATION TO WATER STRESS CONDITIONS

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Abstract

BC₁F₁ plants of cross HD 2967/ Excalibur // HD 2967 were used to generate a doubled haploid population with the objective of introgressing elements of drought tolerance from Australian cultivar Excalibur in HD 2967, widely grown wheat in irrigated conditions of North Western Plains Zone of India. Yield performance of 32 DH lines along with Indian and exotic checks and parental lines was evaluated in irrigated and rainfed conditions for two seasons (2013-14 and 2014-15). GGE biplot analysis revealed that the two environments (irrigated and rainfed) within seasons clustered together while the two seasons differed greatly in overall mean as well as genotypic ranking. Wheat cultivar PBW 644 emerged as most stable entry while high yielding doubles haploids showing seasonal specificity as well as stable ones could be identified. The mean yield advantage shown by DH 984 and DH963 over recipient parent HD 2967 was 11.8% and 10.5 % respectively. Strategy for introgression (from less productive but specifically adapted donor), along with rapid fixation facilitated by DH production, followed by evaluation in multiple environments, as pursued in this experiment, proved to be an effective strategy.

Keywords : *Triticum aestivum*, drought tolerance, doubled haploids, GGE biplots

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major staple food crop providing more calories in human diet than any other crop worldwide. Growing conditions for wheat range from irrigated to semiarid and arid. A significant proportion of wheat production (30%) in India is contributed by crop grown under rainfed conditions (16). Water deficit stress, however, is often encountered under irrigated conditions as well, due to limited availability of irrigation (as in Central India) or during early and late phases of the crop due to rapid loss of water, in conjunction with heat stress. There is also an increased emphasis on developing lines with potential for water saving and minimizing nutrient leaching without sacrificing productivity. One approach, worthy of exploration for meeting such objectives is introgression of elements of drought stress tolerance in high yielding lines. According to (14) the strategy primarily involves characterization of variability for drought stress tolerance in primary wheat gene pool and rapid flow of useful variation into well adapted cultivars of target region. (12) had emphasised that wheat breeding strategy for drought stress should include simultaneous evaluation of the germplasm under both irrigated conditions

(identification of high yielding genotypes) and stress conditions (to fix alleles imparting drought tolerance). The resulting plant material is also likely to possess yield stability in face of climate aberrations which are becoming more frequent and would also respond better to resource conserving agronomic practices. The proposed strategy was tested in the present study by generating and evaluating a set of doubled haploid lines using two well known cultivars as parents. The mega wheat variety, HD 2967, represented the high yielding parent adapted to irrigated conditions of almost entire Indo-Gangetic plains of India. The other parent, Excalibur is a highly drought tolerant cultivar of Australian origin adapted to moisture stress regimes. It is a well characterized genetic stock by virtue of being a subject of several studies (1, 6).

MATERIALS AND METHODS

The F₁ from HD2967 x Excalibur cross was used for backcrossing to HD 2967 and also to generate an F₂ population. BC₁F₁ plants of cross HD 2967/ Excalibur // HD 2967 were used to generate a doubled haploid population during offseason of 2012 at Keylong (District Lahaul-Spiti in Himachal Pradesh). Wheat X maize system (9) of doubled haploid production was followed. About 300 spikes, mostly on

different BC₁F₁ plants were emasculated without clipping the glumes. The emasculated tillers were detached, pollinated with freshly collected maize pollen and cultured on media containing (11) basal salts, 40 g sucrose per liter and 8 ml sulphurous acid per liter. Caryopses obtained from detached tillers, 15 days after pollination were surface sterilized using 0.1% HgCl₂ for 8 minutes in laminar flow and washed with autoclaved distilled water. Caryopses were again washed in 90% ethanol for 2 minutes in laminar flow. After final washing with autoclaved distilled water, caryopses were dissected to rescue haploid wheat embryos on MS salts based solidified plant regeneration media containing 20g sucrose per liter. Regenerated plants were transferred to main season location at Ludhiana and transplanted in cups for hardening. Well tillered haploid plants were uprooted and given chromosome doubling treatment by immersing their crown root region in colchicine (0.075%) solution for six hours followed by washing overnight in running water. Treated plants were transplanted to field (2012-13 crop season). Seed set on colchicine treated plants was planted at offseason station in 2013 for seed multiplication.

For evaluation of DH lines a field experiment was set up at Ludhiana during 2013-14 crop season. Plant material used was 32 DH lines along with checks comprising wheat cultivars for rainfed conditions (PBW 175, C 306, C 285 and PBW 644), exotic drought tolerant lines (Gladius, Krichauff, Babax and Drysdale) and parental lines (HD 2967 and Excalibur). Two environments viz., rainfed (RF) and irrigated (IR) were used. The rainfed environment employed pre-sowing irrigation only while standard package of recommendations was followed for all other agronomic practices under both environments. Material was sown in randomized complete block design with two replications under each environment. Each replication was sown in a plot consisting of 4 rows of 4 m length. The evaluation was repeated in 2014-15 crop season at Ludhiana. For analysis of variance over years and environments glm procedure of SAS® 9.3 software was used (13). For constructing boxplots and GGE biplots Plant Breeding Tools version 1.3 (International Rice Research Institute) was used.

RESULTS AND DISCUSSION

The F₁ of the HD 2967 x Excalibur cross showed the grassy clump growth habit. Grassy clump formation is

a well known phenomenon in wheat F₁ hybrids (3), particularly when diverse parents are involved. A few small ears appeared on rare tillers, late in the season in case of HD 2967 x Excalibur cross, allowing backcross and selfing procedures to be performed. Ear emergence on the clumps at offseason location was even rarer due to relatively shorter growth period and only very early planting resulted in seed formation. Though not a primary objective of the study, inheritance of grassy clump habit, nevertheless, became evident in the F₂ generation. The observed segregation pattern and its chi-square analysis for a two gene interactive system (one gene coming from each parent) is given in table 1.

Phenotypic ratio observed was in accordance with expected 9:7 ratio of grassy clump habit to normal growth habit with highly acceptable p value from chi-square analysis.

For development of DH population around 300 ears of wheat from BC₁F₁ plants of cross HD 2967/ Excalibur // HD 2967 were pollinated with maize pollen and kept in tiller culture media for 15 days. Around 3000 caryopses were obtained from these ears. These were dissected under sterile conditions and 452 haploid embryos were rescued on embryo regeneration media for haploid plant production. A total of 212 haploid plants were regenerated. Colchicine treatment was given to haploid plants and total of 62 doubled haploid plants were obtained. These plants were sent to offseason station for seed multiplication. A set of 32 seed multiplied DH lines were obtained as a result. Reduction in number of progenies at this point was mostly due to appearance of grassy clump growth habit in DH lines under conditions of offseason location. BC₁F₁ generation had been targeted for DH production so expected segregation pattern (as per above discussed inheritance) in DH population was 1:1 for grassy clump habit to normal growth habit. Chi square value (0.064) and p value (0.80) calculated for segregation in DH population further confirms the inheritance pattern observed in F₂.

The 32 doubled haploid lines along with parents and checks (rainfed cultivars of Indian and exotic origin) were evaluated for yield performance in field trials. Parent HD 2967, being one of the most widely grown cultivar in irrigated conditions of the zone, also served as irrigated check. The entire set was evaluated under rainfed and irrigated environments for two years (2013-14 and 2014-15 crop seasons). The analysis of variance (Table 2) for grain yield shows all the three

Yield performance under two irrigation regimes in a set of doubled haploids derived from wheat parents differing in adaptation to water stress conditions

Table 1 : Segregation pattern of F₂ population from HD 2967 Excalibur cross for grassy clump habit.

	Normal growth habit	Grassy clump habit	Total plants
Observed	368	439	807
Expected	353	454	
(O-E) ² /E	0.63	0.49	
$\chi^2 = \frac{(O-E)^2}{E}$	1.13		
Table value	3.84		
p value	0.287		

Table 2 : Pooled analysis of variance for grain yield (kg/ha) over two years and two environments.

Source	DF	Mean Squares	F Value	Probability>F
Replication within environments and Seasons	4	42308.2	0.43	0.7863
Season	1	328620964.6	3345.61	<0.0001
Environments	1	12521068.6	127.47	<0.0001
Seasons Environments	1	1432629.8	4.09	0.0498
Genotypes	41	8728972.3	88.87	<0.0001
Seasons Genotypes	41	2342708.4	6.68	<0.0001
Environments Genotypes	41	416151	1.19	0.29
Seasons Environments Genotypes	41	350621.1	3.57	<0.0001
Error	164	16108799.3		

primary sources of variation viz., genotypes, seasons and environments to be significant. Among the interactions, genotypes x seasons interaction and higher order interaction involving all three primary sources were significant. Environments did not turn out to be interactive with the genotypes. Thus the genotypes do not show significant cross over effect. In other words, same genotypes can perform well across the two environments as environment differences fell short of the cross-over point as explained by Blum (2005). This is desirable as a single genotype with an element of tolerance in high yielding background as envisaged in this study can be identified.

The boxplot of yield under two environments viz. irrigated (IR) and rainfed (RF) across two years is represented in Fig. 1. Mean yield of the set of lines decreased under rainfed conditions in both years indicating effect of stress conditions. However, effect of season seemed to be more dramatic with 2014-15 crop season showing higher yield under both rainfed and irrigated environments.

The mean grain yield for the entire set of genotypes evaluated during the two seasons, over two environments in each season is given in table 3. The

performance and stability of genotypes will be illustrated through an analysis of GGE biplots.

Figure 2 depicts GGE biplots (18) obtained using plant breeding tools software developed by IRRI. Principal component analysis was performed and first two principal components (PC1 and PC2) were used to create interactive biplots.

The biplots are based on scores of PC1 plotted against PC2 for both sources of variation that is environment and genotypes. The total genotype and genotype x environment variation explained by principal components is 93.9% (74.0+19.9 by each PC1 and PC2 respectively).

The biplot in Fig 2 provides environment centred view of mean yield of genotypes. Environments under consideration are: E1-Irrigated 2013-14, E2-Rainfed 2013-14, E3-Irrigated 2014-15 and E4-Rainfed 2014-15. The lines connecting the biplot origin with the markers for the environments are called environment vectors. The angle between the vectors of two environments is related to the correlation coefficient between them. The cosine of the angle between the vectors of two environments approximates the correlation coefficient between them (7, 8, 17). Based on this, the four environments can be grouped

Table 3 : Mean grain yield (kg/ha) of genotypes across two years under two environments.

S. No.	Genotypes	Genotype code for biplot analysis	Overall mean	RF 2013-14 (E2)	IR 2013-14 (E1)	RF 2014-15 (E4)	IR 2014-15 (E3)
1	DH962	G4	4036	3634	4207	4231	4073
2	DH963	G5	6149	5679	5707	5943	7266
3	DH964	G6	5797	4465	5054	7143	6524
4	DH965	G7	5200	4647	4837	5514	5802
5	DH966	G8	4490	3316	3886	5470	5288
6	DH967	G9	5228	3859	4321	6266	6467
7	DH968	G10	5340	4239	4701	5545	6875
8	DH969	G11	2179	1413	1902	2584	2818
9	DH970	G12	2526	2266	2228	2511	3098
10	DH971	G13	5595	4425	4755	5995	7204
11	DH972	G14	3569	2636	2663	4313	4663
12	DH973	G15	3890	1723	3234	5003	5601
13	DH974	G16	5268	3723	4239	6231	6878
14	DH975	G17	4885	2418	2582	7245	7293
15	DH976	G18	5142	2863	3967	6804	6935
16	DH977	G19	5323	3859	4565	6381	6488
17	DH978	G20	5117	4189	4891	5478	5910
18	DH979	G21	5209	4505	4569	5837	5924
19	DH980	G22	5019	4749	4755	5014	5556
20	DH981	G23	4279	2772	4103	5427	4815
21	DH982	G24	4321	2473	3016	5999	5796
22	DH983	G25	5263	4864	4842	5447	5900
23	DH984	G26	6221	3804	4891	7615	8572
24	DH985	G27	3624	1685	4429	4005	4378
25	DH986	G28	5500	5089	5883	5872	5155
26	DH987	G29	4547	1902	3804	5918	6564
27	DH988	G30	5031	3473	3533	6815	6303
28	DH989	G31	4828	3917	3995	5345	6055
29	DH990	G32	5369	4841	4647	6144	5842
30	DH991	G33	4782	3995	4457	5060	5616
31	DH992	G34	4354	3995	3804	4734	4884
32	DH993	G35	3118	1359	1522	4272	5321
33	C-285	G2	2285	1413	1223	3446	3061
34	C-306	G3	4006	2212	2647	5391	5772
35	PBW175	G41	3830	1875	3315	5304	4826
36	PBW644	G42	5933	4701	4918	6810	7302
37	KRICHAUFF	G40	4346	1875	2690	6236	6584
38	DRYSDALE	G36	2514	1570	1461	4166	2859
39	GLADIUS	G38	3879	2554	3696	4160	5106
40	BABAX	G1	3976	2717	2527	5766	4891
41	EXCALIBUR	G37	3154	1821	2642	3674	4481
42	HD2967	G39	5562	4783	4885	5739	6842
CD (0.05)				550.82	478.50	734.91	728.34

Yield performance under two irrigation regimes in a set of doubled haploids derived from wheat parents differing in adaptation to water stress conditions

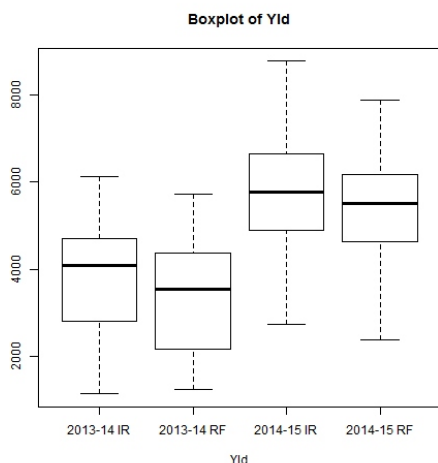


Fig. 1 : Boxplot of yield (kg/plot) under two environments across two years.

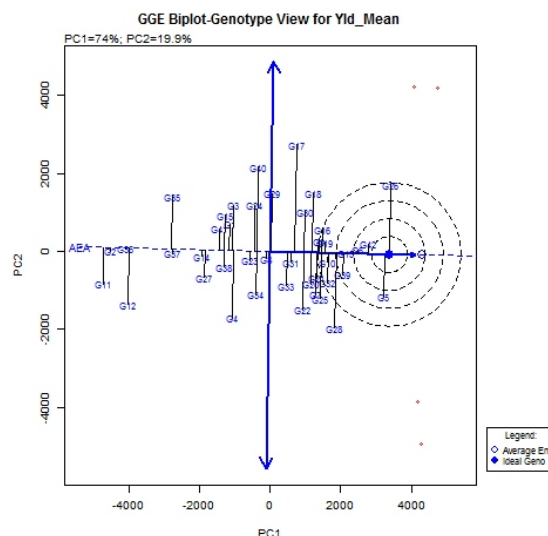


Fig. 3 : Ranking genotypes based on ideal genotype.

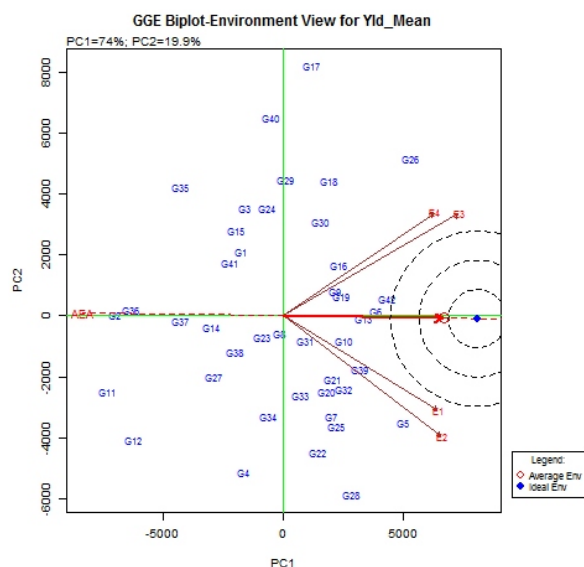


Fig. 2. Environment centred view of mean yield of genotypes

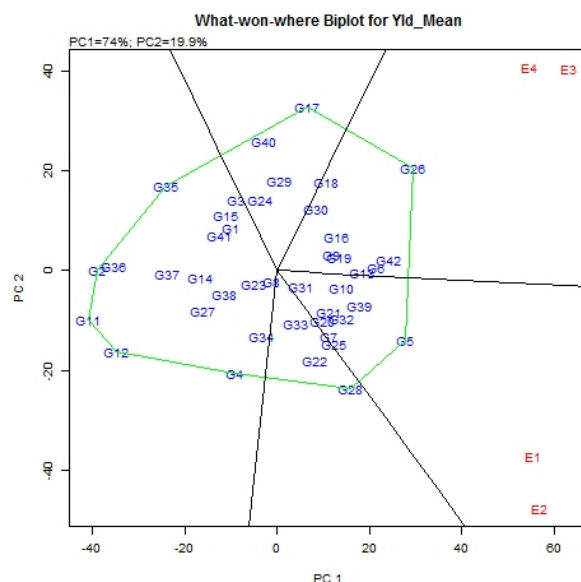


Fig. 4 : Best genotype for each environment.

into two. The environments within a season fall in one group while the two seasons showed large contrast. The presence of wide angles between vectors of two seasons is indication of cross-over of genotype performance across seasons. The length of the environment vectors, which is proportional to the standard deviation within the respective environments and represents the discriminating ability of the environments (17). The vector length of E4 is the largest therefore can be treated as the most discriminating environment.

The ideal genotype should have high mean performance coupled with high stability to give wide adaptability in the target region. As depicted in Fig. 3

the single-headed line called average–environment coordination abscissa (or AEA) points to higher mean grain yield across the locations. The double-headed line is the AEC ordinate and it points to greater variability (poor stability) in either direction. The instability index calculated as per (9) model has the same magnitude as depicted by the biplots. Genotypes G-26 (DH984), G-5(DH963) and G-42 (PBW644) ranked near to ideal genotypes with G42 exhibiting high stability along with high yield. The old and exotic cultivars known for drought tolerance including entries G1 (Babax), G2 (C273), G3 (C306), G40 (Krichauff), G36 (Drysdale), G37 (Excalibur) and G38 (Gladius) did not qualify as ideal genotypes. This situation may have arisen as

stress in both seasons tended to be mild and typically drought adapted genotypes failed to show any advantage in any of the environments. G39 (HD2967), timely sown cultivar and parental line of DH population showed less reduction in yield as compared to the drought tolerant checks. The parents Excalibur (G37) proved to be stable but low yielding. However, limited introgression from such stocks in productive locally adapted backgrounds is a useful strategy as evidenced by promising DH lines obtained in this study. Overall several high yielding DH entries could be identified, showing seasonal specificity (G5, G17, G26, and G28) as well as stability (G6, G16, G19, G18 and G17). The polygon representing what-won-where, also called as convex hull was created joining the cultivars that are farthest from the origin of biplot (Fig 4). Seven genotypes qualified as vertex cultivars with G 26 (DH984) and G 5 (DH963) once again emerging as desirable genotypes. The mean yield advantage shown by G-26 and G-5 over recipient parent HD 2967 was 11.8% and 10.5% respectively.

On the whole, strategy for introgression (from less productive but specifically adapted donor), along with rapid fixation facilitated by DH production, followed by evaluation in multiple environments, as pursued in this relatively small experiment, proved to be an effective strategy. It merits wide application in breeding for stress tolerance.

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THE CONVENTIONAL AND TRANSGENIC BREEDING APPROACHES FOR BIOFORTIFICATION OF RICE GRAINS WITH HIGH FE & ZN CONTENTS AND ENHANCING THEIR BIOAVAILABILITY TO COMBAT MICRONUTRIENT MALNUTRITION—A REVIEW

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Abstract

In the developing countries million of people are suffering from malnutrition. In these countries rice is a staple food in daily dietary system but among grains it is the poorest supplier of iron and zinc which leads to micronutrient malnutrition reducing adult productivity, causing anemia, retarding mental and physical growth. Alternative to improving malnutrition and balancing diet are supplementation chemical fortification and dietary diversification which failed to solve the problem due to high cost, limited infrastructure for processing regulatory control, marketing problem of fortified food and poverty. Hence there is a need to adopt the cost effective micronutrient bio-fortification system. But Fe and Zn bio-fortification of rice grains will not be enough to satisfy the human micronutrient requirement due to the presence of the phytic acid, an antinutrient that can prevent the absorption of iron and Zinc decreasing their bioavailability.

Although phytase is an enzyme capable of degrading phytic acid and improving bioavailability of micronutrients but its use by yeast fermentation as feed additive increases feeding cost. The improvement for iron, zinc and reduced phytic acid in rice grains will provide greater opportunity to eradicate malnutrition among poor families but greatly increasing iron levels in rice grains could result in decreased crop yield which is not acceptable to the farmers. Therefore, the identification of desirable donors containing high iron, zinc and low phytic acid and incorporating these traits into the background of high yielding cultivars through self sustainable and cost effective classical and transgenic breeding approach will also provide further opportunity to develop high yielding cultivated rice varieties with high level of Fe, Zn and low phytic acid eradicating malnutrition. Agronomic management practices also influence micronutrient uptake and their accumulation in bio-fortified rice grains.

Key words : Bio-fortification, micronutrient, malnutrition, anemia, phytic acid.

INTRODUCTION

Plant based foods are potential source of all essential minerals and organic nutrients that are directly or indirectly required by humans. Unfortunately minerals contents are low in many of staple food crops. Rice is the most important staple crop in the world. Nearly half of the world population depends on rice as the source of their calorie but among grains it is the poorest supplier of iron and zinc ranging between 1 to 6 mg/100g of rice which leads to malnutrition. Rice is also the main staple food crop consumed in India and it is the cereal with lowest iron concentration averaging 11 ppm in current commercial varieties and 5-6 ppm after decortification and milling. Iron deficiency leads to anemia and zinc deficiency retards a child mental

and physical growth. The deficiency of Zn is the major constraint for rice production and a global concern for human nutrition (Farooq *et al.* 2018). Iron is involved in electron transport reactions and Zn is important co-factor in gene transcription and the coordination of protein, nucleic acid, carbohydrate and lipid metabolism (Ishimaru *et al.* 2011). Therefore, increasing iron content in rice is a viable option in alleviation of micronutrient malnutrition anemia (10).

Ferritin is an iron storage protein which stores 4500 iron atoms in its cavity in non toxic form (27). Iron stored in ferritin is completely bioavailable (17) and is released when need arises to metabolic functions (7). About 80% of the phosphorus (P) in cereals including rice is stored as phytic acid which not only decreases the bioavailability of phosphate but also considered to

be anti-nutrient factor as it always combines with proteins and cations thereby decreasing the availability of proteins and some important minerals such as iron, zinc, magnesium and calcium (20). Phytate found in the outer layer of the grains binds minerals specially zinc and iron making them less available for digestion and absorption in the small intestine. About 40% of the zinc is absorbed from food with the low phytate content (eg white bread), while only 17 % is absorbed from a food higher in phytate (eg whole grain breads).

Alternative to improving nutrient intake and balancing diet are supplementation, chemical fortified and dietary diversification but this practice is costly and not widely adopted due to limited infrastructure for processing regulatory control and marketing of fortified foods. Therefore, there is need to adopt suitable approach which is self sustainable and cost effective. The conventional breeding is a reasonable strategy to improve content of these micronutrients in rice grains but it is time taking and difficult task to develop high yielding and micronutrient biofortified genotypes. The release of new improved genotypes by classical breeding is too slow to cope with the demands. The biotechnological invention is becoming increasingly important which could be possible through the transfer of the entire codon sequence of the soybeans ferritin gene driven by rice seed storage protein glutelin promoter (Glu B-1) in high yielding rice cultivars by *Agrobacterium* mediated transformation. The majority of these reports use immature embryos as explants for *Agrobacterium* mediated transformation in rice (52).

Significantly increasing the amount of iron and zinc in edible portion of food crop through biofortification will not be enough to satisfy human micronutrient requirements as the rice grains contain phytic acid and anti nutrient decreasing their bioavailability. Content of phytic acid in milled white rice varied from 55-183mg/100g depending on varieties and locations. The chemical description for phytic acid is myo-inositol 1,2,3,4,5,6 hexakis dihydrogen phosphate or myo-inositol hexakis phosphate (IP6). The microbial phytase mainly produced by yeast fermentation degrades phytic acid and used as a feed additive increasing feeding cost. Hence the transgenic expression of phytase is regarded as an efficient and cost effective way to eliminate this limitation which could hydrolyze phytic acid to ortho-phosphate and myo-inositol improving the bioavailability of phosphorus as well as other micronutrients like iron

and zinc. Traditional breeding is also helpful in developing rice cultivars with low phytic acid improving bioavailability of micronutrients and reducing the feeding cost. Promotor substances can counteract the negative effects of antinutrients on iron availability. Promoters should be identified and significantly increased in the important staple food crops.

Global / National Efforts

The micronutrient initiative (MI) is a non profitable organization specializing in addressing micronutrient malnutrition. MI is governed by an international board of directors. It supports and promotes food fortification & supplementation programs in Asia Africa Latin America & provides technical & operational supports in those countries where micronutrient malnutrition is most prevalent. MI's south Asia regional office opened in 1997 to address the needs of large proportion of the regional population suffering from micronutrient deficiencies. MI India mainly focuses on the direction set out in its strategic plan for food fortification and supplementation at the national level and control of micronutrient deficiencies. Because of the importance of rice FAO named the year 2004 International year of rice and the theme of the year was "Rice is life". Screening of rice varieties for variability in iron content started in 1992 at IRRI in collaboration with university of Adelaide, Australia. Initially, tests were performed on determining the effect of environment on the stability of iron content and in 1995 zinc was also included and reported significant genetic diversity.

High iron content materials were identified at IRRI with a range from 6.3 to 24.4 ppm of iron in unpolished grains and the content of Zn in the same materials ranged from 13.5 to 58.4 ppm. The aromatic varieties were in general higher in micronutrient concentration ranging from 18-22 ppm for iron and from 24-35 ppm for zinc which proved that genetic diversity exists and that some varieties are potential donors of high iron & zinc concentration traits. The data on analysis of samples from China and Bangladesh also indicated the genetic variation for Fe & Zn variability in rice grains. The genotype IR68144-3B-2-2-3 derived from cross IR (poor in iron content) x zawa Bombay (contain high iron content) exhibited high iron content in grains and tolerance to rice tungro virus and has excellent grain quality. This variety had very good tolerance to mineral deficient soils such as P, Zn & Fe. Harvest plus

breeding has a specific focus on crop biofortification and has determined a target for the minimum Zn level to be achieved in rice. The Zn breeding target in rice was raised from the previous target levels of 24 mg kg⁻¹ of Zn to a new target of 28 mg kg⁻¹ (Harvest Plus 2014).

The major target countries of rice Zn biofortification programs are Bangladesh, India, Indonesia and the Philippines. The breeding team at IRRI has identified several high Zn rice germplasm as donors early generation and also advanced high Zn material in the background of popular rice varieties like IR64, Swarna, Swarna Sub1, NSIC Rc222, PSBRc82, BR28, BR29, BR11 and ciherang has been produced and shared with national partners. IRRI is coordinating the breeding activities of the country partners and also encouraging them to generate high Zn material in the genetic background of locally adopted popular rice varieties using high Zn donors supplied by IRRI (59). Two high Zn rice varieties BRRI dhan 62 and BRRI dhan 64 have been released for cultivation during the Aman and Boro season in Bangladesh. These two varieties have 19 mg kg⁻¹ and 25 mg kg⁻¹ Zn with a yield potential of 4.2 t/ha and 6 t/ha respectively.

The micronutrients accumulation process in rice grains

Rice shows higher percentage of Fe loss during polishing compared to Zn because Fe accumulation in rice is highest in bran of rice grains and in the scutellum tissues inside the germ layer which are lost during polishing whereas Zn is preferentially accumulated in the central endosperm tissues of grain (36). There is continuous flow from root to grains mediated by transpiration system which can directly transport Zn to grains (28), however Zn movement is restricted by the presence of barriers for root to shoot transfer of Zn and between vegetative and reproductive tissues leading to reduced accumulation of Zn in grains (24).

The factors that affect root Zn uptake in rice plants are root hairs, crown root development root surface area, root anatomy, root exudation of protons which can change soil pH, thereby improve the solubility of Zn in the soil and facilitate its diffusion to root surface (48). Flag leaf which plays an important role in photosynthesis and grain yield was found to have a little contribution to grain Zn (54). The increased root uptake of Zn & root to shoot transfer could not proportionately increase in grain Zn concentrations

indicating that international translocation of Zn from vegetative tissue to grains is the major bottleneck for improving grain Zn concentrations (56, 69).

Agronomic management practices to enhance grain Zn in Rice :

In general increasing nitrogen application negatively influences grain Zn (8; 14; 29; 40; 53; 71). Application of Zn fertilizer to Zn sufficient soil accumulated Zn in vegetative tissues rather in grains but in Zn deficient soil, Zn fertilizer improved grain Zn concentrations in rice (25; 67). Foliar application of Zn fertilizer has shown better results than soil application for increasing grain Zn concentration (37, 64). Alternate wetting and drying (AWD) technology adopted for rice cultivation as a water saving technology also found to increase the Zn in grains. A combination of suitable rice genotype, AWD water management and ZnSO₄ fertilization increased Zn accumulation and availability in rice grains (63). The proper nitrogen fertilization, combined with foliar Zn applications has a synergistic positive effect on grain Zn concentration (29). Thus, in order to address the zinc deficiency issue in rice, various agronomic approaches of Zn biofortification were tested, among which foliar spray found more efficient (11, 51, 62). The combined fertilizer application of 150 kg N/ha and 0.3% ZnSO₄ spray at dough stage was found highly effective for grain yield, content and uptake of nitrogen and zinc in grain in the direct seeded rice (DSR) condition (39).

The Conventional plant breeding approach to enhance rice grain micronutrients and their bioavailability

Breeding for Zn biofortification is similar to iron in that conventional breeding techniques may be used. Substantial genetic variation exists in CGRI germplasm bank and research has shown that high Zn and iron density are positively correlated. It offers a sustainable solution to malnutrition problems by exploring natural genetic variation to develop mineral dense crop varieties (6; 47). Wild species of rice such as *O. nivara*, *O. rufipogon*, *O. latifolia*, *O. officinalis* and *O. granulata* also contain high amount of Zn around 2-3 fold higher than in the cultivated rice with Zn concentration varying from 37 mg/kg to 55 mg/kg in non-polished grains (2, 4, 9). Aromatic rice has also shown high Zn compared to non aromatic rice (18). Wild cultivars *O. nivara*, *O. rufipogon*, *O. barthii* and *O. longistaminata* and African cultivated rice *O. glaberrima* have also been reported to

have higher level of Zn in grain and these are a potential source of high Zn donor (15; 49). Advance back cross breeding methods can be used to exploit these wild resources to combine high Zn and high yield potential. Multiple cross involving several donors and recipient parents such as three way, four way crosses, reciprocal crosses with donor parents high Zn x high Zn crosses involving advanced Zn lines will enhance the Zn levels and yield potential.

There is also positive correlation between grain Zn and grain characters such as grain weight grain length and width so during the selection process some considerations should be given to grain traits (70). High grain Zn traits was found to be tightly linked with aroma while there are no reports of pleiotropic effects of high grain Zn with traits (65). There are several reports indicating significant negative association between grain Zn concentration and yield in rice (13, 24, 42, 66), but a positive relationship between grain yield and grain Zn concentration was observed under Zn deficient soil (18) and in other panel of aromatic rice and land races under Zn sufficient conditions non-significant correlation were observed between yield and grain Zn (12; 50) indicating the possibility to develop high yielding varieties with high level of Zn.

In a line x tester analysis involving six lines and eight testers and a total of 48 hybrids showed significant positive heterosis for grain Zn over the standard micronutrient check variety chittimutyalu. Two crosses (PR116Xchittimutyalu, Mandyavijayxjalamagn) showed more than 50% heterosis for grain Zn (Babu et al 2012). Transgressive segregants were also observed for grain Zn (55). Reports have shown that there is very good heterosis for grain Zn in rice (41). Physical and chemical mutagens have been used in mutation breeding and mutants with high Zn have been identified. A number of IR64 mutants produced by the treatments with Sodium azide were reported to have high Zn (23). Three IR64 mutants lines viz M-IR-180, MIR-49 and M-IR175 had more than 26 mg kg⁻¹ Zn in polished rice as against 16 mg kg⁻¹ in IR64. These mutants can be used as a donor in Zn breeding programmes.

Several QTLs for grain Zn have been mapped using various rice germplasm resources such as rice land races and wild rice species viz. *O. rufipogon* and *O. nivara* (15, 35; 42; 58). Different mapping population like Recombinant inbred lines (RILs), Double haploid (DH), Back cross inbred lines (BILs)

and Introgression lines (ILs) have been used in grain Zn QTL mapping studies (2, 35; 42, 55). The consistently identified grain Zn QTLs on chromosomes 7, 11, 12 are good targets for MAS. Thus it is possible to increase the grain Zn concentration by 10 to 15 ppm in existing population rice varieties by well designated Marker Assisted QTL pyramiding programme. In rice Zn is stored together with phytate which is strong chelator of divalent cations (5; 19; 46). Hence selection should be made for low phytate content. Recently by mutation breeding several mutants with low phytate content have been developed and are good resources as low phytate donors in breeding programmes (34).

The Transgenic breeding approach to enhance rice grain micronutrients and their bioavailability

(16) introduced the ferritin gene isolated from soybean and obtained a three fold increase in iron concentration. The transgene was driven by the glutelin promoter Glu B-1 and therefore it was exclusively expressed in the endosperm which unfortunately almost completely removed during decortification of the rice grains. There are also reports of increasing iron content by over expressing ferritin gene in transgenic rice (16; 61). The ferritin gene from the *Phascolus vulgaris* has been introduced into rice resulting in doubling to tripling of iron content in endosperm even after polishing the grains (61). Breeding for iron rich varieties, generally increase the concentration of zinc showing lineage drag a high content of it was also found in transgenic lines which varied from 34.9 to 55.5 ppm in transform rice line and only 33.6 ppm in control, non transgenic rice grains (61) and reported that after polishing non-transgenic lines had approximately 10 ppm of iron and ferritin transformed had between 8 to 37 ppm of iron.

Lucca et al (2001) performed a series of experiments using three different plasmids to be transformed into rice cells by both Agrobacterium and biotic method. The third plasmid carried mutated version of phytase gene from *Aspergillus fumigatus* which is heat stable and would not be degraded when rice is cooked or boiled. The recombinant phytase gene of *Aspergillus niger* driven by the maize ubiquitin (ubi) promoter was successfully introduced into high yield of rice cultivar via Agrobacterium-mediated transformation to improve the bioavailability of the nutrient elements and the inorganic phosphorus content in transgenic rice plants (Liuqiao et al 2006).

Genetic engineering is considered a valuable strategy

to alleviate Fe deficiency in rice based societies as increases of Fe concentrations in transgenic polished rice grain have exceeded levels achieved by conventional breeding (26;32;60). Constitutive over expression of the rice nicotianamine synthetases (OSNAS) genes has been successfully implanted to increase Fe and Zn concentrations in unpolished and polished rice grain. Increased production of the chelating molecules nicotianamin (NA) and 2-deoxymugineic acid (DMA) has been popular strategy to enhance Fe & Zn uptake, internal transport and loading in to the rice grains (26, 32, 38, 57). Nicotianamine synthesized by nicotianamine synthetase (NAS) is analog & precursor of mugineic acid such as DMA. Nicotianamine facilitated OSNAS over expression on rice yield performance and internal nutrient status is required for the development of high yielding Fe and Zn biofortified rice varieties.

The progeny containing the OE-OSNAS₂ construct showed higher percentage of Fe and Zn in polished rice as compared to OE-OSNAS₁ construct indicating that the OE-OSNAS₂ construct induces higher translocation of Fe and Zn into deeper layer of the outer endosperm which are not lost during the process of polishing. Rice genotypes with faster rates of Zn loading often have higher grain Zn concentrations (68). The higher grain Fe and Zn concentrations of the LY and ⁺HY progenies may be due to faster rates of Fe and Zn loading compared to growth rate of the grains. The significantly higher concentration of Fe and Zn can be achieved by OSNAS over expression without any reduction in grain number, suggesting that it is feasible to couple high grain Fe and Zn concentrations with high grain yields in biofortified rice.

The over expression of OSNAS genes improved the grain Fe and Zn concentrations by several folds and OSNAS₂ & OSNAS₃ over expression also showed increased accumulation of Fe and Zn (26; 33). Ferritin gene OS Fer2 over expressed in abasmati rice (Pusasugandh II) accumulated higher levels of Fe and Zn (Paul et al 2012). The investigations on grain Fe and Zn concentrations traits of back cross two second filial (BC₂F₂) transgenic progeny carrying O_SNAS₁ or O_SNAS₂ over expression constructs under India/Japonica and Japonica/Japonica genetic back grounds indicated that the BC₂F₂ transgenic progeny contained upto 148% higher Fe and 336% higher Zn concentrations in unpolished grain compared to non transgenic progeny (30).

CONCLUSION

The production of high yielding iron and zinc bio-fortified grains of rice genotypes with low phytic acid as well as other added value like aroma through genetic manipulation and improving micronutrients uptake and their accumulation in grains (agronomic bio-fortification) involve multidisciplinary co-operation among plant breeders, biotechnologist and other plant scientists for combating micronutrient malnutrition. The agronomic bio-fortification approach being simpler is also being followed.

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MORPHO-PHYSIOLOGICAL CHARACTERIZATION OF WHEAT CULTIVARS ADAPTED TO DIFFERENT WATER AVAILABILITY REGIMES

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Abstract

Morpho-physiological traits and root shoot traits based characterization of set of 14 released cultivars with the objective of evaluating component traits imparting drought tolerance and combining these into common genetic background through crossing. These cultivars were evaluated in irrigated and rainfed conditions at two sites. GGE biplot analysis revealed that the two environments (irrigated and rainfed) within sites differed in both sites. Cultivars WH-1105 and PBW-644 emerged as best genotypes exhibiting stability and adaptability. HD 3086 showed directional adaptation for irrigated environment. Bidirectional adaptation pattern of genotype released for irrigated environment (WH 1105, HD 2967 and PBW621) to both environments was exhibited. Grain yield showed significant positive correlation with root/shoot ratio (0.544). Root shoot traits served as good add on for characterizing germplasm for moisture stress and water use efficiency.

Keywords : *Triticum aestivum*, GGE biplots, morpho-physiological traits, root shoot traits.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the major staple food crops of the world contributing large proportion of calories and protein in human diet. Human population is growing at rapid pace and significant improvement in wheat yielding ability is required to fulfil needs of ever growing population (8). On the other hand looming threat of climate change and global warming is posing serious problems for sustaining and enhancing wheat production. Abiotic stresses are now taking centre stage of which drought stress is most important and detrimental resulting in yield losses up to 50% or more (11). Drought-stressed regions are defined as those where the amount of water available, mainly through rainfall, is less than 500 mm. Approximately 32 percent of the wheat-growing regions in developing countries experience some type of drought stress during the growing season. About 40 million hectare area in developing world and 25 million hectare area in developed countries is under permanent drought stress (3, 7). These drought prone areas regularly suffer from water deficit during growing season. In India large area under wheat in central zone is rainfed which faces drought like conditions regularly. Also in Northern region non judicious use of ground water resources has led to depletion of ground water table. The most productive wheat growing areas (Punjab, Haryana and Western

UP) face imminent future problems of climate change, water scarcity and soil health. Even under irrigated conditions drought stress tolerance related traits are becoming important for judicious use of valuable water resources which are now becoming scarce due to overexploitation. Physiological and morphological traits constitute important selection criteria for dealing drought stress as these serve as component traits having cumulative effect contributing to yield under stress environment (1). Genetic progress for yield under moisture stress can be enhanced by use of combination for traits conferring better agronomic and physiological performance (5). Hence it is important to characterize available germplasm for various physio-morphological traits so as to use this germplasm in crosses and combine favourable alleles for specific trait into new genetic backgrounds. Keeping in view aforementioned discussion a set of 14 genotypes was assembled for characterization under contrasting environments (rainfed and irrigated) at two sites (site 1 and site 2).

Genotypes represent released set of cultivars adapted to different moisture regimes. Set included old released cultivars for cultivation under rainfed environment in Punjab (C-591, C-273, C-306 and PBW 175), current cultivars released for rainfed environment in Punjab (PBW 644 and PBW 660), recent cultivars released for irrigated environment in Punjab (PBW 621, HD 2967, HD 3086 and WH 1105) and exotic cultivars carrying

drought stress tolerance (Excalibur, Krichauff and Gladius (4, 12) from Australian wheat improvement programs; BABAX (9), a well characterized drought tolerant line from CIMMYT, Mexico).

MATERIALS AND METHODS

Fourteen released cultivars (Table 1) adapted to different moisture regimes were selected for morpho-physiological characterization. Pedigree and targeted environment of release is presented in table 1.

During main season 2014-15 for evaluating assembled germplasm set under field conditions an experiment was set up using a randomized complete block design with two replications. Field experiment was set up at two sites designated as site 1 and site 2. At each site population was evaluated under two environments viz. irrigated (IR) and rainfed (RF). Both sites were located at PAU, Ludhiana in two different experimental areas. The sites differed for soil type and crop rotation followed. The sowing time at site 2 was 14 days later than site 1. Each line was sown in four rows of 2 meter length. Genotypes were characterized for various morphological and physiological traits imparting drought tolerance. In 2015 above mentioned genotypes were screened for root and shoot traits at seedling stage using cigar roll method (17).

Physiological and morphological traits recorded on genotypes :

1. Grain yield (kg m⁻²)
2. Days to flowering (days)
3. Plant height (cm)
4. Peduncle length (cm)
5. Canopy temperature (°C) at early anthesis
6. Canopy temperature (°C) at grain filling
7. Chlorophyll content (CCI) at early anthesis
8. Chlorophyll content (CCI) at grain filling
9. Near differential vegetative index (NDVI) at early anthesis
10. Near differential vegetative index (NDVI) at grain filling
11. Spike length (cm)
12. Spikelets per spike
13. Tillers per meter
14. Flag leaf length (cm)

Traits measured at seedling stage using cigar roll method

1. Root length (cm)
2. Shoot length (cm)
3. Root/Shoot ratio

Canopy temperature was measured at early anthesis and grain filling stage using a portable infrared thermometer (Mikron M90 Series, Mikron Infrared Instrument Co., Inc., Oakland, NJ, USA). Chlorophyll content at anthesis was measured with a SPAD-502 Minolta (Spectrum Technologies Inc., Plainfield, IL, USA) in three flag leaves per plot. Chlorophyll content was measured between 1.00–2.00 h on windless and cloudless days. SPAD meter use red and near infra-red emitting diodes which pass light through the leaf. Chlorophyll absorbance is measured at 650 nm and wavelength peaking at 940 nm was used to measure non-chlorophyll absorbance. Near differential vegetative index (NDVI) is calculated using measurements taken at ~660 nm and ~770 nm. All NDVI measurements were taken with a Green Seeker (10) sensor (Optical Sensor Unit, 2002 Ntech Industries, Inc., Ukiah, CA, USA). The instrument records the reflectance in one bed per plot at speeds of 10–20 times plot⁻¹; the distance between the GreenSeeker and the plot was kept constant at around 50 cm, measuring only one row of the plot to avoid pointing the soil at late grain-filling stages. NDVI measurements were taken twice at anthesis and mid-grain-filling. For screening genotypes using system cigar roll method seeds were surface-sterilized with 0.5% calcium hypochlorite solution for 30 min and then rinsed three times with sterilized water and left at cold temperature (4 °C) overnight. Subsequently 10 seeds were placed on one germination paper (45×30cm, Heavy Germination paper #SD 7615L), which was then rolled to final dimensions of 5-6 cm in diameter and 45cm in height. 10-12 seeds were placed breadthwise with distance of 3-4 cm. Germination paper was then rolled longitudinally. The experimental design was a completely randomized design with two replicate rolls per line. Each replicate contains 8-10 plants. Plants were grown in a controlled-environment growth chamber (Conviron Model No. CMP 6050) with 12h light/12h dark cycle with light intensity of 400 mol m⁻² s⁻¹, 60-70% relative humidity during the day and 70-80% during the night, and temperature of 21 °C during the day and 16 °C during the night.

Table 1 : Genotypes with pedigree used for morphs-physiological characterization.

S. No.	Genotype	Pedigree	Targeted Environment
1.	PBW 175	HD-2160/4/JN/GAGE//JN/KALYANSONA/3/V-18/C-273	Rainfed
2.	PBW 644	PBW-175/HD-2643	Rainfed
3.	C-273	C-591/C-209	Rainfed
4.	BABAX	BOBWHITE/NACUZARI-76//VEERY/3/BLUEJAY/COCORAQUE-75	Rainfed
5.	C-306	REGENT/CZECHOSLOVAKIA-3//2*C-591/3/C-217/NIPHAD-4//C-281	Rainfed
6.	GLADIUS	(DH)RAC875/KRICHAUFF//EXCALIBUR/KUKRI/3/RAC-875/KRICHAUFF/4/RAC-875//EXCALIBUR/KUKRI	Rainfed
7.	KRICHAUFF	WARIQUAM//KLOKA/PITIC 62/3/WARIMEK/HALBERD/4/3-AG-3/AROONA	Rainfed
8.	PBW 660	WG-6761/WG-6798	Rainfed
9.	HD 3086	DBW-14/HD-2733//HUW-468	Irrigated
10.	C-591	PENJAB-TYPE-8-B/PENJAB-TYPE-9	Rainfed
11.	EXCALIBUR	RAC-177(Sr26)/UNICULM-492//RAC-311-S	Rainfed
12.	HD 2967	ALONDRA/CUCKOO//URES-81/HD-2160-M/HD-2278	Irrigated
13.	PBW 621	KAUZ/ALTAR-84/(AOS)AWNED-ONAS/3/MILAN/KAUZ/4/HUITES	Irrigated
14.	WH 1105	MILAN/S-87230//BABAX	Irrigated

Source : GRIS (Genetic Resources Information System for Wheat and Triticale) CIMMYT.

Table 2 : Pooled analysis of variance for grain yield (kg/ha) over two sites and two environments each site.

Source	DF	Mean Squares	F Value	Probability>F
Replication within environments and sites	4	0.0115	2.58	0.0478
Sites	1	0.0007	0.15	0.7041
Environments	1	0.0605	13.56	0.0006
Sites X Environments	1	0.0000	0.01	0.9175
Genotypes	13	0.1522*	34.1	<0.0001
Sites X Genotypes	13	0.0062	3.38	0.0181
Environments X Genotypes	13	0.0080	4.35	0.0063
Sites X Environments X Genotypes	13	0.0018	0.41	0.9586
Error	52	0.0045		

Seedling data in case of cigar roll method was taken after 21 days of sowing. Root length and shoot length of 6-8 plants per genotype per replicate were recorded in cm. Data for one genotype was obtained after taking average of 6-8 plants. For analysis of variance and pooled analysis of variance over sites and environments glm procedure (13) was used. For constructing interactive boxplot and GGE biplots Plant Breeding Tools version 1.3 (International Rice Research Institute) was used. Correlations (Pearson's correlation coefficients) between traits were calculated for two sites each having two different environments.

RESULTS AND DISCUSSION

Set of 14 genotypes (rainfed cultivars of Indian and exotic origin and cultivars adapted to irrigated condition of Indian origin) were evaluated for morpho-physiological and yield performance in field trials. The entire set was evaluated under rainfed and irrigated environments at two sites (Site 1 and site 2) during 2014-15 crop season. The analysis of variance (Table 2) for grain yield shows only one primary sources of variation (genotypes) to be significant. All primary interactions were non-significant. Thus the

Table 3 : Physiological and morphological trait values of genotypes averaged across environments and sites.

Traits	Genotypes													
	PBW 175	PBW 644	C-273	BABA X	C-306	GLAD IUS	KRICH AUFF	PBW 660	HD 3086	C-591	EXCAL IBUR	HD 2967	PBW 621	WH 1105
Days to anthesis	95	97	97	89	92	102	100	103	92	90	103	101	100	97
PL (cm)	105	105	123	80	124	83	90	106	92	121	81	96	92	88
CT at anthesis (°C)	27.68	28.95	28.73	28.95	28.50	28.54	30.46	28.96	30.48	29.06	29.15	29.39	29.55	29.89
CT at grain filling (°C)	27.48	26.90	26.86	27.61	27.05	26.61	28.55	27.24	28.68	27.84	27.60	27.73	27.56	27.93
NDVI at anthesis	0.55	0.58	0.59	0.49	0.55	0.65	0.55	0.62	0.47	0.57	0.59	0.57	0.56	0.55
NDVI at grain filling	0.50	0.54	0.57	0.50	0.52	0.64	0.53	0.62	0.48	0.52	0.63	0.59	0.60	0.53
CC at anthesis	39.20	43.50	38.95	37.14	40.40	46.65	40.73	44.46	38.59	40.89	43.68	43.04	41.48	42.14
CC at grain filling	36.85	37.75	40.13	38.98	37.43	45.58	37.21	42.49	35.94	36.59	41.78	40.98	38.76	38.50
Pe L (cm)	38.9	36.4	47.1	32.9	52.9	33.3	35.8	33.8	34.4	44.6	31.6	32.9	29.6	33.4
FLL (cm)	27.5	29.0	25.9	26.0	29.0	23.9	20.8	25.3	24.8	27.5	24.3	26.3	19.9	27.8
Tillers per meter	135	118	128	124	143	171	151	131	137	129	163	129	124	127
Spike length (cm)	12.00	10.75	9.88	10.75	10.00	9.00	10.31	10.00	10.44	9.44	9.56	11.31	10.81	11.13
Spikelets per spike	17	20	19	18	20	17	19	19	18	17	19	21	21	21
Yield (kg/ha)	5635	6152	3521	4064	5493	4105	6155	4917	5608	4222	4709	5891	6007	6211

Pl: Plant Height, CT: Canopy Temperature, CC: Chlorophyll Content, Pe L: Peduncle Length, FLL: Flag Leaf Length

genotypes do not show significant cross over effect as explained by (2). Genotypes showed significant difference for grain yield at both sites (site1 and site2) and under both environments (rainfed and irrigated).

Figures 1a represents box plot showing grain yield of genotypes. Mean yield of set of genotypes showed decrease under rainfed conditions at both sites. This indicated prevalence of mild moisture stress under rainfed environment. Mean days to anthesis (Fig 1b) at site 1 under rainfed environment showed increment compared to irrigated environment under site 1. However, at site 2 mean days to anthesis showed reversed trend compared to site 1 as under rainfed environment mean days to anthesis showed decrement compared to irrigated conditions. Mean plant height under rainfed environment (Fig 1c) showed reduction at both sites compared to irrigated conditions. However, differences were sharp at site 1. Mean canopy temperature at anthesis (Fig 1d) showed interesting behaviour. Under rainfed environment canopy temperature at anthesis showed decrease at both sites compared to irrigated conditions. Under rainfed conditions evaporative cooling was displayed. Box plot for canopy temperature at grain filling (Fig 2a) displayed pattern similar to canopy temperature at anthesis. Mean NDVI at anthesis (Fig 2b) showed increase under rainfed conditions. This pattern is repeated for NDVI at grain filling (Fig 2c) stage. Mean chlorophyll content at anthesis (Fig 2d) also displayed unusual pattern as its value was more under rainfed environment than irrigated environment. Similar pattern was repeated for chlorophyll content at grain filling stage (Fig 3 a). Mean peduncle length (Fig 3 b) was more under irrigated condition compared to rainfed condition at site 1. At site 2 population mean showed reverse trend. Mean flag leaf length (Fig 3c) at site 1 was more under irrigated environment than rainfed environment. Similar but weaker trend was observed at site 2.

Mean spike length (Fig 3d) showed increase under rainfed environment over irrigated environment at both sites. Mean spikelets per spike (Fig 4a) remained similar under both environments at both sites. Tillers per meter (Fig 4b) showed reduction under rainfed environment at both sites. Trait values averaged over two sites and over two environments in each site for genotypes evaluated are given in table 3. The mean grain yield for the entire set of

Table 4 : Mean grain yield (kg/ha) of genotypes across two sites under two environments.

S. No.	Genotype	Genotype code for biplot analysis	Overall yield	Mean Yield (kg/ha) site 1 (RF) E2	Mean Yield (kg/ha) site 1 (IR) E1	Mean Yield (kg/ha) site 2 (RF) E4	Mean Yield (kg/ha) site 2 (IR) E3
1	PBW 175	G-10	5635.00	5686.67	5696.67	5343.33	5813.33
2	PBW 644	G-12	6151.67	5850.00	6453.33	5756.67	6546.67
3	C-273	G-2	3520.83	3603.33	3226.67	3576.67	3676.67
4	BABAX	G-1	4064.17	3806.67	4576.67	3693.33	4180.00
5	C-306	G-3	5493.33	5393.33	5526.67	5276.67	5776.67
6	GLADIUS	G-6	4105.00	4433.33	4046.67	3870.00	4070.00
7	KRICHAUFF	G-9	6155.00	6346.67	6013.33	6316.67	5943.33
8	PBW 660	G-13	4916.67	4886.67	5260.00	4833.33	4686.67
9	HD 3086	G-8	5607.50	5180.00	6536.67	4773.33	5940.00
10	C-591	G-4	4221.67	3946.67	4106.67	4473.33	4360.00
11	EXCALIBUR	G-5	4709.17	4506.67	4833.33	4866.67	4630.00
12	HD 2967	G-7	5890.83	5640.00	6173.33	5600.00	6150.00
13	PBW 621	G-11	6006.67	5360.00	5623.33	6183.33	6860.00
14	WH 1105	G-14	6210.83	5693.33	6520.00	6140.00	6490.00
CD				526.46	565.14	631.41	493.83

Table 5 : Performance of genotypes for root shoot traits at seedling stage.

S. No.	Genotypes	Root Length (cm)	Shoot Length (cm)	Root/Shoot ratio
1	PBW 175	33.45	14.58	2.29
2	PBW 644	34.15	11.23	3.10
3	C-273	33.73	12.95	2.61
4	BABAX	32.41	13.28	2.44
5	C-306	33.58	11.91	2.82
6	GLADIUS	33.65	11.95	2.83
7	KRICHAUFF	32.35	11.23	2.89
8	PBW 660	34.81	15.62	2.23
9	HD 3086	33.06	12.45	2.66
10	C-591	33.93	17.53	1.94
11	EXCALIBUR	28.86	11.03	2.62
12	HD 2967	33.92	12.75	2.66
13	PBW 621	32.54	11.10	2.93
14	WH 1105	34.63	11.17	3.10
	CD	NS	3.73	NS

genotypes evaluated at two sites and under two environments is given in table 4. The performance and stability of genotypes is illustrated through GGE biplot analysis.

The biplots are based on scores of PC1 plotted against PC2 for both sources of variation that is environment and genotypes. The total genotype and genotype x environment variation explained by principal components is 96.2% (91.3+4.9 by each PC1 and PC2

respectively). The biplot in Fig 5 provides environment centred view of mean yield of genotypes. Environments under consideration are: E1-Irrigated 2013-14, E2-Rainfed 2013-14, E3-Irrigated 2014-15 and E4-Rainfed 2014-15. The angle between the vectors of two environments is related to the correlation coefficient between them. Based on this, the four environments can be grouped into three. Rainfed and irrigated environments under both sites showed diversity from each other. The vector length of

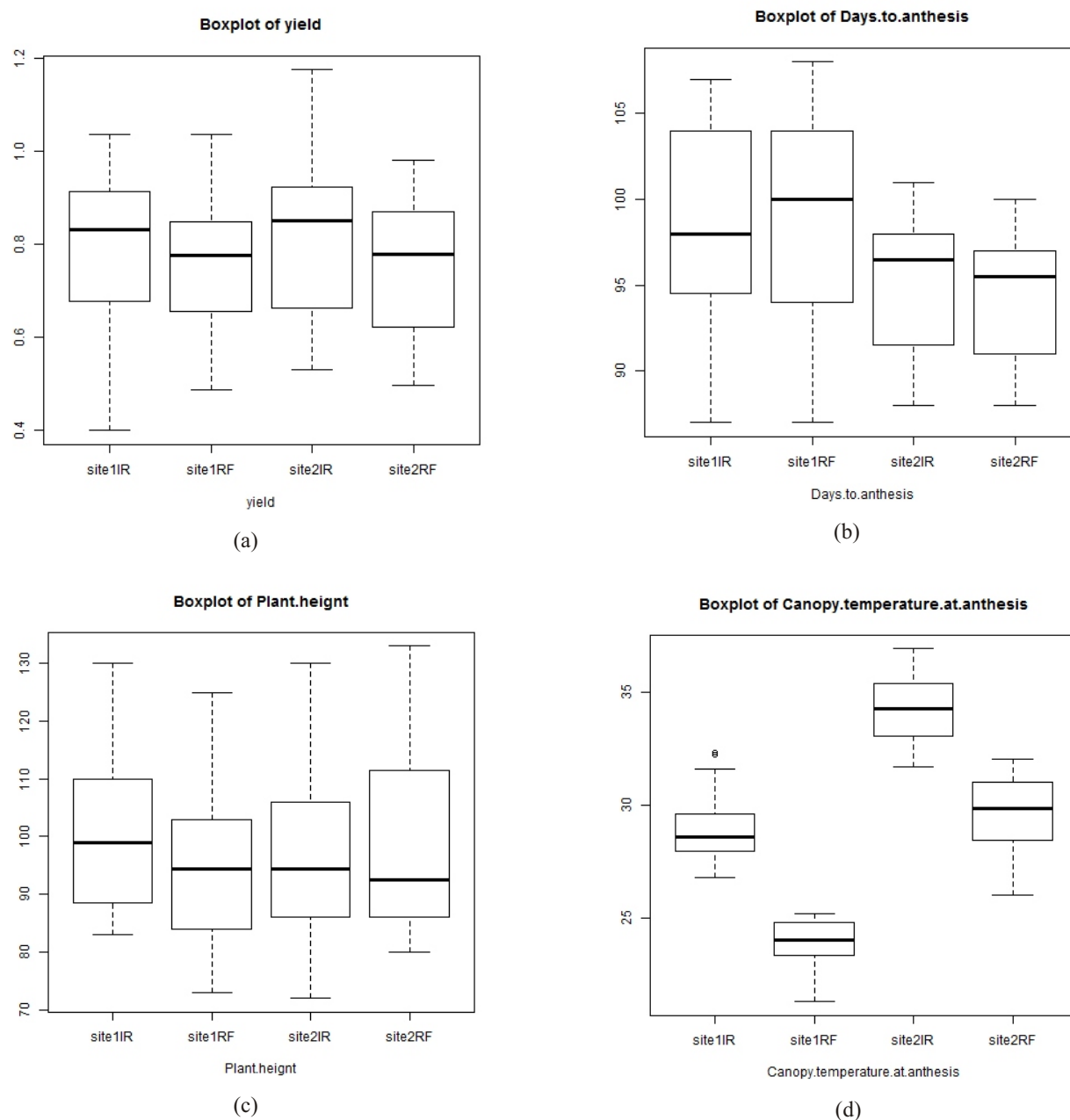


Figure 1 : Box plots showing distribution of (a) grain yield, (b) days to anthesis, (c) plant height and (d) canopy temperature at anthesis for both sites under both environments

E1 is largest and can be treated as most discriminating environment (Yan 2002). Ideal genotype should represent high mean performance along with stability across regions. In figure 6 ranking of genotypes according to ideal genotype (defined as best performing genotype under given set of environments) is presented. WH-1105 (G-14) and PBW-644 (G-12) were closest to ideal genotype hence suggesting better adaptability to sites and environments under consideration. The poly gone representing what-won-

where, also called as convex hull was created joining the cultivars that are farthest from the origin of biplot (Fig 7). HD 3086 (G-8) performed best under irrigated conditions at site 1 (E1). PBW 621 (G-11) and Krichauff (G-9) were best genotypes under rainfed conditions at site 2 (E4). WH 1105 (G-14) and PBW 644 performed best in E2 (rainfed environment at site 1) and E3 (irrigated environment at site 2).

As stress at both sites tended to be mild and typically

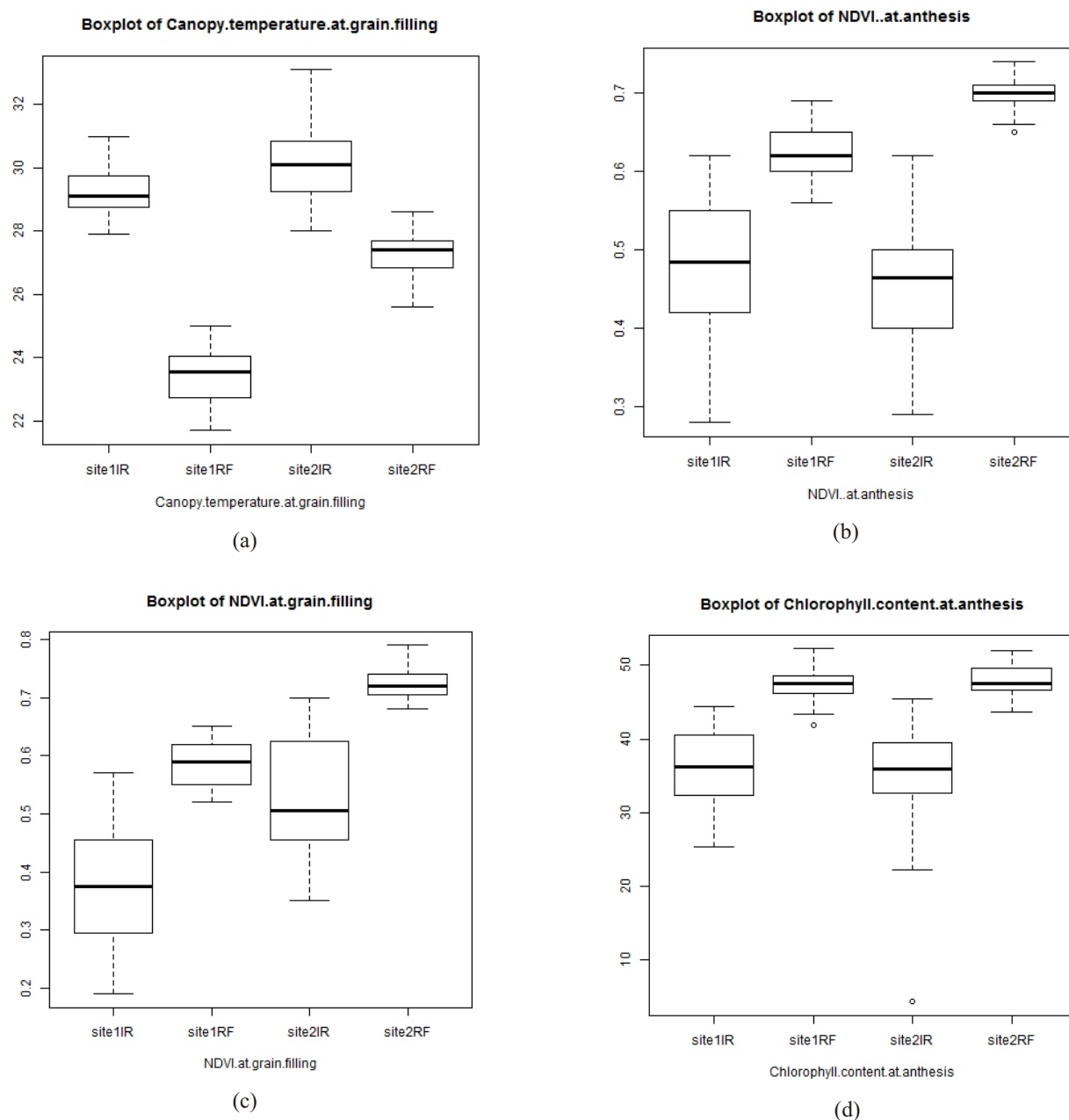


Figure 2 : Box plots showing distribution of (a) canopy temperature at grain filling, (b) NDVI at anthesis, (c) NDVI at grain filling and (d) chlorophyll content at anthesis for both sites under both environments

drought adapted genotypes potential under crossover interaction remained hidden. Field data was supplemented with root shoot trait data. Root related traits constitute important parameters for characterizing germplasm for drought stress related traits. Recently lot of research effort is deviated towards understanding role of root shoot traits under moisture stress (6, 12). The set of genotypes was evaluated for root shoot related traits at seedling stage using cigar roll method. Results obtained are presented

in table 6. For root length and shoot length traits genotypes showed non-significant difference. In case of shoot length genotypes showed significant differences.

For visualizing relationship among various physio-morphological traits and root related traits correlation coefficients were calculated among aforementioned traits. Few interesting correlations were observed between root shoot related traits and field based traits. Grain yield showed significant positive correlation

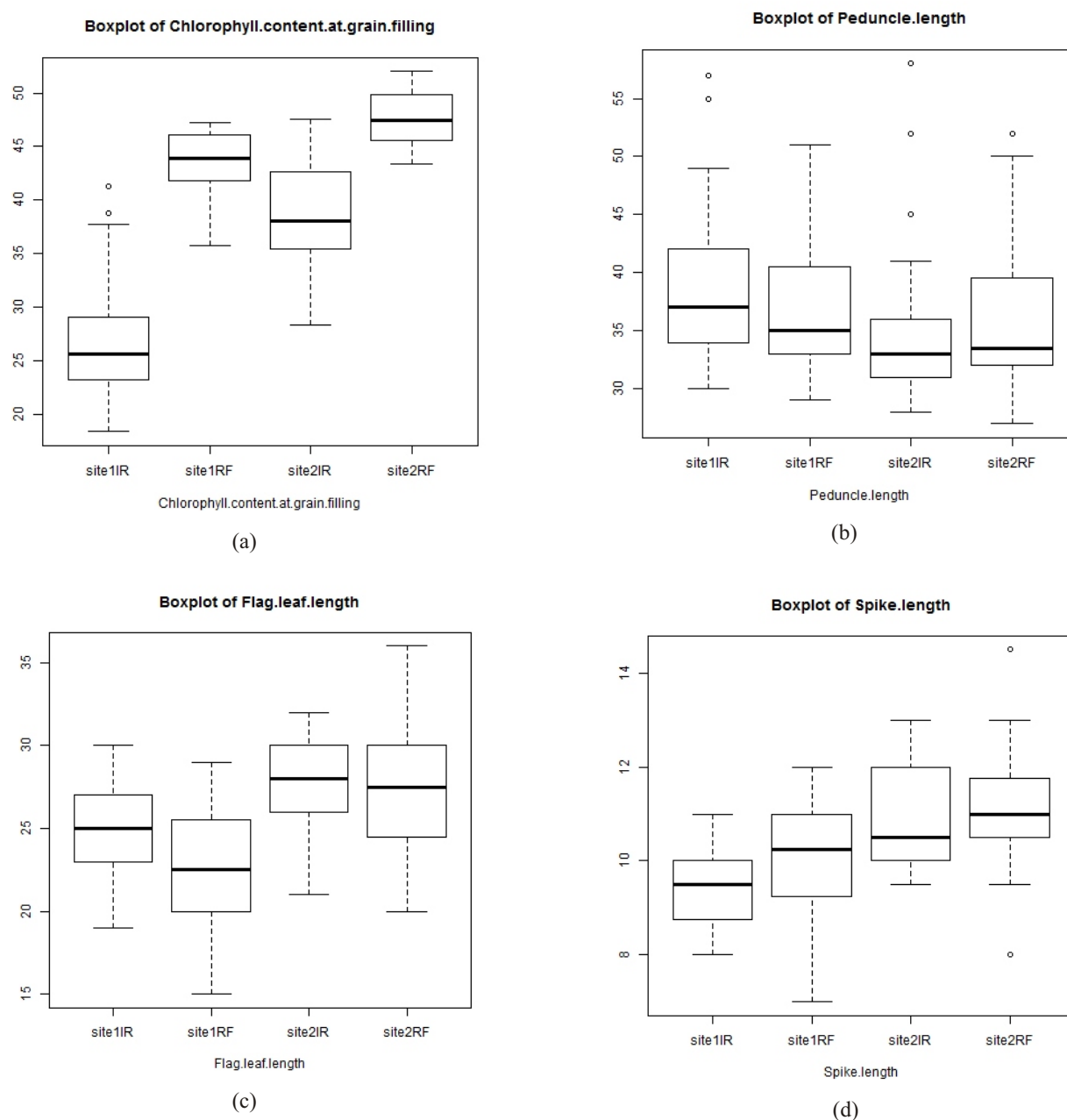


Figure 3 : Box plots showing distribution of (a) chlorophyll content at grain filling, (b) peduncle length, (c) flag leaf length and (d) spike length for both sites under both environments.

with root/shoot ratio (0.544). Spikelets per spike showed significant negative correlation (-0.558) with shoot length and positive correlation with grain yield (0.585).

Overall, characterization experiment revealed bidirectional adaptation pattern of genotype released for irrigated environment (WH 1105, HD 2967 and PBW 621). HD 3086 showed directional adaptation for irrigated environment. Rainfed adapted cultivar PBW 644 showed good grain yield potential for irrigated

environment. Among exotic drought tolerant drought set cultivars Krichauff showed best adaptation to Punjab region agro climatic conditions. Other exotic cultivars and old rainfed cultivars showed specific adaptation to rainfed environment and sub optimal performance under irrigated environments. Babax showed early flowering habit indicating drought escape for avoiding drought stress at anthesis and grain filling stage. Due to exceptional weather (cool and moist) prevailing during 2014-15 crop season,

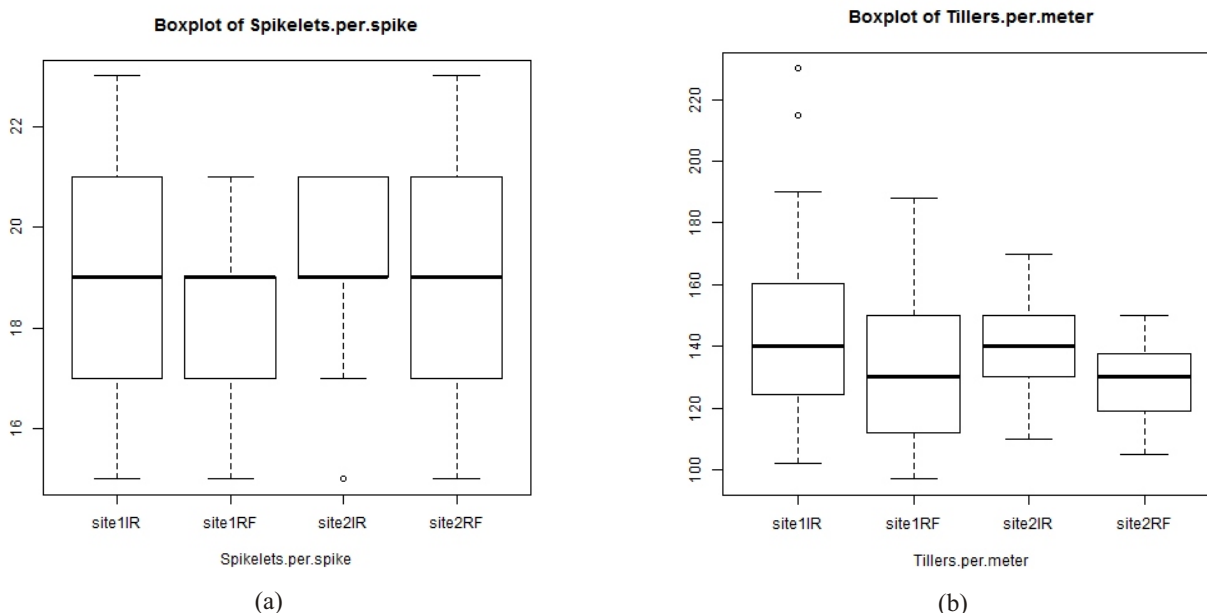


Figure 4 : Box plots showing distribution of (a) spikelets per spike and (b) tillers per meter for both sites under both environments

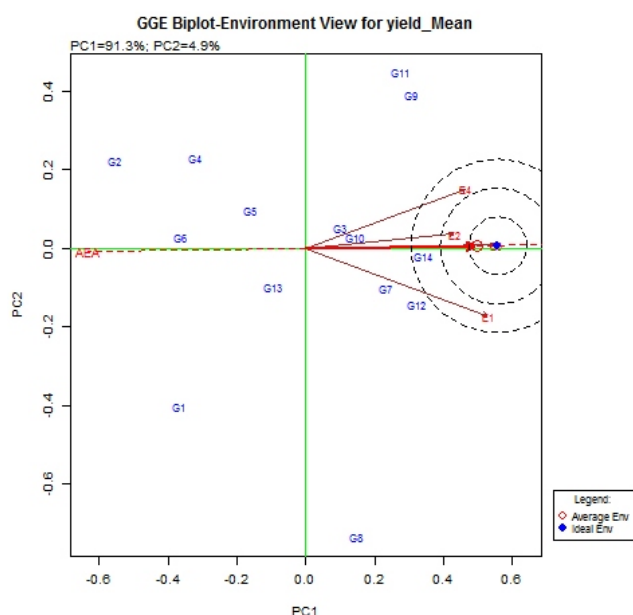


Figure 5 : Environment centred view of mean yield of genotypes

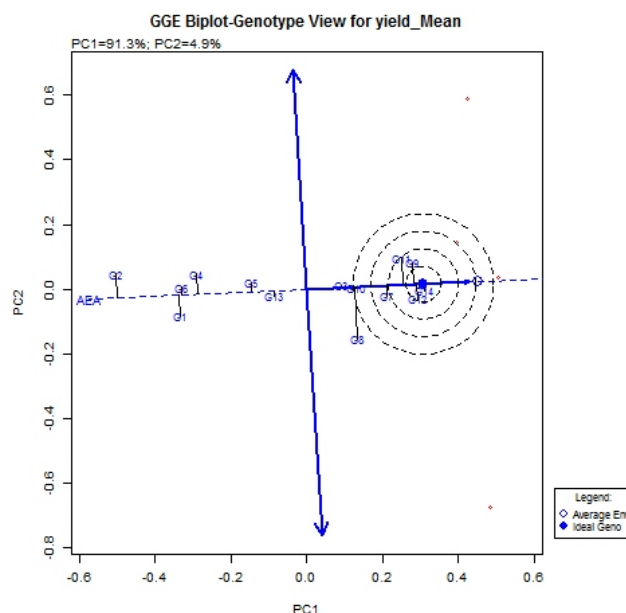


Figure 6 : Ranking genotypes based on ideal genotype.

genotypes which flowered late, had stay green habit and greater chlorophyll content, cooler canopies as well as higher NDVI were generally at a disadvantage. Hence, due to absence of crossover interactions and aberrant weather pattern adaptation pattern for extreme drought in drought tolerant genotypes remained masked. However, in Northern zone of India such

extreme drought regions are rare and crop improvement for water limited environments is more relevant. Also, analysis of root shoot traits served as good add on for characterizing germplasm for moisture stress. Significant high correlation of root/shoot ratio with yield potential can serve as add on to selection criteria for selecting genotypes for moisture stress regimes and water use efficiency. So there is need to

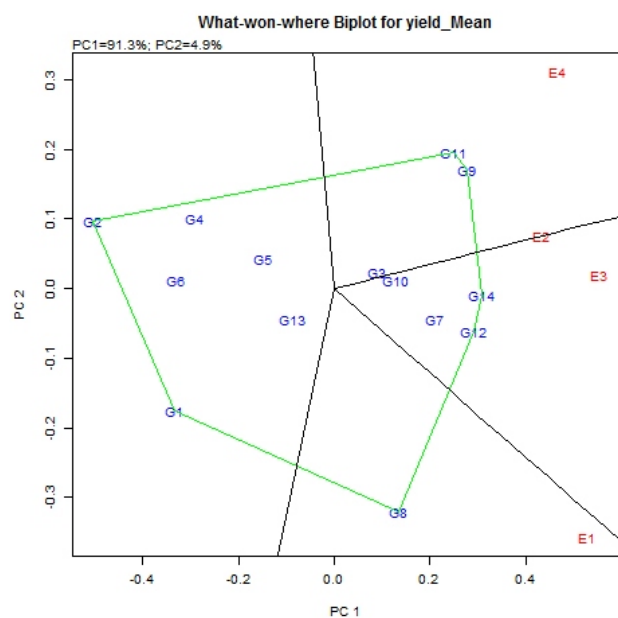


Figure 7 : Best genotype for each environment.

develop populations using drought tolerant sources and exploring further the relationship between root shoot traits, physio-morphological traits and yield performance under varied environments.

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GROWTH, FLOWERING AND BULB YIELD OF TUBEROSE (*POLIANTHES TUBEROSA* L.) CV. MEXICAN SINGLE AS AFFECTED BY NITROGEN AND PHOSPHORUS UNDER VARYING SPACING

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ABSTRACT

An field experiment on tuberose cultivar Mexican Single was conducted at Research Farm, Crop Cafeteria Unit (CCU) of Krishi Vigyan Kendra, Hastinapur, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP) India during the year 2014- 15 and 2015-16. The treatments compared three levels of N (100, 150 and 200 kg N/ha), three levels of P₂O₅ (100, 150 and 200 kg P₂O₅/ha) and with two spacing *i.e.*, 10 x 20 and 20 x 20 cm in a Randomized Complete Block Design (RCBD) with the three replications. To the results obtained that for the maximum yield of spikes flowers and bulbs production of tuberose to be planted at a closer spacing of 10 x 20 cm and with a fertilized 200 kg of N and 150 kg P₂O₅ per hectare. The effect of spacing on vegetative growth and floral characters was observed to be non-significant. The spikes per plant were found to be maximum under wider spacing (20 x 20 cm). To the application of nitrogen at 200 kg/ ha recorded significantly the highest value of vegetative and floral parameters. The number of days to first flowering was earlier at higher level of nitrogen. The response of phosphorus was non- significant on vegetative characters while floral characters *viz.*, rachis length and number of florets per spike were found significant. Tuberose bulb yield in the case of clumps weight tonne per hectare was also found significant and 200 kg phosphorus per hectare recorded the higher values.

Key words : Bulb, nitrogen, phosphorus, spacing.

INTRODUCTION

Tuberose (*Polianthes tuberosa* Linn.) is an predominant or key bulbous flowering perennial ornamental plants. It is commonly called as 'Rajani Gandha' and is native of Mexico. It has been obtain or secure considerable popularity and widely grown for aesthetic aromatic and commercial purpose. It produces waxy, white and fragrant flowers on long spikes which are mostly used as cut flowers for making garlands and with extracting essential oil. It is commercially cultivated in West Bengal, Tamil Nadu, Maharashtra, Karnataka and Uttar Pradesh and Punjab. It blooms profusely or profoundly almost throughout the year and more artistic garland and floral arrangements with the fully fragrance are made from its tuberose flowers.

The choicest with most favourable or advantageous or finest supply of plant nutrients is an important factor in growth and flowering in tuberose during cultivation. The field should be well prepared by 2-3 ploughing and incorporation 40-50 tonnes per hectare of well rotten farmyard manure before planting time *i.e.*,

during February-March. The tuberose bulbs planting are done in March-April at the different distance. Bulb weighing about 40-50 g is suitable for planting for the production of healthy spikes. The fertilizers during crop are done to be fertilized with quantity of N, P & K. It requires being sufficient condition soil moisture for its growth and bulb production of plants. The weekly irrigation is required during May to June in Western Uttar Pradesh. In clayey, slightly sandy loam soil, the fast multiplication of daughter bulbs is satisfactory and with acceptable. One mother bulb gives rise to 06 – 08 daughter bulbs in period of growth, respectively. Out of which 45 per cent bulbs are fit for the next planting. It's magnificent and with inspiring delight cultivation of tuberose is influenced by various agro- techniques including most excellent spacing.

MATERIALS AND METHODS

The study was conducted for two year during 2014-15 and 2015-16 at Research Farm, Crop Cafeteria Unit (CCU) of Krishi Vigyan Kendra, Hastinapur, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP). The soil of trial site was

Table 1 : Response of nitrogen, phosphorus and spacing on vegetative growth and spike yield/ ha in tuberose cv. Single.

Treatments	Plant height (cm)	Number of leaves/ plant	Number of days to flowering	Spike yield/ ha (No.)		
	Polled			2014-15	2015-16	Polled
Nitrogen (Kg/ha)						
100	42.12	41.76	138.92	137510	146617	142064
150	45.38	44.08	132.60	148750	159550	154150
200	49.03	48.13	120.52	161860	178890	170375
CD. (P=0.05)	1.46	0.85	0.45	15062	16007	10183
Phosphorus (Kg/ha)						
100	43.91	41.71	122.36	157520	165940	161730
150	45.01	43.82	119.51	164710	173901	169306
200	48.23	46.78	116.73	175917	176116	176017
CD. (P=0.05)	NS	0.72	NS	NS	NS	80441
Spacing (cm)						
10x10	46.02	44.61	112.47	190604	189417	190011
20x20	47.85	46.74	126.29	178550	176420	177485
CD. (P=0.05)	NS	NS	7.27	12710	13519	70802

clayey, slightly sandy in reaction with P^H 7.5 and having EC value of 0.37 ds/m. The fertility status of trail plot was medium in organic carbon as well as available phosphorus and potassium. The trail was conducted in a Randomized Complete Block Design (CRBD) with involve three stages of nitrogen (100, 150 and 200 kg/ha) and phosphorus (100, 150 and 200 kg/ha) and two spacing differs *i.e.*, 10 x 20 cm and 20 x 20 cm. Thus, total 27 treatments combinations were included with three replications. A fixed basal dose of 2.5 kg/ m² of well vermin compost was incorporation into the soil at the time of field preparation. Nitrogen levels as per treatments were applied in three equal splits in the form of urea. One third of nitrogen, entire quantity of phosphorus in the form of single super phosphate and the potassium at the rate of 120 kg/ha in the form of potash were applied as a basal dose at the time of tuberose bulb planting.

To the remaining two doses of nitrogen were given as a top dressing *i.e.*, one third at 30 days after planting and now the remaining one third at 90 days after planting. The bulbs were pre-treated with 0.15 percent Hexaconazole 5% SC uniformly to present any fungal infection. Bulbs of uniform size (2.0 to 2.5 cm diameter) were planted a depth of 5 cm in the month of March, 2014-15 as well as in 2015-16. To the observations were made on various vegetative growth and flowering characters were recorded for a treatments evaluation. The data collected were

analyzed using statistical method as suggested by (2). Two year data were statistically analyzed and presented in Table 1, 2 and 3.

RESULTS AND DISCUSSION

The objective wise facts and findings derived after analysis of the data have been presented under the following heads :

Vegetative growth characters : To the application of nitrogen significantly include plant height and number of leaves per plant (Table 1). The maximum plant height (49.03 cm) and number of leaves per plant (48.13 cm) were recorded under 200 kg. of nitrogen/ha treatment as compared to lower level of nitrogen (100 kg/ha) in the pooled results. The plant height and number of leaves per plant increased with the application of high dose of nitrogen because nitrogen is an essential part of nucleic acid, which play a important role in promoting the plant growth. While, the given response of phosphorus and spacing was found to be non significant with the regard to plant height. In case of number of leaves per plant, the response with phosphorus was found to be significant. The increases in plant height and number of leaves per plant with the nitrogen application have also been reported by (3).

The numbers of days need to first flowering were significantly affected due to varying levels of nitrogen.

Minimum number of days need to first flowering under 200 kg N/ha while it was maximum under 100 kg/ha treatment. The number of days required for flowering decreased with the increasing level of nitrogen. Similar, obtained results were also reported by (6) in the crop. N application including earlier flowering might be assigned to higher dose supply of N, which results in the early completion of vegetative period. To the application of P_2O_5 had non significant effect an number of days to flowering. With the respect to spacing, the response of were significantly. The closer spacing (10x20cm) flowered earlier as compared to wider spacing (20 x 20 cm). These finding are in closer agreement with (7) who reported that tuberose plants having wider spacing flowered late in both years.

Floral Characters : All these flowering characters increased with the level of N salt. The higher length of spike and rachis length, number of florets per spike and number of spike per plant (2) were recorded under the 200 kg N/ha treatment as compared to 100 kg N/ha. To nitrogen application increased spike and rachis length and number of spike per plant, might be attributed to maximum dose of N, which results in completion of vegetative phase early. Tuberose is promotes more vegetative growth by increasing the amount of assimilates that are needed for improvement in length of spike and rachis. The results of the present study also confirm the findings of (6) in crop.

Significantly the maximum (170375) and the minimum number of spikes per hectare (142064) were recorded with the treatment of 200 and 100 kg N/ha, respectively, similar trend was also observed with respect to bulb yield tonne/ha.

All the flowering characters were made significant except spike length with regard to the phosphorus application. Spike and bulb yield were found significant in merge or amalgamate results and phosphorus @ 200 kg / ha recorded the maximum spike yield of 169306 spikes per hectare, which was remained at par with 200 kg/ ha. Similar results have been noted by (8) and (5). While improvement in bulb yield per hectare with the treatment of NPK fertilizers doses have also been reported by (4, 9).

With due to regards to spacing applications all the following characters were found to be non significant.

The highest spikes per hectare (190011) and bulb yield (44.09 t/ha) were significant observed in the closer spacing of 10 x 20 cm, while the wider spacing (20x20 cm) a minimum number of spikes per hectare (177485) and bulb production (35.96 t/ha). The more spike production per unit area due to respect of closer spacing might due to the simple fact is that more number of plants per unit area were accommodated and most of them have produced flowering spikes production. Similar results have been reported by Singh (10) in tuberose.

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SCIENTIFIC BASIS OF YOGA

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ABSTRACT

Literal meaning of Yoga is "to add", "to join", "to unite", or "to attach" self with Supreme or union of self with vast of cosmos for achieving uninterrupted longlasting happiness by feeling of separation from EGO. Scientifically the main action of yoga is to shift equilibrium from sympathetic to para-sympathetic leading to decrease heart rate, respiratory rate, blood pressure, and achieving relaxation response, emotional balance, thus leading from stress to peace and happiness. All these lead to increase concentration, attention, memory, cognition and judgement, improved respiratory function (vital capacity, total lung capacity, forced expiratory volume) and beneficial effect on chronic obstructive pulmonary disease, asthma and restrictive air way disease, improve gut motility, digestion and treatment for irritable bowel syndrome, improve mood and anxiety through Gamma Amino Butric Acid (GABA), and lower cardiovascular risk factors. In new research studies it has been found that in chronic low back pain, special Yoga is 30% more beneficial than usual care alone in a United Kingdom clinical trial. Also the clinical trials have shown beneficial effects of yoga on cancer outcome and in de-addiction.

Keywords : Yoga, shifting of equilibrium from sympathetic to parasympathetic, emotional balance, neural circuit.

INTRODUCTION

Literal meaning of Yoga is "to add", "to join", "to unite", or "to attach" self with Supreme or union of self with vast of cosmos for achieving uninterrupted longlasting happiness by feeling of separation from EGO. The physical science also postulates one continuous substratum and unity of universe. The term "yoga" first appears in the Hindu scripture *Katha Upanishad* (a primary Upanishad 400 BCE) where it is defined as the 'steady control of the senses, which along with cessation of mental activity, leads to the supreme state.'

Some great yogic personalities:

In the yogic culture Shiva is known the Adi Guru (Adi Yogi: the first Yogi). Shiva expounded various types of Yoga, depending upon the level of preparedness of the person.

Lord Buddha is documented in the history as the personality having the greatest ever, will power to have been achieved by the realization of truth through purification & perfection of body and mind and also achieving the ability to cure suffering humanity from physical diseases through Dhamma.

Swami Vivekanand is the first one to introduce the ancient Yogic wisdom of East to the west. He said "Arise awake and stop not till the goal is reached" and also "You can not believe in God until you believe in Yourself". He emphasized that you are "Divine".

Dalai Lama is present day iconic personality spreading the message of peace, union, mindful awareness, Vipassana meditation or 'Darshan' and combination of meditative absorption with liberating cognition.

History and lineage of yoga :

One of the most detailed and thorough expositions on the yoga is *Yoga Sūtras of Patañjali* and 'Ashtanga yoga' (Eight limb) also known as 'Rajyog' which is a specialized technique of, behaviour modification, purification of body and mind in systematic manner. The eight limbs of Ashtanga Yoga are:

Yama (The five "abstentions"): Ahimsa (non-violence), Satya (Truth, non-lying), Asteya (non-covetousness), Brahmacharya (non-sensuality, celibacy), and Aparigraha (non-possessiveness).

Niyama (The five "observances"): Shaucha (purity), Santosha (contentment), Tapas (austerity), Svadhyaya

(study of the Vedic scriptures to know about God and the soul), and Ishvara-Pranidhana (surrender to God).

Asana Literally means “seat”, and in Patanjali’s Sutras refers to the seated position used for meditation.

Pranayama (“Suspending Breath”) : Prâna, breath, “âyâma”, to restrain or stop. Also interpreted as control of the life force.

Pratyahara (“Abstraction”) : Withdrawal of the sense organs from external objects.

Dharana (“Concentration”) : Fixing the attention on a single object.

Dhyana (“Meditation”) : Intense contemplation of the nature of the object of meditation.

Samadhi (“Liberation”) : merging consciousness with the object of meditation.

Shvetashvatara Upanishad (400-200 BCE) elaborates on the relationship between thought and breath, control of mind, and the benefits of yoga. The Brahmanas (ritualistic texts of the Vedic corpus, c. 1000–800 BCE) and the *Atharvaveda* gave first description of techniques for controlling breath and vital energies; laying emphasis of bodily postures which probably evolved into yogic Asanas. The earliest reference of meditation (control of thought) is found in *Brihadaranyaka Upanishad*. *Chandogya Upanishad* describes the concept of vital energies ‘Prana’. (Ojus. Vital force). *Taittiriya Upanishad* defines yoga as the mastery of body and senses. (PNS). The *Buddhist Meditation* originated in the Upanishadic tradition and emphasised on “formless meditation and elemental meditation”

Ramification of yoga took place as per time as evident from literature as *Yoga Sûtras of Patañjali*, *Ashtanga yoga or Rajyoga*, *Bhagwat Geeta* describes (*Karma yoga*: The yoga of action, *Bhakti yoga*: The yoga of devotion, *Gyan yoga*: The yoga of knowledge). The *Buddhist and Jain yoga* emphasized on mindful awareness and formless awareness. The *Kriyâ-yoga* aims at the “union with the Supreme” while doing the performance of duties in everyday life. *Hatha yoga* emerged as a prominent tradition of yoga distinct from the Patanjali’s *Yoga Sutras* by the first millennium and concentrates on health and purity of the body in contrast to *Yoga Sutras* focus on discipline of the mind. In the 1980s, yoga became popular as a *physical system of health exercises across* the Western

world and lead to gradual distortion in the form of tough complex body postures.

Scientific basis of Yoga: Yoga is not just twisting your body or holding your breath or particular exercise or a technique. “Yoga is the inhibition (*nirodha?*) or the modifications of thoughts (*v?tti*) of the mind (*citta*)”. With control of body systems by the voluntary control of mind The cessation of the perturbations of consciousness achieved through dynamics of the brain circuitry. There are 100 billion nerve cells (approximately same number of stars in Milky Way) and each nerve cell is connected by 10,000 to 40,000 connections – total synapses are more than the stars in the entire universe. It is said that more electrical impulses are generated in one day by a single human brain than by all the telephones in the world and 70,000 is the number of thoughts that it is estimated the human brain produces on an average day.

Thus, there is huge burden of information in the brain so there is need of selection and filtering of information to clear the chaos and clutter. Here the yogic practices come for rescue by sensory attenuation (eye closure, silent environment, relaxed posture), Sensory control and minimum proprioceptive and joint input), isolation with outer world or stoppage of outward flow of energy, thus leading to the decrease in neuronal activity as evident by the electroencephalogram recordings where there is conversion of alpha rhythm to delta rhythm thus showing neuronal relaxation.. Also yogic practices cause cognitive restructuring thus cleaning the chaos and clutter of thought by observation of breath, ‘Tratak’, focusing on “Third Eye” (it is most probably referred for pineal gland which lies in posterior part of upper brain and thought to be a junction centre for spirituality & Science), name chanting thus letting the thought come and go thus leading to state of inner thoughtlessness and emergence of “Authentic pure self”. All this leads to better Sympathetic control via Diaphragmatic deep breathing (khumbak, Kapal bhati etc) and Parasympathetic emergence by Vagal stimulation (Right left nostril alternate breathing, “AUM chanting”), endorphin release and sacral plexus stimulation (lotus posture, ano -coxigial pressure, “Muladhar stimulation”).

Thus, the main action of yoga is to shift equilibrium from sympathetic to para-sympathetic leading to decrease heart rate, respiratory rate, blood pressure,

and achieving relaxation response, emotional balance, thus leading from stress to peace and happiness. All these lead to increase concentration, attention, memory, cognition and judgement, improved respiratory function (vital capacity, total lung capacity, forced expiratory volume) and beneficial effect on chronic obstructive pulmonary disease, asthma and restrictive air way disease, improve gut motility, digestion and treatment for irritable bowel syndrome, improve mood and anxiety through Gamma Amino Butric Acid (GABA), and lower cardiovascular risk factors.

In new research studies it has been found that in chronic low back pain, special Yoga is 30% more beneficial than usual care alone in a United Kingdom clinical trial. Also the clinical trials have shown beneficial effects of yoga on cancer outcome and in de-addiction.

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STUDY ON OVERWEIGHT AND DIFFERENT REDUCE METHOD FOR HEALTHY LIFE

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INTRODUCTION

To maintain the good health the weight should be as per BMI (body mass index) decided by health department as per direction of WHO (World Health Organisation). Nowadays, different activities and exercise is popular to reduce the weight and yoga also significant media to reduce the body weight, gymnasium can also reduce the weight loss. The health club is specialise in safe cardiovascular exercise program to enable you to improve your lifestyle by leading a held there and filler life. The gymnasium is made buy a professional staff to assist you with equipments and provide personal consolation and training to members who seek individual attention. One of the most popular type of home exercise equipment is the treadmill which provides a straight forward efficient aerobic workout.

MATERIALS AND METHODS

There are different methods are used to loss or decrease the weight.

1. Exercise

Exercise increase your stamina and endurance full stop this or to excite the person if your self exhausted at the end of the day too tired to even enjoy you need to make regular exercise a part of your life. exercise reduce stress and activates endorphins causing unnatural high and sense of well being and exercise decreases appetite and acts as a natural appetite suppressant.

2. Diet with low carbohydrate

Low carbohydrate diets can lead to quick weight loss, which has made several of them very popular full stop at the same time how about these diets usually call for followers to eat more meat and that can lead to the other health problems along the way.

3. Gymnasium

The gymnasium is is meant by a professional staff to

Oasis bodies with the equipments and provide personal consultation and training to members who seek individual attention.

RESULTS AND DISCUSION

Exercise increases the number of calories burn please stop this increase the accelerate body weight loss and encourages weight control. Exercise decreases blood pressure and bad cholesterol, LDL while raising HDL for good cholesterol. consistent aerobic work out, coupled with weight training and healthy eating, will get us to our goals for a stop as strength and endurance are developed the treadmill can be used for jogging and/or for interval training. low carbohydrate diet in begin lose weight is the body first burns glycogen which comes from the consumption of Carbohydrates, for energy without these carbohydrates in body big in burning fat for energy, which leads to short term weight loss a low carb diet also acts as a diuretic Kama soap body loss weight almost immediately full stop by eating more fats and proteins in diet body feeds full for longer because they take longer to digest and convert to energy.

CONCLUSION

On the basis of present investigation “Study on the different methods of weight reduced for the healthy life” revealed that exercise, yoga and gymnasium can play the significant role for healthy life. Regularly exercise decrease blood pressure and blood cholesterol. Exercise decrease blood pressure and LDL or bad cholesterol while raising HDL or good cholesterol. jogging and for interval training and different type yoga are also useful for healthy life the gymnasium is also completed as the different equipment is a trade mail which provides a straightforward efficient aerobic workout.