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IN-VITRO EFFECT EVALUATION OF PLANT LEAF EXTRACTS AGAINST *FUSARIUM OXYSPORUM* F.SP.CICERICA USING WILT IN CHICKPEA THROUGH FOOD POISON TECHNIQUE IN DISTRICT MEERUT (UP)

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ABSTRACT

Chickpea wilt caused by *F. oxysporum* f. sp. *ciceri*. In-vitro evaluation of four plant leaf extracts revealed that, among these extracts per cent inhibition over control was found maximum (71.93) in *Azadirachta indica* followed by *Lantana camara* (59.32) and it was found minimum in *Argemone mexicana* (42.80). *Parthenium hysterophorus* was found least (47.11) effective to inhibit the mycelial growth of *Fusarium oxysporum* f. sp. *ciceri* under in-vitro conditions.

Keywords: Botanical, Evaluation, Food-poison, *Fusarium*, In- vitro and Wilt

Introduction

Occurrence of chickpea wilt was first described in India by (4). Chickpea wilt caused by *F. oxysporum* f. sp. *ciceri*. In India chickpea (*Cicerarietinum* L.) variously known as Gram or Bengal gram. 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. Chickpea 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. One hundred-gram of 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. Pulse crops play an important role in Indian agriculture, besides being rich in protein. 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 (Anonymous, 2016).

This crop (chickpea) is subjected to attack by a number of fungal, viral, bacterial and nematode diseases. To study the compatibility as well the antifungal mechanism of plant extracts the poisoned food technique (5) was used, 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 collect from healthy chickpea plants. *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. Leaf extract of *Azadirachta indica* 100 per cent controlled the spore germination of *F. oxysporum* followed by *Lantana camara* (6). According to (2) were reported that the chickpea wilt caused by *F. oxysporum* f. sp. *ciceri* and it is one of the most severe diseases, which causes heavy losses (20-100%) and this is depends

upon stage of infection and wilting. *F. oxysporum* f. sp. *ciceri* is the most destructive and widespread fungal disease of chickpea. It has drastic effect on yield causing cent per cent loss under favorable conditions (12).

Test Pathogen: The pathogen (*F. oxysporum* f. sp. *ciceri*) is a facultative saprophyte or a heterotroph in nature and it can survive as mycelium and chlamydospores in seed, soil and also on infected crop residues. If any wound are found in the roots or at the formation point of lateral roots the fungus were inserted into this. Test pathogen proceeds to infect the host through its sporangial germ tube or through mycelium by invading the plants roots. It can easily obtain their food from organic matter through decomposing method. Test pathogen life cycle can be divided into three stages like dormant, parasitic and saprophytic stages. 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 (7).

Wilt disease: According to (9) was reported that the wilted chickpea plants in the multiple disease sick field at seedling stage did not exhibited any rotting on outer surface of the root. However, these seedlings were splitting vertically from collar region to downwards then it showed brown, black discoloration of internal tissues, while at adult stage of the wilt affected plants showed typical wilting symptoms like; drooping of leaflets, rachis and lamina. When an affected plant was uprooted and splitting the root of the wilted plants exhibited more pronounced internal brown to black discoloration of the xylem vessel. Same symptoms were founded under this study; wilt symptoms can be seen on the seedlings as well as at the time of maturity stage of the wilted plant of chickpea (JG 62) like; 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 and ultimately dry up.

Materials and Methods

A study has been conducted at Department of Botany, Meerut College; Meerut (Uttar Pradesh) to know the effectiveness of different plant leaf extracts to minimize the mycelial growth of *F. oxysporum* which is responsible for wilt disease in chickpea pulse crop by poison food technique (8).

The experiment was carried out for two consecutive years 2019-20 and 2020-21 under *In-vitro* condition in the laboratory of the said Department of Botany.

Plant leaf extracts (Botanical)

Total four botanicals viz., *Azadirachta indica* (Neem tree), *Parthenium hysterophorus* (Weed plant), *Lantana camara* (Ornamental plant), and *Argemone mexicana* (Pioneer plant) were used and its fresh 200 g. leaves are obtain from natural flora of District Meerut (Uttar Pradesh).

Sl. No.	Type of plants	Binomial name	Family	Plant part used
1	Tree plant	<i>Azadirachta indica</i>	Meliaceae	Fresh leaf
2	Weed plant	<i>Parthenium hysterophorus</i>	Asteraceae	Fresh leaf
3	Ornamental plant	<i>Lantana camara</i>	Verbenaceae	Fresh leaf
4	Pioneer plant	<i>Argemone mexicana</i>	Papaveraceae	Fresh leaf

(1) ***Azadirachta indica* (Neem tree)**-It is typically grown in tropical and semi-tropical regions. It is one of two species in the genus *Azadirachta*, and is native to the Indian subcontinent and most of the countries in Africa. It has commonly known as Neem, Nimtree or Indian lilac. Neem is a tree in the mahogany family *Meliaceae*. Neem seeds kernel extract and its leaf powder are use as botanical pesticide. Neem are used as key ingredient in non-pesticidal management (NPM), providing a natural alternative to synthetic pesticides. It acts as anti-fungal properties.

(2) ***Parthenium hysterophorus* (Weed plant)**-*Parthenium* is a genus of North American shrubs in the sunflower tribe within the Daisy family. All members of this genus have commonly known as feverfew. It has commonly known as Gajarghans and it is the most common invasive species in India. A *Parthenium* plant is responsible for milk fever disease in livestock and also responsible for the respiratory malfunction in human.

(3) *Lantana camara* (Ornamental plant)-

Lantana camara uses an ornamental plant into the house. It's commonly known as wild-sage and trickery. Leaf extract of the plant were found anti-fungal property in nature. It's having small tubular shaped flowers. Belong to the family *Verberaceae*. It has spread out of the Americans when it was brought to Europe by Dutch explorers and cultivated widely, soon spreading further into Asia and Oceania countries.

(4) *Argemone mexicana* (Pioneer plant)-

Argemone mexicana belong to the family *Papaveraceae*, is a species of poppy found in Mexico and now widely naturalized in many parts of the world. It is tolerant of drought and poor soil conditions. It is poisons to grazing animals, but it has been used in medicinally by many peoples. Its seeds contain 22-36% of non-edible oil which is also called as Argimone oil or Kalkar oil. This oil contains some toxic alkaloids like; *Sanguinarine* and *Dihydrosanguinarine* act as anti-fungal property in nature.

Isolation Method

Method of isolation was followed as according to suggested by (1) he was stated that isolation was making from the infected root samples and its purification of the culture was successfully done by repeated transfer of hyphal tip and with single-spore culture by dilution method. Underground portion of affected plant roots-stem up to height of collar region was selected for the isolation of the test pathogen. Plant showing typical symptoms of chickpea wilt, under natural condition was collected from chickpea growing field of the farmers of district Meerut were taken and brought to the laboratory of the Department of Botany, Meerut College, Meerut (U.P.) India.

Selected diseased parts of specimens (root-stem parts) were properly washed in running tap water for the removal of externally attached dust particles from the whole specimens to reducing the other contamination. Then it's were split open and taken small bits (2.5 mm) from the portion of collar region along with some healthy tissue portions with the help of properly sterilized sharp steel blade. This taken small bit (piece) was surface sterilized with 0.1 per cent solution of Sodium hypochlorite (NaOCl) for one minute under aseptic conditions. After that this pieces was washed three times from the sterilized water to

remove the traces of solution from the surface of particular pieces. Excess moisture was dried from the surface of piece by placing them between two fold of Whatman No 1 filter paper.

Total five dry pieces of sterilized root were placed in each Petri-dish. Four piece at the corner and one piece at the centre of Petri-dish. These Petri-dishes were sifted into the Biological oxygen demand (B.O.D.) for incubation at $28 \pm 2^{\circ}$ C temperature for 2 days. After 24 hours of inoculation when mycelial growth was visible in different Petri-dishes around the incubated pieces of root, finally cut advanced growth stage (hyphal tip) of the mycelium and further it was transferred into the agar slants test tube.

Purification technique

The pure culture of fungus was obtained by adopting single spore technique. It was purified and maintained on agar slants for further studies. Two per cent dilute spore suspension in distilled water was poured on plain agar Petri-dishes to form a very thin layer surface and spore suspension was allowed to fix down on this layer. Then fixed spores were separated singly from each other. It was marked separately by glass marker. Circled spore was lifted along with agar layer in a form of block with the help of dummy cutter from Petri-dishes. Block was transferred to Petri-dishes which were pre-contained 2 per cent sterilized PDA medium. As soon as the mycelial growth was clearly visible from single spore block, then regular sub-culturing was done, till pure culture was not obtained.

Identification of the test pathogen

The observations on radial growth, colony growth, colony pattern, substrate colour and mycelium colour of test pathogen were recorded as suggested by (11). *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 (10). For identification of the test pathogen (*F. oxysporum*) was firstly based on its Morphological characteristics like; colony, mycelium, sporodochia, microconidia & macroconidia and chlamydospores features and secondly based on its Cultural characteristics like; radial growth characteristics and sporulation of spore.

Morphological studies of the test pathogen

For identification of the test pathogen, which is based on its morphological study of the wilt disease causing fungus *F. oxysporum* f. sp. *ciceri* through the use of best suited medium (PDA) was taken for obtaining its better mycelial growth. When mycelial growth of test pathogen were clearly seen on the PDA surface, it slide was prepared with the help of mounting medium viz., cotton blue and lacto phenol then observed under stereo binocular (6.4-40x).

Cultural studies of the test pathogen

Identification of the test pathogen (*F. oxysporum* f. sp. *ciceri*) during the investigation which was based on its cultural characteristic which is mainly based on measurements of its radial growth of mycelium on different mediums and other on its spore-sporulation that is mainly based on average grade percentage of its spore presence on glass slide under stereo binocular microscope.

Preparation of stock solution from plant leaf extracts

Total hundred g of fresh leaf material from all four botanicals, separately were harvested from natural flora and it's were washed properly with running tap water, then it were rinsed with distilled water. All rinsed leafy materials were air dried under aseptically conditions and was macerated separately with 100 ml of distilled water in a warring blender. The leaf extract was filtered separately in plastic test tubes with required dose through the help of double-layered muslin cloth and then it was centrifuged at 5000 rpm for 5 minutes. Its supernatant was collected and filter through the use of Whatman No. 1 filter paper. Each filtrate liquid was heat sterilized and preserve as stock (100%) solution under aseptically conditions. All were used as a stock solution for this experiment.

In-vitro effect evaluation of botanicals through food poison techniques

Two ml of stock solution of each extract was incorporated into the 100 ml medium (PDA) to make 2% concentration of the extract. 15 ml of incorporated molten PDA poured into sterilized autoclavable glass Petri-plates. After solidification of inoculated PDA medium, all these plates were

inoculate individually with the 5 mm in diameter disc of pure culture of *Fusarium oxysporum* f. sp. *ciceri* was placed on PDA surface at the centre. Un-inoculated (with the stock solutions-plant extracts) PDA medium was poured and after its solidification of these Petri-plates only were inoculated with the same disc size (5mm) of *Fusarium oxysporum* f. sp. *ciceri* was served as control. Then after all these plate were incubated at $25 \pm 1^\circ \text{C}$ under incubation room for 7 days.

The experiment was conducted in completely randomized block design with four replications and five treatments included suitable control (without adding any botanical extracts into the PDA).

Experimental details:

Design: CRD

Replication: Four

Treatments: Five

Treatments details:

Treatments	Common name	Scientific name
T ₁	Neem (Tree)	Azadirachta indica
T ₂	Gajarghans (Weed plant)	Parthenium hysterophorus
T ₃	Wild-sage (Ornamental plant)	Lantana camara
T ₄	Maxican poppy (Pioneer plant)	Argemone mexicana
T ₅	Control	-

The observation on radial mycelial growth/ colony diameter in millimetre (mm) of the test pathogen (*Fusarium oxysporum* f. sp. *ciceri*) was assessing at an interval of 24 hours and continued till untreated plates were fully covered with test pathogen mycelial growth. The efficacy of plant leaf extracts (botanicals) was expressed as per cent of radial growth/cfu over the control which was calculated by using the formula of (Vincent, 1947).

Per cent inhibition (I)	=	C - T	x 100
		C	

Where,

I= Per cent inhibition

C = Growth of the test fungus in untreated control plates.

T = Growth of the test fungus in treated plates.

* Measuring scale: In millimetre (mm).

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under below head:

In-vitro effect evaluation of plant leaf extracts against test pathogen

The experiments were conducted during the years 2019-20 and 2020-21. Fresh and sterilized leaf extracts were used as a stock solution for this experiment. Total hundred g of fresh leaf materials from all four botanicals as described under "Materials and Methods". This experiment was conducted in completely randomized block design with four replications and five treatments included suitable control (without adding any botanicals in the Petri-plates). The results are presented in table -1.

Table- 1: In-vitro effect evaluation of botanicals against *Fusarium oxysporum* f. sp. *ciceri*.

Treatment No.	Treatment s details	Per cent of radial growth (mm)			Per cent Inhibition over control (mm)		
		Year (2019-20)	Year (2020-21)	Mean (%)	Year (2019-20)	Year (2020-21)	Mean (%)
T ₂	Azadirachta indica	23.12	23.10	23.11	71.75	72.11	71.93
T ₂	Parthenium hysterophorus	43.62	43.47	43.54	46.70	47.53	47.11
T ₃	Lantana camara	33.37	33.62	33.49	59.23	59.42	59.32
T ₄	Argemone mexicana	47.72	46.47	47.09	41.69	43.91	42.80
T ₅	Control	81.85	82.85	82.35	00.00	00.00	0.00
S.E. (m) ±		0.817	0.687	0.364			0.538
CD at 5%		2.484	2.090	1.353			1.999

*=Mean of four replications.

*Figure in parentheses indicates transformed values.

The result presented in table -1 revealed that the per cent inhibition over control was found maximum (71.93%) in the leaf extracts of *Azadirachta indica* followed by *Lantana camara* (59.32) and it was found minimum into the leaf extract of *Argemone mexicana* (42.80%). *Parthenium hysterophorus* was found least (47.11%) effective to inhibit the mycelial growth of *Fusarium oxysporum* f. sp. *ciceri* under in-vitro conditions.

Natural products which were isolated from plant appear to be one of the best alternatives in plant disease management as they are known to have minimal environmental impact and danger

to consumers in contrast to synthetic pesticides.

The present investigations confirmed earlier reports. Many researchers have reported fungal inhibitory property was found in to the *Azadirachta indica* and *Lantana camara* botanicals

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EVALUATION OF SEED GERMINATION PATTERN OF *HIPPOPHAE RHAMNOIDES* L. IN DIFFERENT CONDITIONS

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Abstract

Hippophae rhamnoides (sea buckthorn) commonly known as Leh- Berry is a unique medicinal and aromatic shrub belongs to family Elaeagnaceae. It is hardy, drought and cold resistant plant useful for land reclamation and known for its root nodules. Present study aims with germination of *Hippophae spp* in different conditions. The seed germination study was conducted by using various treatments and conditions. This will help in preparation of repository of germplasm (seedlings) for plantation drive of this species in near future.

Keywords: *Hippophae*, *Seed Germination*, *Treatments*, *Germplasm*

Introduction

More than 15000 species of higher plants occur in India of which about 9000 is economically important. Over 9500 wild plant species are used by the tribal societies of India (33). Among them, *Hippophae rhamnoides*, known as sea buckthorn is one of the oldest land plant dating from the Ice age. Locally it is known as *Ames* or *Chuk* and commonly as *Leh berry*. It is a unique medicinal and aromatic shrub /small tree with 2.5-6m in height belongs to family Elaeagnaceae. The main trunk has thick and rough bark. The young branches are smooth, grey and light ash coloured with needle shaped thorns (39). It is a hardy plant, drought and cold resistant, useful for land reclamation and farm stream protection through its vigorous vegetative reproduction and strong, complex root system with nitrogen –fixing nodules (31). It is cultivated and naturally grown in the various part of the world, including India, Pakistan, and Nepal. Bhutan and Afghanistan to China, Mongolia, Russia, Kazakhstan, Hungary, Romania, Switzerland, Germany, France and Britain and Northward to Finland, Sweden and Norway (32,39).

The fruits of *Hippophae rhamnoides* called as “*Tsestalullu*” in Leh Ladhakh region of India, constitute an important source of many medicinal and nutritional products. It is used for the treatment of several diseases in traditional medicine in various countries throughout the world. In Ladakh, the *Sowa Rigpa System* (Amchi System of medicine) has been using the plant parts like leaves, berries, pulp oil, seed oil etc in different herbal formulations.

The pulp obtained from the berries has tremendous medicinal values. It is rich in source of carbohydrates, amino acids, essential fatty acids & vitamins A, C, E & K. It also contains carotenoids, oxalic acid, and minerals (Ca, Fe, Mg, Cu, Zn etc).

The fruits have anti-inflammatory and anti-oxidant properties and are used as for alleviating pain, in promotion of tissue regeneration & to boost immune system. It also used as a anti-cancer agents and for curing cardio-vascular disease. The various *In vivo* study of Seabuckthorn oil reported to have anti-inflammatory, anti-oxidant, anti-microbial, anti-ulcer properties and hepato-protective properties. Bio-active oil has also been obtained from the young leaves & branches have been incorporated into an ointment for treating a wide variety of skin damages including burns, bedsores, eczema and radiation injury.

Seed is a unit of life developing from fertilized ovule. Botanically seeds are essential for young plants whose life activities are going on at a minimum rate. They represent the most critical phase of a plant's life cycle and are responsible for the evolutionary continuum of plant species (11). Seed characteristics, germination preferences and seed dormancy patterns have been proposed as tools for understanding evolutionary patterns (5). Germination of seed represents a dynamic period in the life cycle of plants and as a seed, makes the transition from a metabolically quiescent to an active and growing entity (20).

Seed germination phase of plants is considered critical for the cultivation of plants as its timing largely predetermines the chances of survival of a seedling up to maturity (36) and it indirectly determines the crop stand density and consequently the yield of resultant crop (15). Temperature is important environmental factor that regulates seed germination (25). Alternate low and high moderate temperature treatments induce and enhance germination of dormant seeds.

There are various germination obstacles in *Hippophae* spp. seeds resulting in propagation difficulties. According to Fronchot *et al.* (2009), *H.rhamnoides* seeds have a weak dormancy. Internal dormancy in seeds of sea buckthorn can be broken by stratification in moist sand for 90 days at 2 to 5°C (27).

Considering above facts, the importance to introduce this species in Uttarakhand, present study aims with germination of *Hippophae* in different conditions.

The seed germination study was conducted by using various treatments and conditions. This will

help in preparation of repository of germplasm (seedlings) for plantation drive of this species in near future.

Materials and Methods

Collection of planting material:

Seeds of sea buckthorn were collected from Leh Ladakh area for present study. Ladakh constitutes the eastern most part of states Jammu and Kashmir. Ladakh cover about 117,000sq.km and includes the Karokoram range and the upper Indus River Valley. Ladakh is one of the highest place on earth with average altitude being above 12,000 ft. It is linked with the Kashmir valley by the Zojila (10,098ft) passes and form part of outer Himalayas. The geographical area of district is 45,110sq.km.with Leh as the district headquarter.

Fresh berries/seeds of *H.rhamnoides* were collected from Nubra valley (Leh Ladakh).The Nubra valley (34.6° N Latitude – 77.7° E Longitude) in Ladakh comprises the valley of Shyok River from its acute angled bend down to its confluence with Nubra and further towards Indus. This area lies between two great mountain range i.e. Ladakh (on the south) and Karakoram (on the north) (34°15'45" to 35°30'N Latitudes and 76° 55'to 78° 05'E Longitudes). The valley portion of Nubra is wide and well vegetated with thickened of sea buckthorn-a thorny shrub, which the villagers use for fuel & for fencing their field compared to mountain slopes & remaining part of Ladakh districts. The berries were dried in sunlight and stored in cloth bags under room-temperature. Seed are then separated from dried berries and processed for further analysis. Collection of seed of *H.rhamnoides* was kept for experimental work. Dried seed were brought to the laboratory, shade dried for a week and subsequently used for germination.

Experimental Site

The present investigation was carried out in the laboratory and Farm of Department of Medicinal and Aromatic Plants, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar. Bharsar is situated 60km far from Pauri Garhwal on Pauri-Thailsain-Ramanagar National Highway No 121/41 at altitudes between 1900-2300 masl.

The climate is represented by mild summer, high precipitation and severe cold prolonged winter. The maximum average temperature ranged between 25-35°C while minimum temperature ranged between -2°C – -5°C during winter with frequent snow fall and area remains under snow for 15-20 days during December-January.

Seed Volume

It was measured by water displacement method for which seeds were dipped in a known volume of water in a measuring cylinder and after immersing the seeds the rise in water level was noted. Ten replicates with 50 seeds in each replicate were used for this purpose. Seed volume (V) was calculated using following formula:

$$V = V_2 - V_1$$

Where V_1 is initial water level and V_2 is final level after dipping the seeds. Mean seed volume with standard deviation was calculated.

Water Uptake

To determine the water uptake by the seeds in each category, five replicates of five seeds each were randomly taken and weighed individually for their initial weight using the electric balance described above. Seeds were then soaked in distilled water and kept at room temperature (25±°C). Weight of these seeds was taken after every 24 hrs until the constant weight was attained by the seeds *i.e.* the weight remained constant (5). Seeds were wiped with tissue paper every time before weighing to remove excess water from the surface. Water Imbibitions was estimated as percent increase in weight of seed using following formula.

Percent Imbibitions = $\frac{\text{Imbibed weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$

Seed Moisture Content

Moisture content of the seeds was determined by oven dry method "the low constant temperature oven method as prescribed in ISTA, 1999". Seeds were dried in ventilated electric oven at 103±2°C for 17±1 hours. For this purpose, ten seeds were weighed individually as described above, kept in oven for 17 hrs and dry weight determined. The moisture content of seeds was calculated following

Evans (1972) as:

$$\text{Moisture Content} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

Viability Test

The viability of seeds was determined following the method described by (26). For this purpose, 3 replicates of 10 seeds each were taken and soaked in 0.1% solution of TTC [2, 3, 5 triphenyl tetrazolium chloride (0.5%)] with pH 6.0 and incubated at 37°C for 24 hrs. Subsequently seeds were dissected gently into two halves and coloration of the seeds was observed under a dissecting microscope. The red colour of embryo and cotyledons indicate viability while non-viable seeds do not attain any colour.

Seed Germination

To study seed germination under different experimental sets, 3 replicates of 25 seed in laboratory and 20 seeds in field conditions were used for any experiment. The substratum was moistened regularly with distilled water to keep it moist. Prior to placing the seeds for germination all the seeds were surface sterilized by 0.1% aqueous solution of HgCl_2 for one minute followed by washing with distilled water 2-3 times. The similar process was repeated with 50% ethanol before sowing to avoid microbial contamination. The germination boxes (Whatman Filter Paper No 9 on Petriplates for laboratory experiments) were kept at room temperature (25±2°C) unless specified for any experiment. Similarly, seeds were also sown in stray foam seedlings trays containing garden soil: sand: FYM in 1:1:2 ratio and thereafter placed in open, under polyhouse and nethouse conditions for further observations. Counts of radicle emergence were taken daily which was taken as the criterion for germination.

Acquisition of germinability

Seed germination was studied as described below:

(i) Germination in different media

Effect of different media commonly used for germination on the germinability of seeds of *H.rhamonoides* was studied. The media used included pretreatments plant growth hormones

i.e. GA₃ and IBA (100, 200, 300, 400 and 500 ppm) in laboratory experiments and 100, 200 and 300 ppm for field based experiments. Similarly, pretreatment of KNO₃ (100, 200 and 300 µm/L) and Thiourea (10, 20, 30 µm/L) were also employed. Germination in the seeds under laboratory experiments was studied using three constant temperature regimes (i.e. room temperature, 20±2°C, 25±2°C) in seed germinators (Gaury International, Australia). Procedure for germination including replications was same as described above.

For all the experiments, the seed germination percentage was calculated following the procedure of International Seed Testing Association (ISTA, 1999).

Germination % = [Number of germinated seeds / Total number of seeds] 100

Other germination related parameters were also calculated through various formulae such as: Speed of germination (SG) as per Magurie (1962); mean germination time (MGT) as per Eliss and Roberts (1981); peak value (PV) as per 10; and germination index (GI) as per Kendrik and Frankland (1969). The formulae are given below:

SG = ? (n/d)

MGT = $\sum dn / \sum n$

PV = highest seed germinated/d

GI = Total % germination/time taken to reach 50% germination

where, n = number of seeds germinated; d = number of days

Results and Discussion

Seed Parameters and Viability

Seed is considered as unit of life that develops from fertilized ovule. It provides a way for species to survive in addition to protecting and sustaining life. Seed characters in combination with seed germination have been proposed as tools for understanding evolutionary patterns (5). Germination of seed represents a dynamic period in the life cycle of plants as it makes the transition from a metabolically quiescent to an active and growing entity (20). For germination to occur, the

dry quiescent seeds must imbibe water and hydrated (34). Similarly seed moisture study revealed that sometime moisture below 0.5% can contain the seed viable. Therefore seed moisture, imbibitions and seed volume are studied prior to germination along with seed viability (18).

Fresh seed weight of *H.rhamnoides* was recorded 0.06 -0.08 gm with moisture content being 14.3% and seed volume 2.5 milliliter. The viability of seeds was recorded 75% collected for present study. The seed moisture content is one of the most important factors controlling seed longevity (Vijay *et al.*, 2009). It has been published before that high moisture content makes the seed vulnerable to fungal infection and thereby reducing germination (20) besides irreversible macromolecular structural change which can advance the process of deterioration and resulting in non viability of seeds (Vijay *et al.*, 2009).

The result of imbibitions (Fig 2) suggest that it takes 72 hrs to attain saturation indicates that seed needs comparatively higher moisture to initiate germination. Similarly, higher viability in seeds for the plant inhabiting areas of harsh environment conditions as a defense mechanism to overcome mortality risks (Prakash *et al.*, 2005). High viability of seeds was also observed by Bhatt *et al.* (2005) Vashishta (2006) in high altitude plants *Swertia angustifolia* and *Angelica* species.

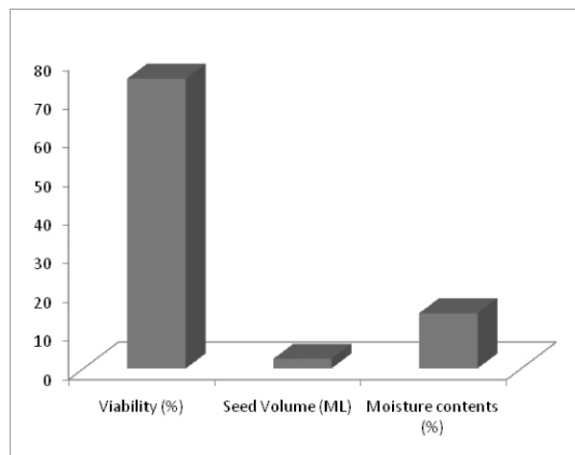


Fig. 1. Seed viability, seed volume and moisture contents

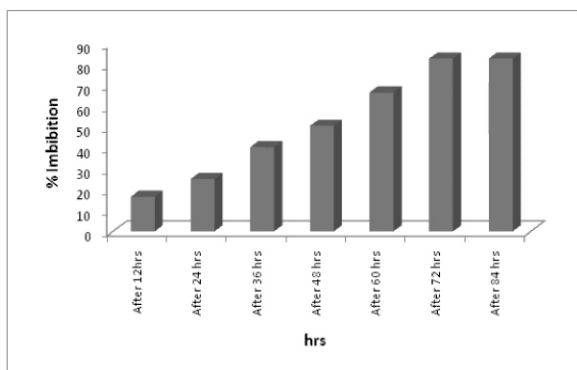


Fig.2. Imbibitions potential of seeds of *H. rhamonoides*

Seed germination and related parameters

Data on % germination, days required for initiation of first germination and complete germination at room temperature, at 20°C and 25°C in seed germinator are presented in table 1. Table indicates that maximum germination was achieved 76% in IBA 300 ppm pretreatments followed by 72% in IBA 200 ppm, 68% in GA₃-400 ppm and 65% in KNO₃-300.

Table 1. Effect of pretreatments and temperature on seed germination in laboratory condition.

Treatments	Room Temperature			20 °C			25°C		
	%G	Initiation of Germination (Days required)	Complete germination (Days required)	%G	Initiation of Germination (Days required)	Complete germination (Days required)	%G	Initiation of Germination (Days required)	Complete germination (Days required)
Control	64	6	19	64	6	19	40	6	13
GA ₃ -100 ppm	32	6	6	52	6	19	68	6	13
GA ₃ -200 ppm	32	6	19	52	6	13	36	6	13
GA ₃ -300 ppm	64	6	19	52	6	13	32	6	13
GA ₃ -400 ppm	68	6	19	48	6	19	36	6	13
GA ₃ -500 ppm	36	6	19	32	6	13	44	6	13
IBA-100 ppm	64	5	16	64	6	16	48	8	16
IBA-200 ppm	72	5	16	60	5	16	72	6	18
IBA-300 ppm	76	4	18	60	5	16	72	8	16
IBA-400 ppm	64	4	16	64	5	16	64	8	16
IBA-500 ppm	64	4	16	64	5	16	60	8	16

However, early germination (4 days) was displayed in all KNO₃, Thiourea and IBA300-500 treatments. Germination completed within 6 days in the seeds pretreated with GA₃-100 while it took 16-22 days to complete germination. At 20°C in seed germinator, highest germination was recorded 64% in control, IBA100, 400 and 500 ppm and lowest 32% in GA₃-500ppm. It took 5-6 days to initiate germinate in all treatments while in the treatment viz., GA₃-200,300 and 500 ppm, germination was completed within 13 days of sowing compared to all IBA treatments where took 16 days compared to 19 days in control and GA₃-100ppm treatments. At 25°C, germination was improved compared to 20°C especially 72% in IBA200-300ppm and 68% in GA₃-100ppm treatments. However, it was recorded low (32-36% only) in other GA₃ treatments. Germination

delayed compared to 20°C and was initiated within 6-8 days while it took 13 (GA₃ treatments) -18 (IBA treatments) days compared to 6-22 days at room temperature and 13-19 days at 25°C.

In general, maximum germination of 76% was recorded at room temperature when seeds were pre-treated with IBA 500ppm, early germination within 4 days in KNO₃, Thiourea and IBA300-500 ppm pre-treated seeds and completion of germination within 6 days of sowing in GA₃-100 treatments at room temperature. Data suggest that room temperature of 15-20° may be ideal conditions, although early initiation as well as competition of germination may be influenced by various treatments of plant growth hormones and other chemicals which may fulfill chilling / light requirement of the seeds.

Tables 2 indicates that maximum germination of 55% was recorded in the seeds pre-treated with Thiourea 300 $\mu\text{m/L}$ in open nursery conditions when seeds sown in styaro- foam seedlings tray. This was followed by Thiourea 100 $\mu\text{m/L}$ (45%) and GA_3 -200 ppm (40%). Seeds treated with KNO_3 showed minimum germination (20-30%). Germination was delayed in open nursery conditions compared to laboratory and it took 13 days for onset of germination in all treatments. Similarly, germination was completed within 17-22 days in all treatments and was lasted for 3-4 more days than laboratory. In polyhouse, under similar treatments, germination improved especially in treatments viz., Thiourea-200 $\mu\text{m/L}$ (75%), KNO_3 -300 $\mu\text{m/L}$ (65%) with improved germination also in some of the GA_3 treatments. Onset of germination was 1 day earlier in all treatments compared to open nursery conditions. However, it took 22-26 days to complete germination except GA_3 -200 ppm treatments where germination was completed in 12 days. In Net house, Thiourea-200 $\mu\text{m/L}$ and Thiourea-200 $\mu\text{m/L}$, and KNO_3 -300 $\mu\text{m/L}$

treatments displayed highest germination (70%) while KNO_3 -100 $\mu\text{m/L}$ and control recorded only 20% seed germination. Onset of germination was on 12th day of sowing while it was between in Thiourea - 100 & 200 $\mu\text{m/L}$ while the days required for onset of germination was between 12-17 days in other treatments in nethouse condition. GA_3 -200 and 300 ppm treatments took only 12 days to complete germination while for other treatments germination completed between 17-26 days of sowing.

Comparatively, germination was better in polyhouse conditions followed by nethouse and open nursery conditions and maximum germination of 70-75% in Thiourea and KNO_3 treatments. KNO_3 has long been used in seed germination studies for its action, without being clear about its role (17). However, it has been found to substitute the light requirements for germination for many positively photoblastic seeds (37). In addition, Thiourea is known to promote the germination of chilling requirement of the plant (1).

Table 2. Effect of various treatments in different conditions

Open nursery condition			
Treatments	% Germination	Initiation of Germination (Days required)	Complete germination (Days required)
Control	35	13	22
GA_3 -100 ppm	35	13	17
GA_3 -200 ppm	40	13	17
GA_3 -300 ppm	30	13	22
KNO_3 -100 $\mu\text{m/L}$	25	22	22
KNO_3 -200 $\mu\text{m/L}$	30	13	17
KNO_3 -300 $\mu\text{m/L}$	20	13	22
Thiourea-100 $\mu\text{m/L}$	45	13	22
Thiourea-200 $\mu\text{m/L}$	35	13	22
Thiourea-300 $\mu\text{m/L}$	55	13	22
Polyhouse condition			
Control	20	12	26
GA_3 -100 ppm	35	12	22
GA_3 -200 ppm	50	12	12
GA_3 -300 ppm	50	12	22
KNO_3 -100 $\mu\text{m/L}$	15	12	22
KNO_3 -200 $\mu\text{m/L}$	30	12	22
KNO_3 -300 $\mu\text{m/L}$	65	12	22

Thiourea-100 $\mu\text{m/L}$	55	12	22
Thiourea-200 $\mu\text{m/L}$	75	12	22
Thiourea-300 $\mu\text{m/L}$	50	12	26
Net house condition			
Control	20	17	26
GA ₃ -100 ppm	40	12	22
GA ₃ -200 ppm	45	12	12
GA ₃ -300 ppm	45	12	12
KNO ₃ -100 $\mu\text{m/L}$	20	14	22
KNO ₃ -200 $\mu\text{m/L}$	35	12	26
KNO ₃ -300 $\mu\text{m/L}$	70	12	22
Thiourea-100 $\mu\text{m/L}$	55	10	17
Thiourea-200 $\mu\text{m/L}$	70	10	12
Thiourea-300 $\mu\text{m/L}$	50	12	26

The values of speed of germination (SG) , mean germination time (MGT) , peak value (PV) and germination index (GI) under laboratory and nursery conditions are presented in Table 3 and table 4, respectively. At room temperature, the value of SG was minimum (0.27) in Thiourea-200 $\mu\text{m/L}$ while it was maximum (0.89) in GA₃-400 ppm. Minimum values of SG at 20°C was recorded (0.42) in GA₃-500 ppm while it was maximum (0.84) in control. GA₃-300 and 100 ppm treatments displayed minimum and maximum values, respectively for SG at 25°C. The values of PV and MGT were almost similar as initiation of germination and completion was almost on same date. At 20°C, the values of SG and MGT was maximum in control while it was minimum (0.42) in GA₃-500 ppm treatments. PV value was 1.00 in GA-300 -400 ppm. At 25°C, SG, PV, MGT and GY values were maximum in GA₃-100 ppm while it was minimum in GA₃-300 ppm treatment. Reducing MGT in GA and Thiourea in some cases showed their effectiveness as it ascribed to chilling and light requirement of seeds and stimulated germination (17).

Table 3. Germination parameters as influenced by temperature and various pre-treatments in laboratory

Room Temperature					20°C				25°C			
	SG	PV	MGT	GI	SG	PV	MGT	GI	SG	PV	MGT	GI
Control	1.23	1.23	0.84	10.66	0.84	0.84	0.84	10.66	0.53	0.77	0.53	6.66
GA ₃ -100 ppm	0.421	0.007	0.42	5.33	0.68	0.68	0.68	8.66	0.89	1.31	0.89	11.33
GA ₃ -200 ppm	0.421	1.33	0.42	5.33	0.68	1.00	0.68	8.66	0.47	0.69	0.47	6.00
GA-300 ppm	0.84	1.23	0.84	10.66	0.68	1.00	0.68	8.66	0.42	0.62	0.42	5.33
GA ₃ -400 ppm	0.89	1.30	0.90	11.33	0.63	0.63	0.63	8.00	0.47	0.69	0.47	6.00
GA ₃ -500 ppm	0.47	0.47	0.47	6.00	0.42	0.62	0.42	5.33	0.58	0.84	0.57	7.33
KNO ₃ -100 $\mu\text{m/L}$	0.42	0.50	0.42	6.87								
KNO ₃ -200 $\mu\text{m/L}$	0.35	0.53	0.34	5.63								
KNO ₃ -300 $\mu\text{m/L}$	0.50	0.59	0.50	16.25								
Thiourea-100 $\mu\text{m/L}$	0.35	0.53	0.34	11.25								
Thiourea-200 $\mu\text{m/L}$	0.27	0.87	0.27	8.75								
Thiourea-300 $\mu\text{m/L}$	0.38	0.58	0.38	12.50								

The minimum values of SG, PV, MGT and GI was recorded in KNO₃-100 $\mu\text{m/L}$ in open nursery, polyhouse and nethouse conditions except GI value in net house where it was minimum (1.77) in control (Table 4). Similarly, Thiourea-200 $\mu\text{m/L}$ treatments displayed maximum SG, PV, MGT and GT value in polyhouse and net house while values of these parameters was highest in Thiourea-200 $\mu\text{m/L}$ which indicated light requirement of seed for speedy and constant germination.

Table 4. Germination parameters as influenced by nursery conditions and various pretreatments

Open Nursery					Polyhouse				Net House			
	SG	PV	MGT	GI	SG	PV	MGT	GI	SG	PV	MGT	GI
control	0.27	0.32	0.27	2.63	0.15	0.15	0.15	1.66	0.19	0.19	0.19	1.17
GA ₃ -100ppm	0.23	0.35	0.23	2.63	0.27	0.32	0.27	2.92	0.31	0.36	0.31	2.35
GA ₃ -200ppm	0.31	0.47	0.30	3.07	0.38	0.39	0.39	4.16	0.34	0.75	0.34	5.00
GA ₃ -300 ppm	0.23	0.27	0.23	2.31	0.38	0.46	0.39	4.17	0.35	0.75	0.35	5.00
KNO ₃ -100 µm/L	0.19	0.23	0.19	1.47	0.11	0.14	0.11	1.25	0.15	0.18	0.15	1.43
KNO ₃ -200 µm/L	0.23	0.35	0.23	2.30	0.23	0.27	0.23	2.50	0.27	0.27	0.28	2.92
KNO ₃ -300 µm/L	0.19	0.23	0.19	1.59	0.54	0.64	0.53	5.41	0.50	0.63	0.50	5.83
Thiourea-100 µm/L	0.35	0.41	0.35	3.46	0.42	0.50	0.42	4.58	0.42	0.65	0.42	5.50
Thiourea-200 µm/L	0.27	0.32	0.27	2.69	0.57	0.68	0.57	6.25	0.53	1.16	0.53	7.00
Thiourea-300 µm/L	0.42	0.50	0.43	4.23	0.38	0.46	0.39	4.16	0.39	0.38	0.39	4.16

During this investigation, we recorded different observations than recorded earlier. According to (27), seeds of Sea buckthorn need high temperature to germinate at 10-120°C. Lu (1992) reported 13.2% germination after 47 days compared to 95% in 6 days for seeds at 24 to 26 °C. Germination was increased slightly by exposure to light intensities/m². In cold desert environment where natural resources are limited and only a few plant species are able to cope with harsh climatic condition, *H.rhamnoides* is adapted very well (Singh *et al.*,1991). This species can propagated by seeds and vegetative means (4); Singh *et al.*, 2005). In natural habitats, regeneration of this species through seeds is not upto mark and seedling growth is also slow. Although propagation through shoot cuttings or root suckers is quite successful, rooted plants showed low survival in the field (4). Also, the seedling developed using chemical treatments, show high survival in field condition (Butola and Badola, 2006).

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FREQUENCY, SPECTRUM AND PHENOTYPING OF RADIATION INDUCED MORPHOLOGICAL MUTANTS IN LENTIL (*LENS CULINARIS MED.*)

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Abstract

A wide spectrum of induced morphological mutations for various plant characters including plant height, leaf size, habit, days to flowering, branching pattern, pod size, maturity period, vegetative (non-flowering), sterility, persistence of green colour of the stem and leaves even at maturity were isolated from the treated populations of the three lentil varieties in M_2 generation. The mutation frequency was very high at 300 Gy compared to other dose levels. Similarly, the spectrum was also broad at 300 Gy dose. Varietal differences were noticed in respect to the frequency and spectrum of morphological mutations induced with P-38 exhibiting higher number and types of mutations compared to the other two varieties.

Keywords : Lentil, Mutation, Frequency, Spectrum.

Introduction

Lentil (*Lens culanaris* Medicus.) is one of the most important cool season food legume crop cultivated worldwide in semi-arid regions, particularly in the Indian sub-continent and in the dry areas of Middle East. It has been originated in East Mediterranean region, such as Asia Minor and Egypt. India is third producer of lentil. It was reported that only 5% of the total area of pulses cultivation is shared by lentil. Lentil is an excellent dietary staple because of there of high protein content and nutrient density that compliments the nutritional deficiencies of cereal based diet. The varieties of lentil under cultivation have low yield levels because of narrow genetic base and susceptibility to various diseases. The area under pulses including lentil has been shrinking at a fast rate because of increasing demand for staple grain like rice and wheat. The only option left to improve production is to increase per-hectare productivity of the cultivars. The cultivars grown in the Indian Sub-continent are *microsperma* type, low yielding and with almost no recognizable variability among them. It was reported that the lentil germplasm from India exhibits least variability (3). Exotic bold-seeded types are poorly adapted to the prevailing Indian climatic conditions. To increase productivity of lentil, it is, therefore necessary to create variability and select desirable types with stable genotypes. Hybridization in lentil (*Lens culinaris*) is cumbersome as flowers are very small, fragile and cleistogamous. Mutation breeding is relatively a quicker method for improvement of crops. It has been observed that induced mutation can increase yield as well as other quantitative traits in plants. Induced mutagenesis is one of the alternative breeding methods which can be applied to enhance the variability and correct one of more defects of cultivars. Studies on experimental mutagenesis in pulses particularly in this crop are limited

and confined mainly to cereal crops. Therefore, induced mutations are a worthwhile approach to increase genetic variability for quantitative characters in this crop. The present study has been taken up to analyze the effect of gamma rays on the frequency and spectrum of morphological mutations in M_2 generation in lentil.

Materials and Methods

Dry, healthy and well filled seeds of uniform size of three *microsperma* varieties viz. P-38, P-577 and LL-19 were subjected to irradiation at 100 Gy, 200 Gy and 300 Gy of gamma rays from a CO^{60} source located at the Division of Genetics, IARI, New Delhi. For each treatment (dose) 200 seeds of each variety were used. Comparable controls were maintained throughout the experiment. Treated seed along with control were sown immediately after irradiation in the experimental field to raise M_1 generation. Seed from each M_1 plant were harvested individually and separately. M_2 generation was raised following M_1 plant to row method. Twenty seeds from each M_1 plant were sown in a single row. A spacing of 25 x 15 cm was followed between rows and between plants in a row, respectively. M_2 populations were screened at different growth stages (from seed germination to maturation) for various types of induced morphological mutations. A number of mutants were selected on the basis of changed phenotypic appearance in plant forms viz. height, growth, maturity period, leaf size and colour, seed size and colour, etc. compared to respective controls.

Results and Discussion

A number of viable morphological mutants for various plant were isolated from the treated populations of the three lentil varieties in M_2 , several of which are useful from the breeder's point of view. The phenotypes of these mutants are briefly described as follows.

1. Mutants for plant height

- (a) **Stunted:** Several miniature plants with height ranging from 5.0 cm to 14.0cm were grouped under this category. Height in these mutants was reduced due to condensation of internode length. These mutants were compact with

normal green coloured stem and leaves but early maturing. Number of branches and pods per plant, leaflet size, biological and grain yields and seed size and weight were considerably low while harvest index increased slightly compared to control.

- (b) **Dwarf:** Reduced height mutants with a final height of about 18.0 cm. These mutants were early maturing but number of pods per plant, seed weight, biological and grain yields and harvest index were less than the control though the number of branches per plant were comparable to the control.
- (c) **Semi-dwarf:** These mutants measured upto a height of 22.0 cm at maturity. The mutants have normal appearance but showed reduction in leaflet size, number of branches and pods per plant, biological yield, total grain yield, harvest index and 100-seed weight compared to respective controls. However, the semi-dwarf mutant plants matured earlier than control.
- (d) **Tall:** Mutants were 10.0 to 15.0 cm taller and 13 to 15 days late maturing compared to the control. Number of pods per plant, grain yield and harvest index were comparatively less in the mutants over the control.

2. Mutants for abnormal flower development and sterility

- (a) **Partial sterile:** Plants have normal appearance and normal flowering. However, in considerable number of flowers (upto 50%) no pod formation occurred and these flowers upon examination were found to be pollen sterile. Because of this, in general, there was one pod per bunch, while control bears 2-3 pods per bunch. Due to reduced pods number, biological and grain yields per plant and harvest index were also reduced over the control.
- (b) **Complete sterile:** The plant developed very small flowers that were completely sterile due to under development of gynoecium and androecium. No seed set was observed.
- (c) **Flowerless:** There was no flowering in these mutants and these remained vegetative throughout.

3. Mutants for leaflet size

- (a) **Narrow leaved:** In these mutants, leaflet length was normal or slightly reduced but the width reduced considerably. This narrow leaved character is associated with reductions in plant height, number of branches and pods per plant, biological and grain yields though seed set

percent (number of pods per bunch) and seed weight and harvest index were comparable to control. The colour of plant was also slightly yellowish green compared to dark green of control and the mutant matured 10-15 days earlier than control.

- (b) **Broad leaved:** There is considerable increase in the width of the leaflets of these mutants compared to that of control but no change in leaflet length. The increase in leaflet size is also associated with increase in other characters like plant height, number of branches and pods per plant, days to maturity, biological and grain yields and harvest index over their respective controls.

4. Mutants for altered maturity period

Mutants for alteration in the maturity period both in positive as well as negative side were recorded in the treated populations in M_2 .

- (a) **Early maturing:** Mutants matured 15 days earlier than control and were dwarf or semi-dwarf in stature. There were no changes in the number of branches per plant, leaflet size, seed setting and 100-seed weight in the mutants compared to controls. However, pods per plant, biological and grain yields and harvest index were considerably reduced than control.
- (b) **Late maturing:** These mutants came to maturity 15-18 days later than control. The late maturity of these mutants was also associated with tall stature (7-10 cm taller than control). Further, the number of branches per plant also showed a slight increase over control. Though leaflet size and seed size and weight were normal, number of pods per plant, biological yield, total grain yield and harvest index were comparatively lower than control.

5. Other morphological mutants

- (a) **Large poded:** Mutant plants with considerably bigger pods than control and associated with increase in leaf size, biological yield, total grain weight, harvest index and 100 seed weight.
- (b) **Spreading type:** This is a mutant for plant habit with wide angled branches and also with more branches emerging from the base of the plant compared to the compact and narrow angled branches of the control. The numbers of branches are also more in the mutant compared to control. Further, number of pods per plant, biological yield and total grain yield are increased over those of control. In other characters, there was no change between mutant and control.

- (c) **Persistence of green colour in leaves and stem even at maturity:** The leaves and stem normally turn from green to yellow and then to light yellow as they advance to maturity. However, in this particular mutant, the green colour in leaves and stem persisted even after the plant attained maturity. But for this change, there was no alteration in the mutant compared to control.

Frequency and Spectrum of Morphological Mutations

Morphological mutation frequencies were determined both in term of percent M_2 (M_1 plant) progenies and mutants per thousand M_2 plants. The data reveal that the mutation frequency (both in terms of M_1 plant progenies and M_2 plants) recorded an increase with increase in radiation dose. The frequencies were comparatively high in cv. P-38 and low in the other two varieties. Maximum numbers of morphological mutations were recorded at 300 Gy in all the three varieties and it was highest (25%) in P-38 and lower (9.59%) in P-577. Overall 9.94% of M_2 progenies in P-38 showed segregation for morphological mutations, while the corresponding value in the other two varieties was around 5.0% (Table1). The frequency of induced morphological mutations per 1000 M_2 plants in different varieties ranged from a maximum of 26.76 at 300 Gy in P-38 to a minimum of 0.89 at 100 Gy in P-577. The overall mutant frequency was high in P-38 (9.22 per 1000 M_2 plants) and low in P-577 (Table 1).

A wide spectrum of morphological mutations including stunted, dwarf, semi-dwarf, tall, spreading, narrow and broad leaved, partial and complete sterile, flowerless, large poded, early and late maturing and persistence of green colour at maturity were recorded in M_2 (Table 2). In cv. P-38, mutants with spreading habit and stunted types were more frequent while late maturing and complete sterile were less frequent. On the other hand, plants with spreading habit and persistence of green colour at maturity were more frequent in P-577 and LL-19 while dwarf, semi-dwarf and broad leaved types in P-577 and stunted, dwarf and flowerless in LL-19 were less frequent. Though certain types of mutants (for e.g. spreading types, stunted, etc.) were recorded in all

the three varieties, some mutants were observed in only one or other variety. For instance, broad leaved mutants were absent in P-38, large poded types were absent in both P-577 and LL-19 (Table 2). The spectrum of mutants induced at 300 Gy was broad compared to the other doses. Similarly, the spectrum of mutants isolated in P-38 was wide compared to the other two varieties.

The phenotyping of the isolated mutants in M_2 generation led to the classification of these mutants into different categories like plant habit, shape, plant height, and days to flowering, branching, plant colour, leaf, flower and others. These mutants were grouped into 14 different types. The spectrum of mutations induced was broad at 300 Gy compared to other dose levels. Similarly, the frequency of various types of mutations induced was also high in M_2 populations that received 300 Gy gamma dose. Varietal differences were noticed in respect of frequency and spectrum of morphological mutations induced with P-38 exhibiting higher number and types of mutations compared to the other two varieties. Although, economic values of most of the mutants in different morphological categories can not be established but some mutants can be used as source of many beneficial genes in cross breeding programmes or for the improvement of some quantitative traits (11), may be useful in mapping genes (4) and in determining the evolution of crops (20). The pleiotropic effects of mutated genes or chromosomal aberrations or gene mutations were considered as the root cause for the development of such morphological

mutants (24, 5). Each category of mutants showed different frequency of occurrence not only in three cultivars of lentil but also within the cultivar in different mutagenic dose signifying the concentration dependency of the cultivars for induction of macro-mutations. (23) reported that a wide spectrum of viable mutants can be expected due to the mutability of each gene of agronomic interest in mutation experiments. The genes responsible for the altered plant size and growth habit were reported to be monogenic recessive (10, 16, 15 17, 19). The mutant types which appeared more frequent in the treated population indicate the higher sensitivity of genes responsible for these traits toward the mutagen. Workers studied on the induced morphological mutants in different crops plants have attributed the altered phenotypes to the chromosomal breakage, disturbed auxin synthesis, disruption of mineral metabolism and accumulation of free amino acids (16, 6, 7, 21). Differential effect of radiation on the spectrum of morphological mutants induced has also been reported by some previous workers in lentil and other crops (9, 16, 2, 22, 1, 13). Evidences are also available on the effect of genetic differences (even as small as single gene difference) on not only the total mutation rate but also on the spectrum of mutations (14, 12, 18, 9). The morphological mutants identify in the present study may not be economically feasible to commercialize directly due to presence of some undesirable traits but in context of plant breeders, these can be further exploited as source of many elite genes or as a parent in hybridization programmes.

Table 1. Morphological mutation frequency in M_2

Variety	Dose (in Gy)	Total M_2 (M_1 plant) progenies studies	M_2 progenies showing segregation		Total M_2 plant screened	Mutants	
			No.	%		No.	Per thousand
P-38	Control	15	-	-	315	-	-
	100	91	5	5.49	4021	14	3.49
	200	48	4	8.33	1913	19	9.95
	300	32	8	25.00	1237	33	26.76
	Total	171	17	9.94	7171	66	9.22
P-577	Control	16	-	-	335	-	-
	100	125	3	2.40	5618	5	0.89
	200	98	5	5.10	3899	15	3.85
	300	73	7	9.59	2751	23	8.39

	Total	296	15	5.07	12263	43	3.51
LL-19	Control	15	-	-	307	-	-
	100	141	3	2.13	6327	10	1.58
	200	112	5	4.46	4459	16	3.59
	300	88	9	10.23	3346	34	10.16

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INDUCED MUTATIONS IN LENTIL (*Lens culinaris* Medik.)

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Abstract

Seeds of three lentil varieties were radiated with gamma radiation to determine the mutagen sensitivity. The increasing doses of gamma-rays decreased germination, root and shoot lengths, seedling fresh weight, pollen sterility and survival of plants. LD₅₀ values determined for various seedling parameters. Chromatin volume and nuclear DNA amounts estimated revealed significant intervarietal variation with P-38 having highest values for both parameters. A correlation of radiation injuries with chromatin content and DNA amount was worked out and found to be positive. The frequency of chlorophyll mutation indicated a dose dependent increase in P-38 and P-577 with maximum mutations occurring at 300 Gy dose while in LL-19 chlorophyll mutations were more frequent at lower doses thereby suggesting differentials response of the three lentil varieties to gamma radiations. The spectrum of chlorophyll mutations induced include chlorina, xantha, virescent, xantho-viridis and redina types. The effectiveness and efficiency of gamma rays was higher at low dose levels and gradually decreased with increase in the dose of gamma rays

Keywords: Differential, Radiosensitivity, LD₅₀, Microsperma, Chromatin Content, Nuclear DNA Content, Mutation

Introduction

The area under pulses including lentil has been shrinking at a fast rate because of increasing demand for staple grain like rice and wheat. The only option left to improve production is to increase per-hectare productivity of the cultivars. The cultivars grown in the Indian Sub-continent are microsperma type, low yielding and with almost no recognizable variability among them. Exotic bold-seeded types are poorly adapted to the prevailing climatic conditions. To increase productivity of lentil, it is, therefore necessary to create variability and select desirable types with stable yield. Hybridization in lentil (*Lens culinaris*) is cumbersome as flowers are very small, fragile and cleistogamous. Therefore, induced mutations is a worthwhile approach to increase genetic variability for quantitative characters in this crop. Many physical and chemical mutagens have been used for induction of useful mutants in a number of crops but limited reports are available on crops such as lentil. Induction of chlorophyll mutation, in general is considered as a measure to assess the effectiveness of various mutagens. The present study has been taken up to analyze the effect of gamma radiation on different parameters, relationship of radiosensitivity with chromatin and nuclear DNA contents in M₁ generation, frequency and spectrum of chlorophyll mutations, effectiveness and efficiency in M₂ generation in lentil.

Materials and Methods

Seeds of three microspermavarieties viz. P-38, P-577 and LL-19 were subjected to irradiation at 100 Gy, 200 Gy and 300 Gy of gamma rays from a ^{60}Co source located at the Division of Genetics, IARI, New Delhi. For each treatment (dose) 200 seeds of each variety were used. Treated seed along with control were sown immediately after irradiation in the experimental field to raise M_1 generation. Comparable controls were maintained through out the experiment. Data on various seedling parameters like germination and survival (from field experiment), shoot length, root length and seedling fresh weight (from laboratory experiment) were collected in M_1 generation. Pollen sterility was determined by staining the pollen grain from fully developed anther before dehiscence. Based on these observation, lethality, dose effect, percent reduction in various seedling parameters were worked out. LD_{50} values were determined. Seeds from each M_1 plant were harvested individually. M_1 generation was raised following M_1 plant to row method. Twenty seeds from each M_1 plant were sown in a single row. Various types of chlorophyll mutations were recorded in the M_2 generation and they were classified following (10). Chlorophyll mutation frequencies were estimated on M_1 plant progeny as well as M_2 seedling basis, whereas mutagenic effectiveness was calculated as the ratio of mutated families or mutant seedlings in M_2 to the amount (dose) of radiation applied, while the efficiency was determined as the ratio of mutated families to M_1 seedling lethality or pollen sterility in M_1 following (15).

Prior to irradiation somatic karyotypic analysis and nuclear DNA estimations were carried out on all varietal controls. For karyotypes, root tips were pre-treated with PDB for 3h and fixed in freshly prepared aceto-alcohol (1:3) for 24h and slides were prepared in 2% aceto-carmin. Chromosome measurements were made with the help of Olympus micrometer. Chromatin volume was calculated by the formula $\pi r^2 L$, where L is the length of chromosome and r is the radius of a chromatid at metaphase. For nuclear DNA estimation, root tips were fixed in ice cooled 4% neutral formaldehyde for 2h and again fixed in Carnoy's fixative (6:3:1) for 24h, hydrolyzed in 5N

HCL for 1h and stained in Feulgen solution (pH 2.2) for 1h. The stained root tips were washed in SO_2 water for 10 min. and squashed in a drop of glycerol. Photometric measurements were made using Vicker's M-85 Scanning Microdensitometer. All arbitrary relative absorption units were converted into absolute amounts using *Allium cepa* standard ($2C = 33.50 \text{ pg}$) (35).

Results and Discussion

Germination, root and shoot length, seedling fresh weight, plant survival and pollen sterility decreased progressively with increasing doses of gamma rays in all the 3 lentil varieties. The treatments at 300Gy was particularly severe resulting in drastic reduction in seedling germination and growth. The trend, in general, was similar in all the three varieties studied. LD_{50} values for shoot length and seedling growth are more radiosensitive compared to the other parameters. The results suggested differential radiosensitivity of the three varieties tested with cv. P-38 being more radiosensitive than the other two varieties (Table 1).

A dose dependent decrease in germination, root and shoot lengths, seedling fresh weight and plant survival in gamma irradiated population observed may be due to the disturbance caused by radiation at physiochemical levels of cells or acute chromosomal damage or due to combined effect of both (27,36,14). The retardation of growth may also be either due to mitotic delay or mitotic arrest caused by irradiation (6,27). Sparrow et al. (1952) hold the view that mitotic inhibition may be related to physiological disturbances caused due to chromosome breakage in nucleus. (6) attributed genetic loss arising due to chromosomal aberrations for radiation induced growth inhibition. Shoot growth was reported to be mainly dependent on cell elongation while root growth on cell division (13). In the present study, it appears that cell elongation was more affected than cell division, thus leading to more reduction in shoot lengths compared to root lengths. The varietal differences in mutagenic sensitivity were also reported in several crops including lentil (22,21,33,16,4,8,18).

The total chromatin length of haploid complements ranged from 46.26 μ in var. P-38 to as low as 30.90 μ in var. P-577, while the total chromatin volume ranged from 46.05 μ^3 (P-38) to 23.93 μ^3 (LL-19). The nuclear DNA content per cell was higher in P-38 with a 2C value of 9.99 pg, while it was low in LL-19 (2C=8.76pg). The correlation analysis revealed a highly positive relationship of radiosensitivity with both nuclear DNA as well as chromatin contents. Thus the seeds of var. (P-38) (which has highest values for 2C DNA as well as chromatin volume) were more radiosensitive while the seeds of LL-19 were comparatively less sensitive (Table 2).

Radiosensitivity in higher plants is known to be controlled by a number of related nuclear factors like nuclear volume, chromatin volume and chromosome size (30). Differential radiosensitivity observed among the varieties of lentil tested may be due to differences in their genetic makeup. Such varietal differences in radiosensitivity has also been reported in pea (2) and lentil (27). It has been reported that sensitivity to radiation injury was positively correlated with nuclear or chromosome volumes (31). (3), on the other hand, pointed that radiosensitivity is controlled by DNA content along with other factors like chromosome morphology, chromosome number and naturally occurring chemicals. A relationship between frequency of chromosome aberrations per roentgen and nuclear volume or chromosome size had also been reported by some other workers (29,28). The results of the presents study support the hypothesis that radiosensitivity in higher plant is directly related to the amounts of nuclear DNA and chromatin per cell.

Considerable number of M_1 plant progenies in all the three varieties showed segregation for chlorophyll mutation though the frequency was high in P-38 and low in LL-19. The frequency of segregating M_1 plant progenies increased with increase in radiation dose in cultivars P-38 and P-577. However, in LL-19 the reverse trend was noticed. The same hold good for the number of chlorophyll mutant seedling also. In P-38 the number of M_1 plant progenies showing segregation for chlorophyll mutations increased from 6.59 percent (at 100 Gy) to 15.63 (at 300 Gy) while corresponding figures in P-577 were 5.60 percent

(at 100 Gy) to 13.70 percent (at 300 Gy). In cv. LL-19 however, the chlorophyll mutation frequencies, particularly at higher doses, were comparatively low. The total number of M_1 plant progenies showing chlorophyll mutation in M_2 of LL-19 were 6.38%, 3.57% and 5.68% at 100 Gy, 200 Gy and 300 Gy dose levels, respectively. The frequency of chlorophyll mutants (on M_2 seedling basis) was high in P-38 (0.75%) and low in LL-19 (0.50%). An increase in chlorophyll mutation frequency was observed in varieties P-38 and P-577 with increase in the dose of gamma rays. In var. LL-19, however, chlorophyll mutations were more frequent at lower dose (100 Gy) than at higher dose (300 Gy) (Table 3).

Chlorophyll mutations have been used as an index in evaluating the mutagenic action of different treatments in several pulse crops (12,17,39). The chlorophyll deficient chimeras are considered as an indicator for higher frequency of viable mutations in M_2 and subsequent generations (26). The frequency of chlorophyll mutations induced in M_2 was highest in cv. P-38 and lowest in cv. LL-19 suggesting varietal differences which may be attributed either due to genetic differences or to differences in mutagenic sensitivity among the three lentil varieties (1,37)

A wide spectrum of chlorophyll mutations were recorded including xantha, chlorina, virescent, xantho-viridis and redina. Redina types were mainly confined to lower doses of radiation treatments. The chlorina type mutation was most frequent in all the three varieties and the redina type was least frequent. Xantha and chlorina mutation frequencies recorded an increase with increase in the dose of gamma rays in varieties P-38 and P-577, but in cv. LL-19 there was a decrease in mutant frequency at higher dose (Table 3). The frequency of virescent mutant, although showed a positive dose dependent increase in the two varieties P-38 and P-577, it remain constant in all the treatments of the third variety LL-19. Xantho-viridis types was recorded in all treatments of cv. LL-19, at 100 Gy and 300 Gy treatments in P-38 while in P-577 only at 300 Gy treatment. Based on their frequency in three varieties, the order of chlorophyll mutations is as follows.

Chlorina>Xantha>Virescent>other types
(Table 3)

There are difference in the general order of relative frequency of different chlorophyll mutation types recovered with different treatments by various workers. (22) working with X-rays and N-nitroso-N-methyl urea (NMU) reported the order as xantha>viridis> chlorina> albina. (5) recorded them in order of xantha> tigrina> viridis> striata> albo-xantha> virido-xantha in gamma rays and NMU treated populations while (34) observed them in order of chlorina > xantha> albina> virescence> xantho-chlorina. No mutagen was found to be specific for induction of particular type of chlorophyll mutations (20).

The mutagenic effectiveness of gamma rays was high at lower dose (100 Gy). However, in cv. P-577, the effectiveness of gamma rays (calculated on the basis of M_2 seedlings), was observed to increase with increase in radiation dose (Table 4). 100 Gy gamma rays treatment, was highly effective in all 3 lentil varieties whereas 200 Gy and 300 Gy treatments were moderately effective in P-38 and P-577 only and least effective in LL-19 (Table 5). Mutagenic efficiency at that low dose of gamma rays was highly efficient compared to higher doses. However, the efficiency values determined as the ratio of percent mutated families to sterility deviate from the above general trend particularly in cvs. P-38 and P-577 with 200 Gy dose in both cases being highly efficient compared to 100 Gy and 300 Gy gamma rays dose in LL-19 was highly efficient (0.66) and 200 Gy dose in the same variety was least efficient (0.12) (Table 4).

Since chlorophyll mutations are most conspicuous and easily detectable they have been

extensively utilized to find out the sensitivity of a crop plant to mutagens and also the relative effectiveness and efficiency of different mutagenic treatments (11,9). In the present study, in general, it was observed that mutagenic effectiveness (based on M_1 plant progenies and M_2 plants) was higher at low dose levels and gradually positively dose dependent. Mutagenic efficiency based on Mf/S (mutated families/sterility) and Mf/L (mutated families/lethality) of gamma rays was also higher at low doses. Similar results were earlier recorded by many workers (19,32,34). The decrease in effectiveness and efficiency at higher dose levels of radiations may be due to failure in proportionate increase in mutation frequency with increasing dose and/or due to biological damage (sterility and lethality) occurring at a faster rate than the frequency of mutations (15), while the increase in the mutagenic effectiveness with increased dose of gamma rays observed in LL-19 indicated that the mutation rate per unit dose of radiation has not reached the saturation point (24). The observed increase in the mutagenic efficiency (Mf/S) at higher doses of gamma rays in some cases suggest that the induced pollen sterility was of a lower magnitude than the response for mutation induction by the mutagen. Mutagens induce differential genetic and cytogenetic changes (7). Therefore, the mutagenic effectiveness and efficiency will also depend upon the nature of induced mutations and chromosomal aberrations. The magnitude of effectiveness and efficiency also depends on the method of computing the rate of mutation (M_1 plant progenies or M_2 Mutants) (25). Effectiveness and efficiency of gamma rays were found to vary with varieties/variatal group used (23).

Table 1. Effect of radiations on seedling parameters, plant survival and pollen sterility in M₁.

S. No	Variety	Treatment	Germination				Shoot length			Root length			Seedling fresh weight			Plant survival at maturity %	Pollen sterility %
			No. *	% contr ol	% reduc tion	LD50	(cm.)	% reduc tion	LD50	(cm.)	% reduc tion	LD50	(mg.)	% reduc tion	LD50		
1.	P-38	Control	112	100.00	0.00	202.15	6.61	0.00	138.67	2.44	0.00	243.68	55.20	0.00	126.47	100.00	4.34
		100 Gy	93	83.04	16.96		3.82	42.21		2.01	17.62		29.30	46.92		97.78	18.07
		200 Gy	51	45.54	54.46		2.41	63.54		1.35	44.67		22.78	58.73		95.83	25.04
		300 Gys	34	30.36	69.64		1.57	76.27		1.01	58.60		15.61	71.72		90.63	41.04
2.	P-577	Control	150	100.00	0.00	288.19	6.71	0.00	182.69	2.60	0.00	259.80	54.10	0.00	156.75	100.00	5.15
		100 Gy	128	85.36	14.64		4.12	38.59		2.15	17.31		29.13	46.16		96.67	14.41
		200 Gy	104	69.33	30.67		3.28	51.12		1.52	41.54		26.40	51.20		93.88	20.27
		300 Gy	77	51.33	48.67		2.15	67.96		1.15	55.77		16.48	69.53		93.15	35.99
3.	LL-19	Control	164	100.00	0.00	219.09	6.83	0.00	210.86	2.77	0.00	267.37	62.44	0.00	183.00	100.00	3.93
		100 Gy	143	87.20	12.80		4.48	34.41		2.30	16.97		35.69	42.84		97.16	9.60
		200 Gy	114	69.51	30.49		3.54	48.17		1.62	40.43		32.34	48.21		96.43	19.91
		300 Gy	94	57.32	42.68		2.54	62.81		1.27	54.15		21.77	65.14		95.45	33.82

Table 2. Chromatin and nuclear DNA content and their relationship with radiosensitivity

S. No.	Variety	Chromatin length (μ)	Chromatin volume(μ^3)	2C DNA (pg)	M1 seedling injury	Dose (Gy)	'r' value with	
							Nuclear DNA	Chromatin volume
1.	P-38	46.26	46.05	9.99	Reduction in germination	100	0.925	0.903
						200	0.778	0.999
						300	0.830	0.987
2.	P-577	30.90	25.34	9.69	Reduction in shoot length	100	0.991	0.877
						200	0.799	0.991
						300	0.903	0.943
3.	LL-19	40.19	23.95	8.76	Reduction in root length	100	0.959	0.884
						200	0.885	0.884
						300	0.944	0.961

Table 3. Chlorophyll mutation frequency in M₂

Variety	Dose (in Gy)	Total M ₁ plant progenies studies	M ₁ plant progenies (M ₂ rows) showing segregation		Total M ₂ seedling screened	Mutants		Spectrum of different mutants (per cent M ₂ seedling)				
			No.	%		No.	%	Xantha	Chlorina	Virescent	Xantho-viridis	Redina
P-38	Control	15	Nil	-	318	Nil	-	0.09	0.22	0.08	0.05	0.05
	100	91	6	6.59	4021	20	0.50	0.26	0.42	0.16	-	-
	200	48	5	10.42	1913	16	0.84	0.40	0.73	0.24	0.08	-
	300	32	5	15.63	1237	18	1.46	0.19	0.36	0.13	0.04	0.03
	Total	171*	16	9.36	7171*	54	0.75	0.07	0.13	0.15	-	-
P-577	Control	16	Nil	-	338	-	-	0.13	0.28	0.08	-	0.13
	100	125	7	5.60	5623	14	0.25	0.25	0.44	0.18	0.15	-
	200	98	9	9.18	3898	24	0.62	0.13	0.24	0.09	0.03	0.04
	300	73	10	13.70	2759	28	1.02	0.14	0.24	0.09	0.06	0.05
o	Total	296*	26	8.78	12280*	66	0.54	0.09	0.18	0.08	0.05	-
LL-19	Control	15	Nil	-	307	Nil	-	0.12	0.21	0.09	0.06	-
	100	141	9	6.38	6329	37	0.58	0.12	0.21	0.09	0.06	0.02
	200	112	4	3.57	4461	17	0.38	0.09	0.22	0.08	0.05	0.05
	300	88	5	5.68	3351	16	0.48	0.26	0.42	0.16	-	-
	Total	341*	18	5.28	14141*	70	0.50	0.40	0.73	0.24	0.08	-

Included only treated ones.

Table 4. Effectiveness and efficiency in three varieties of lentil cultivars.

Variety	Dose (in Gy)	Mutagenic effectiveness		Mutagenic efficiency	
		%MF	%M ₂ seedlings	% MF	%MF
		RD	RD	S	L
P-38	100	0.0659	0.0050	0.36	0.39
	200	0.0521	0.0042	0.42	0.19
	300	0.0521	0.0049	0.38	0.22
P-577	100	0.0560	0.0025	0.39	0.38
	200	0.0459	0.0031	0.45	0.30
	300	0.0457	0.0034	0.38	0.28
LL-19	100	0.0638	0.0058	0.66	0.50
	200	0.0179	0.0019	0.18	0.12
	300	0.0189	0.0016	0.17	0.13

% MF= Per cent mutated families (Data given in Table 3)

S = Per cent pollen sterility (Data are given in Table 1)

L = Per cent lethality (Data are given in Table 1)

D = Dose of gamma rays

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STUDY THE EFFECT OF NITROGEN AND SPACING ON GROWTH PARAMETERS OF MARIGOLD

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Abstract

This study was carried out at the Department of Horticulture, C.C.S. University, Campus, Meerut, (U.P.), during 2017-18 and 2018-19 to examine the effect of nitrogen and spacing on growth parameters of Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. The experiment was laid out in Factorial Randomized Block Design (F.R.B.D.) with three replications. The results revealed that different levels of nitrogen and spacing had a significant effect on the vegetative growth characteristics of the Marigold. Among four different nitrogen levels viz; 0, 150, 200 and 250 kg N/ha; pooled results showed that applying 250 kg nitrogen per hectare had a significant effect on growth attribute parameters such as plant height (87.48 cm), primary branches per plant (17.44), secondary branches per plant (23.86), plant spread (41.78 cm), diameter of main stem (1.57 cm), fresh weight of plant (253.72 g) and dry weight of plant (53.27 g). Similarly, among four different spacing's viz, 30x30 cm, 45x30 cm, 45x45 cm and 60x45 cm, pooled results indicated that the maximum plant height (86.28 cm) was recorded at closer spacing i.e. 30x30 cm and maximum fresh weight (270.80 g) and dry weight (56.80 g) of plant at spacing i.e. 45x45 cm, while maximum primary branches per plant (18.39), secondary branches per plant (25.13), plant spread (42.70 cm) and diameter of main stem (1.63 cm) were observed under wider spacing i.e. 60x45 cm. As for as the interactions of nitrogen levels and spacing are concerned, the maximum plant height (94.06 cm) was recorded under the application of 250 kg N/ha and closer spacing 30x30 cm (N₃S₁). The maximum numbers of primary branches per plant (21.06), secondary branches per plant (27.99), plant spread (48.29 cm) and diameter of main stem (1.76 cm) were recorded under the application of 250 kg N/ha and wider spacing of 60x45 cm (N₃S₄); while the maximum fresh weight of plant (314.33 g) and dry weight of plant (65.73 g) were recorded with the application of 250 kg N/ha and spacing 45x45 cm (N₃S₃).

Keywords: Nitrogen, Spacing, Vegetative Growth, Marigold

Introduction

Marigold (*Tagetes erecta* L.) is one of the famous flowers that belongs to the Asteraceae (compositae) family and is cultivated throughout India all around the year. It is a native of central and South America, particularly Mexico, and spread to other parts of the world during the early 16th century (9). Marigold seeds are easy to grow and they easily bloom everywhere. Marigold, also known as 'Gaiinda,' is among the most well-known flowers in our nation due to its ease of cultivation, adaptability to a wide range of climatic and soil conditions, long flowering period, and attractive coloured flowers with excellent keeping qualities. Flowers have long been used in churches, temples, receptions, farewells, birthday celebrations, wedding ceremonies, and other public and social events. The interest for Marigold blossoms

at the time Dashara, Diwali and Ugadi celebrations is very high. It is grown commercially in West Bengal, Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Tamil Nadu, Uttar Pradesh and Delhi. Marigold is used as a snare harvest to control organic product borers in tomato plants and to suffocate the nematode population in the soil. It's also one of the most popular sources of xanthophylls, which are used as a natural food additive to light up egg yolks and poultry skin (5). Furthermore, its ethanol-based flower extracts are being successfully used to dye fabrics commercially, resulting in a variety of colours on fabrics (20). The principle pigment in the flower is xanthophylls, particularly lutein, which accounts for more than 80-90% and is present in the form of Esters of Palmitic and Myristic acid. Hence, there is great demand for natural colours of marigold in the International market.

At present, India's total area and production of floral crops is 303 thousand hectares, with 2263 thousand MT of loose flowers and 647 thousand MT of cut flowers. (NHB - 2018-19). Nitrogen applied as fertilizer is the main source used to meet the nitrogen (N) requirements of plant growth. (11). When used properly, at the right application rates and at the correct time, N contributes to optimal growth (7). Nitrogen is major constituent of protein, which occurs in the reproductive and vegetative cells of the every plant. Besides, nitrogen is present in many other plant compounds which have great physiological importance in metabolism, such as chlorophyll, nucleotides, phospholipids, alkaloids, enzymes, hormones and vitamins. It also promotes plant vegetative growth, and an insufficient nitrogen dose contributes to low yield and poor quality. Hence, flower yield can be increased to a large extent by improving soil fertility by judicious application of nitrogen.

Spacing plays an important role in healthy vegetative growth and in the production of good quality flower. A wider spacing increases the photosynthetic area and decrease the competition for nutrients, while the reverse is true for closer spacing. Therefore, wider spacing facilitates good vegetative growth but in turn affects flower yield,

while closer spacing increase flower yield, but vegetative growth gets affected. Moreover, the interaction effect of fertilizer nitrogen and spacing may dramatically influence the growth and flowering behavior of Marigold. Hence, considering the above facts, the present research work was carried out to study the effect of nitrogen and spacing on the growth parameters of Marigold (*Tagetes spp.*)

Materials and Methods

The present experiment was carried out at the Horticultural Research Farm, Department of Horticulture, C.C.S. University, Campus, Meerut, (U.P.) India, during winter season of 2017-18 and 2018-19. The soil of experimental field was sandy loam and neutral in reaction (7.2 pH), low in organic carbon (0.40%), medium in available nitrogen (0.054%), phosphorus (0.0078%) and potassium (0.0210%). The experiment was designed as a Factorial Randomized Block Design with three replications. Sixteen treatments comprise four levels of nitrogen i.e. 0 kg/ha (N_0), 150 kg/ha (N_1), 200 kg/ha (N_2) and 250 kg/ha (N_3); four levels of spacing i.e. 30x30 cm (S_1), 45x30 cm (S_2), 45x45 cm (S_3) and 60x45 cm (S_4); and their interactions (N_0S_1), (N_1S_1), (N_2S_1), (N_3S_1), (N_0S_2), (N_1S_2), (N_2S_2), (N_3S_2), (N_0S_3), (N_1S_3), (N_2S_3), (N_3S_3), (N_0S_4), (N_1S_4), (N_2S_4), (N_3S_4) were used for the experimental study. Four weeks old, healthy, and uniform seedlings were transplanted into plots 1.80x 1.80 m in size, at the specified spacing. Nitrogen doses were applied through urea. One half-dose of nitrogen was applied at the time of seedlings transplanting and the remaining half dose was applied in two split doses at 30 and 50 days after transplanting as top dressing. The data related to growth parameters namely, plant height, primary branches per plant, secondary branches per plant, plant spread, diameter of main stem, fresh weight of plant and dry weight of plant were recorded time to time from the randomly selected five tagged plants. The data recorded during the course of investigation were statistically analyzed by using analysis of variance (14)

Results and Discussion

Effect of Nitrogen

The data presented in Table (1) also revealed that the different levels of nitrogen had a significant influence on all of the marigold growth attributes parameters during the both years of the study. The significant maximum plant height (87.48 cm), number of primary branch (17.44), number of secondary branch (23.86), plant spread (41.78 cm), diameter of main stem (1.57 cm), fresh weight of plant (253.72 g) and dry weight of plant (53.27) were found under a higher dose of nitrogen N_3 (250 kg N/ha), followed by N_2 (200 kg N/ha) and N_1 (150 kg N/ha) at the full bloom of observation. This could be due to increased nitrogen levels increasing activities such as cell size, elongation of cells, and photosynthetic activities. (6) observed that higher level of nitrogen (250 kg N/ha) caused a significant influence on increasing most of the growth parameters. The favorable effect of N in promoting plant growth might be due to more metabolic transport, increased photosynthesis and cell multiplication as reported by Tripathi (1999) in marigold. Nitrogen at this level is most likely ideal for plant growth and, as a result, the reproductive phase. These results are in concurrence with the findings of (1) and (16) in marigold. (10) reported that the application of 400 kg N /ha gave the highest plant height, number of primary and secondary branches, number of flowers, single flower weight and flower diameter in marigold.

Effect of Spacing

A Perusal of data presented in Table (1) revealed that various growth parameters were significantly influenced by spacing. The maximum plant height (86.28 cm) was recorded under closer spacing (30x30 cm) and minimum in wider spacing (60x45 cm). Plant height can increase with closer spacing due to intra-plant competition for light, moisture and space, or aeration. The resultant elongation of the main stem or increase in stem length can be due to elongation of cells and an increase in the number of cells as a result of cell division. The current findings are consistent with the findings of (19), (12) in African marigold. When compared to other spacing treatments, wider

spacing (60x45 cm) resulted in the highest number of primary per plant (18.39), secondary branch per plant (25.13), plant spread (42.70 cm), and diameter of main stem (1.63 cm). This could be due to increased availability of plant nutrients, water and better sun light exposure under wider spacing, which encourages more lateral plant growth. The data presented in Table (1) revealed that the highest fresh weight (270.80 g) and dry weight (56.80 g) were recorded under spacing (45x45cm).

Interaction Effect of Nitrogen and Spacing

The data presented in Table (2) also showed that the interaction between nitrogen and spacing levels was found to be significant for most of the vegetative growth characteristics of marigold. Among the treatments, the combination of nitrogen and spacing, i.e. 250 kg N/ha with wider spacing 60x45cm (N_3S_4) gave highest values in growth character such as number of primary branch per plant (57.03) and number of secondary branch per plant (21.06), plant spread (27.99 cm) and diameter of main stem (1.76 cm). The improvement in the number of branches per plant due to nitrogen increased synthesis of amino acid, protein, alkaloids and protoplasm in the plant. The findings of the study were confirmed by (2). The higher spread, diameter of main stem recorded under the above combinations might be attributed to the wider space available for growth and optimum supply of nutrients, especially of nitrogen. Similar results were also obtained by (3) in African marigold. The maximum fresh weight of the plant (314.33 g) and dry weight of the plant (65.73 g) were measured using 250 kg N/ha and 45x45 cm spacing (N_3S_3), followed by 200 kg N/ha and 45x45 cm spacing (N_2S_3). The increase in the dry weight of the plant was due to overall promotion and luxurious vegetative growth. These results are in conformity with the report of (8) in chrysanthemum, (4) in chrysanthemum. Similarly, the maximum plant height (94.06 cm) was recorded under the soil application of 250 kg N/ha with closer spacing of 30x30 cm (N_3S_1), followed by 150 kg N/ha and closer spacing 30x30 cm (N_2S_1).

Table 1: Effect of nitrogen and spacing on growth parameters of Marigold (*Tagetes erecta* L.)

Treatment	Plant height (cm)	Number of Primary branches/plant	Number of Secondary branches/plant	Spread of Plant (cm)	Diameter of main stem (cm)	Fresh weight of plant (g)	Dry weight of plant (g)
Nitrogen (kg/ha)							
0 (N ₀)	68.27	13.24	18.22	31.12	1.33	172.66	37.08
ts17150 (N ₁)	81.84	16.09	22.67	37.54	1.51	229.51	48.74
200 (N ₂)	84.57	16.70	23.21	40.30	1.54	239.64	50.94
250 (N ₃)	87.48	17.44	23.86	41.78	1.57	253.72	53.27
SE (m) +	0.285	0.074	0.065	0.127	0.003	0.667	0.248
CD at 5%	0.834	0.217	0.190	0.373	0.009	1.949	0.727
Spacing (cm)							
30x30 (S ₁)	86.28	14.01	19.34	33.51	1.37	183.93	38.83
45x30 (S ₂)	82.36	14.79	20.41	35.14	1.42	205.86	43.45
45x45 (S ₃)	77.82	16.28	23.08	39.38	1.54	270.80	56.80
60x45 (S ₄)	75.70	18.39	25.13	42.70	1.63	234.94	50.96
SE (m) +	0.285	0.074	0.065	0.127	0.003	0.667	0.248
CD at 5%	0.834	0.217	0.190	0.373	0.009	1.949	0.727

Table 2: Interaction effect of nitrogen and spacing on growth parameters of Marigold (*Tagetes erecta* L.)

Treatment	Plant height (cm)	Number of Primary branches/plant	Number of Secondary branches/plant	Spread of Plant (cm)	Diameter of main stem (cm)	Fresh weight of plant (g)	Dry weight of plant (g)
Interaction (NxS)							
N ₀ S ₁	69.23	12.96	17.90	30.76	1.31	169.19	35.66
N ₁ S ₁	90.03	14.03	19.33	31.90	1.37	182.99	38.76
N ₂ S ₁	91.83	14.33	19.86	34.69	1.39	188.49	39.53
N ₃ S ₁	94.06	14.73	20.30	36.69	1.41	195.06	41.36
N ₀ S ₂	68.33	13.03	17.96	30.93	1.32	170.93	36.99
N ₁ S ₂	85.56	14.86	20.69	32.96	1.43	208.76	43.09
N ₂ S ₂	86.89	15.16	20.99	37.73	1.45	214.10	45.26
N ₃ S ₂	88.66	16.13	21.99	38.96	1.47	229.66	48.46
N ₀ S ₃	67.96	13.26	18.33	30.99	1.34	176.36	37.99
N ₁ S ₃	77.50	16.66	23.86	40.99	1.56	287.63	60.36
N ₂ S ₃	81.30	17.36	24.96	42.40	1.61	304.89	63.13
N ₃ S ₃	84.53	17.86	25.16	43.16	1.66	314.33	65.73
N ₀ S ₄	67.59	13.73	18.70	31.79	1.35	174.16	37.69
N ₁ S ₄	74.26	18.83	26.79	44.33	1.69	238.66	52.76
N ₂ S ₄	78.26	19.96	27.03	46.40	1.73	251.10	55.86
N ₃ S ₄	82.69	21.06	27.99	48.29	1.76	275.83	57.53
SE(m) +	0.571	0.148	0.129	0.255	0.058	1.334	0.497
CDat 5%	1.668	0.435	0.379	0.747	0.017	3.898	1.453

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GENETIC VARIABILITY STUDIES IN FENNEL (*FOENICULUM VULGARE*) IN ARID WESTERN RAJASTHAN

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Abstract

A total of 18 genotypes of fennel were evaluated to assess the extent of genetic variability, heritability and genetic advance. Analysis of variance showed significant differences among the genotypes and significant variability concerning all the characters. Estimates of genotypic and phenotypic variances indicated that, in general phenotypic variances were higher than genotypic variances for all the characters. In addition, high heritability (broad sense) coupled with high genetic advance as a percent of mean was observed in fennel genotypes for dry matter accumulation at maturity, biological yield, harvest index (%), and oil content.

Keywords: Fennel, Genotypes, Genetic Variability, Heritability, Genetic Advance

Introduction

Fennel (*Foeniculum vulgare* Mill.) is a cross-pollinated diploid species with chromosome number $2n=22$ belonging to the family Apiaceae. It is native to Europe and the Mediterranean region (1). Fennel is cultivated throughout the temperate and subtropical regions in the world. In India, it is mainly grown in Gujarat and Rajasthan as a cold-weather crop. In Rajasthan, fennel is mainly cultivated in the Southwestern regions. Among all the seed spices, fennel has potential as a cash crop in the state of Rajasthan.

The development of high-yielding varieties requires knowledge of the existing genetic variability and heritability of characters. Therefore, evaluating the available germplasm is important for gathering information about genetic variability in a particular crop. However, since most yield attributing characters are quantitatively inherited and highly affected by the environment, it is difficult to judge whether the observed variability is heritable. Therefore, besides genetic variability, the estimates of the genotypic and phenotypic coefficient of (GCV and PCV, respectively) variations, genetic advance, and heritability are helpful in understanding the nature of inheritance of different traits. Therefore, the present study was undertaken to estimate the genetic variability, heritability, and genetic advance in fennel in arid western Rajasthan.

Materials and Methods

A total of 18 fennel genotypes were grown in randomized complete block design with three replications during *Rabi* 2016-17 at College of Agriculture, Mandor, Jodhpur. Each genotype was planted in an experimental plot size of (4m×3m) with 45 cm x 30 cm row to plant spacing. The recommended package of practices was adopted to raise a healthy crop. The crop was irrigated at 12-15

days intervals to maintain optimum moisture throughout the experimentation. For observations, 10 competitive plants were marked in each plot. Observations were recorded on 14 different growths, yield, and quality parameters, as mentioned in Table 1. The data obtained on various characters were subjected to statistical analysis as per randomized block design. The mean data were statistically analyzed for analysis of variance (7). To compare the genotypes, GCV, PCV, heritability (h^2), and genetic advance (GA) were calculated for each character by using standard statistical procedures (2).

Results and Discussion

The results revealed that the fennel genotypes differed significantly for all the parameters studied (Table 1). This indicates the presence of an adequate amount of variability, which will be helpful in the selection of suitable genotypes. The highest plant height at maturity was recorded in 'Hisar Swaroop' followed by 'Pant Madhurika' and 'AF-01' while; lowest in 'GF-12'. The variation in plant height was due to the inherent genetic makeup of the genotypes, which in some way influenced by the activity of endogenous growth regulators. These results are in agreement with (8, 11, 4), and (5). The highest values of dry matter accumulation and number of effective branches/plant were recorded in 'RF-143' followed by 'RF-145'. A probable reason for higher dry matter accumulation was the higher number of branches per plant and comparatively longer crop duration, which resulted in accumulation of more photosynthates. These results agree with the findings of (12) and (11).

Genotype 'Co-1' was found earliest in commencement of 50% flowering and maturity, while 'Hisar Swaroop' was observed to take the longest duration. These results are in lines with the earlier findings of (6) and (3). The minimum branches per plant in 'Co-1' might have resulted in a high quantity of florigen synthesis, responsible early commencement of the reproductive phase. The early genotypes can be especially useful for developing short-duration cultivars to fetch the better market price and give better economic returns. The maximum number of umbels per plant and biological yield was recorded in 'RF-157'.

Genotypes 'Rajendra Saurabh' exhibited maximum umbellets per umbel, while the lowest umbellets per umbel were noted in 'RF-125'. Similar results were also reported by (6). The maximum number of seeds per umbel was reported in 'GF-11' followed by 'RF-205' and 'Azad Saunf-1', while minimum in 'RF-143'. The highest values of harvest index and 1000-seed weight were recorded in 'GF-12' followed by 'GF-11'. These findings confirm well with the results of (13). The variation observed in these factors may be due to the genetic makeup of the genotypes. Maximum seed yield was noted in 'RF-205' closely followed by 'RF-157', while 'Pant Madhurika,' 'RF-101' and 'Hisar Swaroop' being at par recorded lowest seed yield. These findings confirm with (6) and (12). Genotype 'RF-205' closely followed by 'AF-02' and 'Co-1' recorded the highest oil content, while 'Pant Madhurika,' 'RF-101' and 'Azad Saunf-1' was observed to be lowest in oil content. The findings are in close conformity with (13) and (10).

The mean performance of the genotypes shows a wide range of variability for all the traits (Table 2). The variation was highest for biological yield (54.3-88.3 q/ha) followed by seed yield (15.8-25.2 q/ha) and the number of seeds per umbel (248-325). This may be due to the existence of diversity in genotypes evaluated. The range and coefficient of variations were high for oil content, dry matter accumulation at maturity, and harvest index. A similar finding was also reported by (4, 10) and (5). For all the characters studied, the PCV was higher than the corresponding GCV (Table 2). However, the differences between PCV and GCV were narrow, which implied their relative resistance to environmental variation. It also indicates that genetic factors have been predominantly responsible for the expression of specific attributes and selection could be made effectively based on phenotypic performance.

In the present investigation, heritability, according to (9), was observed to be high for dry matter accumulation at maturity, oil content, biological yield, and harvest index (Table 2). This is indicative of the fact that these characters are less influenced by the environment and may respond much to selection. High heritability is helpful in identifying appropriate characters for selection and enables the breeder to select superior

genotypes based on phenotypic expression of quantitative characters. A similar finding was also reported by (4, 10) and (5). Genetic advance as percentage of mean ranged between 2.0% for days to maturity to 52.3% for oil content. High magnitude (>40%) of genetic advance (Table 2) was estimated for oil content and dry matter accumulation at maturity, which is in agreement with earlier reports of (4, 10) and (5).

High heritability coupled with high genetic advance for traits like oil content, dry matter

accumulation at maturity, biological yield, and harvest index suggested the preponderance of additive genes. Results indicate that these parameters are very important for selecting a suitable genotype because if the heritability of a character is high, selection for such a character should be fairly easy. This is because there would be a close correspondence between genotypic and phenotypic variation due to a relatively smaller contribution of the environment to the phenotype.

Table 1. Mean performance of fennel genotypes for growth, yield and quality

Genotypes	Plant height at maturity (cm)	Dry matter accumulation (g/plant)	No. of effective branches/plant	Days to 50% flowering	Days to maturity	No. of umbels /plant	No. of umbellets / umbel	No. of seeds/umbel	1000-seed weight (g)	Seed yield(g/plant)	Seed yield(q/ha)	Biological yield (q/ha)	Harvest index (%)	Oil content (%)
RF-101	149	60.5	20.0	96.3	168	21.4	21.9	265	4.27	24.2	16.1	55.2	29.3	1.13
RF-125	135	59.5	24.7	103.3	171	23.1	19.4	298	4.20	28.0	19.0	58.6	32.8	1.15
RF-143	163	105.2	29.3	103.3	175	23.6	21.4	249	4.46	25.8	17.6	87.3	20.1	1.47
RF-145	162	101.5	28.3	99.7	171	22.4	23.9	300	4.30	28.9	19.7	86.8	22.7	1.39
RF-157	160	99.5	27.3	98.7	171	25.1	20.9	294	4.50	33.1	22.2	88.3	25.2	1.92
RF-178	157	97.3	26.7	103.7	172	24.2	24.0	275	4.21	27.9	18.3	80.3	22.9	1.22
RF-205	151	95.8	26.0	99.3	170	24.0	23.0	309	5.10	37.7	25.2	85.6	29.5	2.35
AF-01	169	93.2	25.9	103.3	173	22.1	25.4	270	5.03	29.8	20.1	82.0	24.6	1.56
AF-02	155	83.5	24.1	103.0	170	21.9	24.8	255	4.60	25.8	17.7	72.8	24.4	2.16
GF-02	144	54.7	20.7	99.3	170	19.4	23.0	297	5.13	29.5	19.5	55.8	35.1	1.63
GF-11	145	55.3	20.2	99.0	167	19.3	23.3	325	5.23	31.3	20.9	57.9	36.1	1.47
GF-12	135	50.7	24.3	100.0	170	23.0	24.8	262	5.32	31.5	20.6	54.3	38.1	1.32
Hisar Swaroop	171	101.2	19.1	109.3	178	18.8	22.5	268	4.94	24.5	16.2	83.6	19.5	1.52
ctlparPant Madhurika	170	97.7	21.2	104.7	176	19.0	23.5	269	4.69	23.8	15.8	81.6	19.8	0.94
Azad Saunf-1	157	85.8	22.3	99.3	169	22.0	21.6	301	4.85	30.9	20.4	77.6	26.4	1.13
Co-01	148	58.2	21.4	95.3	163	19.6	24.0	276	5.03	26.5	18.0	56.1	32.2	2.15
Rajendra Saurabh	161	80.2	22.0	104.7	177	21.3	26.2	282	5.21	31.3	20.6	74.3	27.9	1.52
Sirohi Selection	143	55.2	21.4	102.3	172	20.9	23.9	253	5.21	27.2	17.5	55.0	31.8	1.27
SEm±	5.1	2.4	1.0	2.2	2.2	0.9	1.0	8.1	0.12	1.1	0.67	3.36	1.6	0.04
CD (p=0.05)	15	6.8	2.7	6.5	6	2.6	2.8	23	0.33	3.1	1.9	9.7	4.5	0.13

Table 2. Mean, range, coefficients of variation, heritability, expected genetic advance and genetic advance as per cent of mean for various characters of fennel genotypes

Characters	Mean	Range		Coefficients of variation (%)		Heritability (h ₂) (%)	Expected genetic advance	Genetic advance (mean %)
		Min.	Max.	Genotypic	Phenotypic			
Plant height at maturity (cm)	154	135	171	6.390	8.607	55.13	15.09	9.77
Dry matter accumulation (g/plant)	79.7	50.1	105.2	25.30	25.82	96.06	40.73	51.09
No. of effective branches/plant	23.6	19.1	29.3	12.56	14.38	76.24	5.33	22.58
Days to 50% flowering	101.4	96.3	109.3	2.192	3.827	24.70	2.28	2.24
Days to maturity	171	163	178	1.619	2.738	34.99	3.38	1.97
No. of umbels/plant	21.7	18.77	25.13	7.79	10.66	53.43	2.55	11.73
No. of umbellets/umbel	23.2	19.43	26.19	6.062	9.375	41.81	1.87	8.07
No. of seeds/umbel	280.4	248	325	7.096	8.682	66.80	33.50	11.95
1000-seed weight (g)	4.79	4.20	5.32	7.843	8.872	78.16	0.68	14.28
Seed yield (g/plant)	28.7	23.80	37.73	11.82	13.52	76.44	6.12	21.28
Seed yield (q/ha)	19.2	15.8	25.2	11.75	13.21	79.13	413	21.54
Biological yield (q/ha)	71.84	54.3	88.3	18.27	19.98	83.59	2472	34.42
Harvest index (%)	27.69	19.50	38.07	20.04	22.27	81.01	10.29	37.17
Oil content (%)	1.52	0.94	2.35	25.91	26.43	96.10	0.78	52.33

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THE EFFECT OF PINCHING ON GROWTH AND YIELD OF CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM*) CV. SNOWBALL

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Abstract

An experiment was carried out at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut during August – November, 2020. The experimental materials comprised of sixteen treatments were planted in randomized complete block design (RCBD) with three replications to observe the effect of pinching on growth and yield of chrysanthemum (*Chrysanthemum morifolium*) cv. Snowball. Results showed the significant variation among all characteristics. Result also revealed that among the treatments, the highest plant height (54.31 cm) at 120 DAT was observed from T₁ No pinching (control). The highest number of branches per plant (7.81 plant⁻¹) at 90 DAT recorded under T₂ treatment. The highest number of leaves per plant (95.01 plant⁻¹) at 90 DAT showed by treatment T₂, the highest leaf area (58.78 cm²) at 120 DAT showed by treatment T₂, the highest number of flowers per plant (76.48 plant⁻¹) recorded under the treatment T₂. The highest flower yield per plant (272.59g) was obtained under the treatment T₂. The highest flower yield per plot (9.88 kg) was obtained under the treatment T₂. The highest flower yield per hectare (36.58 t ha⁻¹) had been registered with the treatment T₂.

Keywords: Pinching, Growth, Chrysanthemum, Randomized Complete Block Design

Introduction

Chrysanthemum is a leading commercial crop grown for cut and loose flowers and also as a pot plant (14). It is a native of China and belongs to the family Asteraceae. The basic chromosome number of the genus is 9 and a wide range of ploidy levels is found in different cultivars of the species with 2n = 36, 45, 47, 51 and 75. The size of flowers varies from 2.5 to 4 cm and colour is usually in shades of yellow and white with a cream zone at the centre. The chrysanthemum was first introduced into the western world during the 17th Century. In 1753 Karl Linnaeus renowned Swedish botanist, combined the Greek words chrysos, meaning gold with anthemion, meaning flower. Chrysanthemum flower is one of the most versatile flowers and is the second most popular flower, after roses in the world having a various type, size and colour, that is why in more recent times, growers within several countries began to propagate chrysanthemums. Hybridizers in England, France, Japan, and the United States have developed a wide range of floral colours, shapes, and sizes. Today, its colours include various shades of pink, purple, red, yellow, bronze or orange, and white. Chrysanthemum is among the more popular flowers grown in our country for its diversified beauty of colours, shapes, shades and keeping quality.

Pinching is one of the most important operations in chrysanthemum culture. Pinching refers to the removal of the growing tips of the plant to induce the growth of vegetative laterals. It reduces the plant height, promotes axillary branching, delays flowering and helps in breaking resetting. Pinching is performed both in suckers and in cuttings. It is normally done with the thumb and forefinger. Pinching is most essential for small-flowered chrysanthemum. Several research workers have been studied and assessed the effect of pinching in different varieties of chrysanthemum crops (5, 16, 17) and (19). First pinching is done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves. A second pinching may be necessary if the plants make straggly and lean growth. Two types of pinching are performed in chrysanthemum. In soft pinching, the soft tip of the shoot along with 2-3 open leaves is removed while in hard pinching a longer portion up to hard shoot is removed. In the case of standard chrysanthemum, only single bloom on a branch is usually allowed to produce. The pinching is not done if only one central bloom is desired on the main branch. Single pinching is done if two flowers are desired, whereas double pinching is done for four flowers. In spray chrysanthemum numerous small to medium-sized flowers are produced, therefore, two pinching are required to encourage lateral growth. As a general rule rooted cutting are pinched 2 weeks after planting or approximately 100 days before full bloom. The commercial cultivation of chrysanthemum with superiority flowers and higher yield is needed for consumption in local market and to offer livelihood specially to the marginal and small farmers (18). Thus, the pinching can play a vital role in the improvement of flowering and yield of chrysanthemum. So, by applying pinching we can regulate the plant architecture and also improve the quality of flowers (8). Snowball varieties of chrysanthemum have long been grown as cut flower in many parts of the world, while its production as a pot-plant is more recent and demands the development of dwarf species. Limited researches have been done regarding pinching for growth and yield on chrysanthemum crop. Considering the above facts, the present research work was undertaken to assess effect of on the growth and yield in Chrysanthemum (*Chrysanthemum morifolium*)

cv. Snowball. The study will be helpful for commercial cultivation of Chrysanthemum cv. Snowball and their related developments.

Materials and Methods

The present investigation was carried out at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut during August-December, 2020. Modipuram (Meerut) is geographically located between 29° 04'N latitude and 77° 42'E longitude at an altitude of 237 m above the mean sea level. The study area is situated in a sub-tropical and semi-arid climatic zone with hot summer and cold winter. The region experiences a mean maximum temperature of 40 – 45 °C during summer and a mean minimum temperature of 7-8 °C during winter. The frost often occurs in the region from December – February. The monsoon generally arrives in the last week of June and ceases by the end of September. The total rainfall as well as its distribution in this region is highly uneven. About 80-90 per cent of the total rainfall occurs during July – September in this region. The experimental site was sandy loam soil with adequate drainage. The seeds were sown in a well-prepared seedbed in open condition of 2 x 3 m size nursery beds in broad cast method on July 1st 2020. Healthy seedlings with uniform growth having 3-4 leaf, having a size 12 cm height were transplanted at spacing of 45cm×30cm in 1.35×2.10 m plots. After transplanting light irrigation was given in field. The experiment was planned out in randomized complete block design (RCBD) with 16 treatment and three replications.

Sl. No	Notation	Treatment
1.	T ₁	No pinching(control)
2.	T ₂	Pinching at 20 DAT
3.	T ₃	Pinching at 30 DAT
4.	T ₄	No disbudding(control)
5.	T ₅	Complete disbudding
6.	T ₆	Untreated with ethephon (control)
7.	T ₇	250 ppm ethephon
8.	T ₈	500 ppm ethephon
9.	T ₉	Pinching at 20 DAT + Complete disbudding
10.	T ₁₀	Pinching at 30 DAT+ Complete disbudding
11.	T ₁₁	Pinching at 20 DAT+250 ppm ethephon
12.	T ₁₂	Pinching at 30 DAT+250 ppm ethephon

13.	T ₁₃	Pinching at 20 DAT+500 ppm ethephon
14.	T ₁₄	Pinching at 30 DAT + 500 ppm ethephon
15.	T ₁₅	Complete disbudding+250 ppm ethephon
16.	T ₁₆	Complete disbudding+500 ppm ethephon

RESULTS AND DISCUSSION

Plant height (cm)

The plant height was significantly influenced by pinching. Among the treatments, T₁ No pinching (control) gave highest plant height (54.31cm) at 120 days stage. It has been also observed from the study that the treatment T₁ No pinching (control) gave maximum height (13.48cm) at 30 days stage and show the same pattern at 60 and 90 days stage it might be due to no pinching after 20 days of transplanting stimulate the cell elongation and cell multiplication in plant height. These results are in close conformity with the findings of (1, 2), and (3).

Number of branches per plant

umber of branches significantly influence by concentration and pinching. The highest number of branches per plant (7.81plant⁻¹) showed by treatment T₂ presented Table 1. The increase in number of branches per plant might be due to cell elongation and cell multiplication. It has been also observed from the study that the treatment T₂. Similar results were observed by (4) and (5).

Number of leaves per plant

Number of leaves plant⁻¹ significantly influenced by concentration and pinching presented Table-2. The highest number of leaves (84.73plant⁻¹) was recorded with the treatment T₂. The increase in number of branches per plant might be due to cell elongation and cell multiplication. It has been also observed from the study that the treatment T₂. Similar results were observed by (1) and (2).

Leaf area (cm²)

Leaf area significantly influences by concentration and pinching presented Table-3. The highest leaf area(58.78cm²) was recorded with the

treatment T₂. It might be due to that pinching after 20 days of transplanting. The increase in leaf area might be due to cell elongation and cell multiplication. Similar results were observed by (6) and (7).

Average flowers yield plant⁻¹

The flower yield plant⁻¹ was significantly influenced by the application of different pinchingpresented Table-4. Among the treatments applied, the highest flowers yield plant⁻¹ (272.59g) was obtained from the plant treated with T₂. The highest flowers yield per plant might be due to the fact that pinching increased the number of flowers. Pinching enhances induction of flower bud break i.e., differentiation of floral primordial in the apical growing region which leads to the increased production of flower per plant. It might be due to more vegetative growth and a greater number of flowers in this stage that leads to a greater number of flowers per plant. Similar observations have been recorded by (11, 12, 9) and (8).

Average flower yield per plot (kg)

The flower yield per plot was significantly affected by the application of different pinching presented Table-5. Among the treatments T₂ (9.88 kg) The increase in the yield of chrysanthemum might be due to the pinching treated plants at 20 DAT stage enhanced vegetative growth in terms of plant height which might have resulted higher production of flower per plot which directly gave higher yield of flower in chrysanthemum. Similar observations have been recorded by (12, 9, 10), (9)

Average yield (t ha⁻¹)

Flower yield was significantly affected by the application of different pinching presented Table-6. Among the treatments, the maximum flower yield per hectare (36.58t ha⁻¹) had been recorded under the T₂. The increase in flower yield was due to the production of a greater number of flowers per plant and increases the average flower yield per plot. Similar observations have been recorded by (9, 10).

Table 4.1 Effect of pinching and disbudding on plant height (cm) of chrysanthemum crop at different stages

Treatments		Average Plant height (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T ₁	No pinching (control)	13.48	28.68	48.26	54.31
T ₂	Pinching at 20 DAT	11.58	26.18	45.68	52.40
T ₃	Pinching at 30 DAT	11.28	25.81	45.38	51.84
T ₄	No disbudding (control)	13.25	28.36	47.86	53.76
T ₅	Complete disbudding	9.51	25.01	44.51	50.61
T ₆	Untreated with ethephon (control)	12.80	27.76	47.46	53.43
T ₇	250 ppm ethephon	13.68	29.42	48.76	54.81
T ₈	500 ppm ethephon	13.81	29.95	50.26	55.36
T ₉	Pinching at 20 DAT + Complete disbudding	11.02	24.88	44.20	50.36
T ₁₀	Pinching at 30 DAT+ Complete disbudding	8.25	23.25	40.34	45.63
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	11.82	26.37	46.08	52.71
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	12.34	26.91	46.83	52.90
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	12.62	27.33	47.22	53.12
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	12.10	26.68	46.42	52.69
T ₁₅	Complete disbudding+250 ppm ethephon	10.34	25.19	44.78	51.24
T ₁₆	Complete disbudding+500 ppm ethephon	10.81	25.46	45.10	51.52
SEm±		0.44	0.97	1.69	1.97
CD (p=0.05)		1.24	2.77	4.81	5.61

Table2. Effect of pinching and disbudding on number of branches plant⁻¹ of chrysanthemum crop at different stages

Treatments		Average No. of branches plant ⁻¹		
		30 DAT	60 DAT	90 DAT
T ₁	No pinching(control)	1.31	6.74	7.75
T ₂	Pinching at 20 DAT	1.33	6.77	7.81
T ₃	Pinching at 30 DAT	1.28	6.71	7.68
T ₄	No disbudding(control)	1.25	6.68	7.61
T ₅	Complete disbudding	1.13	6.48	7.33
T ₆	Untreated with ethephon (control)	1.22	6.64	7.55
T ₇	250 ppm ethephon	1.35	6.80	7.85
T ₈	500 ppm ethephon	1.38	6.82	7.89
T ₉	Pinching at 20 DAT + Complete disbudding	1.10	6.42	7.25
T ₁₀	Pinching at 30 DAT+ Complete disbudding	0.96	5.52	6.47
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	1.45	6.87	8.02
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	1.42	6.84	7.95
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	1.50	7.02	8.20
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	1.48	6.93	8.10
T ₁₅	Complete disbudding+250 ppm ethephon	1.18	6.61	7.49
T ₁₆	Complete disbudding+500 ppm ethephon	1.16	6.56	7.39
SEm±		0.05	0.24	0.27
CD (p=0.05)		0.13	0.68	0.78

Table 3. Effect of pinching and disbudding on number of leaves plant⁻¹ of chrysanthemum Crop at different stages

Treatments		Average No. of leaves plant ⁻¹			
		30 DAT	60 DAT	90 DAT	120 DAT
T ₁	No pinching(control)	25.16	70.66	94.16	83.54
T ₂	Pinching at 20 DAT	25.51	71.54	95.01	84.73
T ₃	Pinching at 30 DAT	24.90	68.11	93.52	81.42
T ₄	No disbudding(control)	24.71	67.55	92.68	79.51
T ₅	Complete disbudding	23.50	61.58	87.38	74.10
T ₆	Untreated with ethephon (control)	24.43	65.56	91.16	78.41
T ₇	250 ppm ethephon	25.76	72.70	96.41	86.91
T ₈	500 ppm ethephon	26.20	73.32	97.15	87.12
T ₉	Pinching at 20 DAT + Complete disbudding	23.21	60.18	85.10	71.48
T ₁₀	Pinching at 30 DAT+ Complete disbudding	20.40	49.42	58.12	54.20
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	26.84	74.79	100.18	91.45
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	26.51	74.23	98.45	89.62
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	27.54	76.90	105.77	94.65
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	27.28	75.10	103.62	92.60
T ₁₅	Complete disbudding+250 ppm ethephon	24.11	64.31	90.57	76.62
T ₁₆	Complete disbudding+500 ppm ethephon	23.79	62.61	88.21	75.54
SEm±		0.91	2.49	3.39	2.99
CD (p=0.05)		2.59	7.09	9.65	8.52

Table 4. Effect of pinching and disbudding on Leaf area (cm²) of chrysanthemum crop at different stages

Treatments		Average Leaf area (cm ²)			
		30 DAT	60 DAT	90 DAT	120 DAT
T ₁	No pinching(control)	28.62	33.54	43.49	58.48
T ₂	Pinching at 20 DAT	28.80	33.84	43.85	58.78
T ₃	Pinching at 30 DAT	28.26	33.22	43.16	58.27
T ₄	No disbudding(control)	27.90	32.76	42.90	57.90
T ₅	Complete disbudding	26.86	31.48	41.58	56.57
T ₆	Untreated with ethephon (control)	28.62	32.49	42.65	58.72
T ₇	250 ppm ethephon	29.14	34.26	44.25	59.34
T ₈	500 ppm ethephon	29.43	34.63	44.50	59.56
T ₉	Pinching at 20 DAT + Complete disbudding	26.42	31.10	41.35	56.34
T ₁₀	Pinching at 30 DAT+ Complete disbudding	25.02	30.08	40.10	55.17
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	30.18	35.10	45.14	60.25
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	29.78	34.91	44.72	59.74
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	30.86	35.72	45.68	60.79
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	30.51	35.42	45.41	60.53
T ₁₅	Complete disbudding+250 ppm ethephon	27.70	32.30	42.32	57.36
T ₁₆	Complete disbudding+500 ppm ethephon	27.38	31.88	41.80	56.78
SEm±		1.02	1.20	1.56	2.10
CD (p=0.05)		2.91	3.41	4.43	5.96

Table 5. Effect of pinching and disbudding on no. of flowers plant⁻¹ and diameter of flower (mm) of chrysanthemum crop

Treatments		No. of flowers plant ⁻¹	Diameter of flower (mm)
T ₁	No pinching(control)	75.36	96.35
T ₂	Pinching at 20 DAT	76.48	97.41
T ₃	Pinching at 30 DAT	74.81	95.10
T ₄	No disbudding(control)	73.54	94.92

Treatments		No. of flowers plant ⁻¹	Diameter of flower (mm)
T ₅	Complete disbudding	67.46	92.46
T ₆	Untreated with ethephon (control)	72.40	94.51
T ₇	250 ppm ethephon	77.15	98.68
T ₈	500 ppm ethephon	78.92	99.62
T ₉	Pinching at 20 DAT + Complete disbudding	65.38	92.10
T ₁₀	Pinching at 30 DAT+ Complete disbudding	58.14	90.36
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	81.46	102.16
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	80.77	101.04
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	83.64	104.48
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	82.72	103.28
T ₁₅	Complete disbudding+250 ppm ethephon	71.76	93.72
T ₁₆	Complete disbudding+500 ppm ethephon	69.52	93.18
SEm ±		2.72	3.50
CD (p=0.05)		7.73	9.96

Table 6. Effect of pinching and disbudding on flower yield plant⁻¹, flower yield plot⁻¹ (kg) and flower yield (t ha⁻¹) of chrysanthemum crop

Treatments		Flower yield plant ⁻¹ (g)	Flower yield plot ⁻¹ (kg)	Flower yield (t ha ⁻¹)
T ₁	No pinching(control)	261.95	9.66	36.13
T ₂	Pinching at 20 DAT	272.59	9.88	36.58
T ₃	Pinching at 30 DAT	249.32	9.44	35.78
T ₄	No disbudding(control)	236.59	9.26	35.46
T ₅	Complete disbudding	202.38	8.30	33.16
T ₆	Untreated with ethephon (control)	224.52	9.04	34.68
T ₇	250 ppm ethephon	285.48	10.04	37.28
T ₈	500 ppm ethephon	296.25	10.16	37.81
T ₉	Pinching at 20 DAT + Complete disbudding	196.38	8.02	32.35
T ₁₀	Pinching at 30 DAT+ Complete disbudding	130.54	4.68	30.51
T ₁₁	Pinching at 20 DAT+250 ppm ethephon	321.57	10.51	38.74
T ₁₂	Pinching at 30 DAT+250 ppm ethephon	307.51	10.32	38.41
T ₁₃	Pinching at 20 DAT+500 ppm ethephon	352.68	10.94	39.48
T ₁₄	Pinching at 30 DAT + 500 ppm ethephon	335.78	10.75	39.12
T ₁₅	Complete disbudding+250 ppm ethephon	218.59	8.78	34.37
T ₁₆	Complete disbudding+500 ppm ethephon	210.33	8.55	33.48
SEm ±		9.58	0.34	1.30
CD (p=0.05)		27.26	0.95	3.71

Conclusion

The observations recorded from the present investigation revealed that the pinching effect in the growth and yield characters in chrysanthemum flower crop. Timely planting and pinching effect in the plant growth and yield in the field. Pinching carried out in chrysanthemum

improved in plant height (cm), number of branches per plant, number of leaves per plant, leaf area (cm²), average flowers yield plant⁻¹, average flower yield per plot (kg), average yield (t ha⁻¹). Among the all the treatment, pinching the plants showed the highest efficacy and it could be used as treatment in cultivation of *Chrysanthemum morifolium* for growth and yield.

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ROLE AND IMPACT OF NAV RATNA NOMINEES BY OUR PRIME MINISTER MR. NARENDRA MODI IN PROMOTING THE SWACHH BHARAT ABHIYAN

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Abstract

“Swachh Bharat Abhiyan”, is a mission for which the government has promised “total sanitation” by 2019, which means every household in India will have a toilet by the targeted deadline. So it can be affirmatively said that Clean India mission is the need of the hour. Today 60 percent of India’s population practices open defecation which puts them at risk of diseases like cholera, diarrhoea, typhoid etc. India also faces economic loss because of poor hygiene and sanitation in the country. Swachh Bharat’s connection with economic activity of the country advocating the idea of Clean India, Prime Minister Sri Narendra Modi had said that “The pursuit of cleanliness can be an economic activity, contributing to GDP growth, reduction in healthcare costs, and a source of employment.” If India and its tourist destinations are clean, it will bring more people and will also bring about a paradigm shift in the country’s global perception. So, let us make Swachh Bharat Abhiyan a mass movement and save our country from all the dangers.

Keywords : Swachh Bharat Abhiyan, NAN RATNA.

Introduction

Our Prime Minister Sri Narendra Modi invited nine well-known people to join the Swachh Bharat Abhiyan or ‘Clean India’ campaign that he launched on 2nd October, 2014 in the national capital and requested each of them to draw nine more into the initiative to take it viral. Citing Gandhi ji’s principle of ‘Cleanliness next to Godliness’ our PM initiated the nationwide drive and also nominated 9 personalities who would then nominate nine more after completion of their tasks. Very eagerly the nominated personalities jumped into the limelight and were found across India sweeping roads. Call it publicity stunt or even seeking the chanced attention, these personalities made headlines and were covered all across the channels. Goa Governor, Mridula Sinha, Cricket legend, Sachin Tendulkar, Yoga guru, Baba Ramdev, Politician, Shashi Tharoor, Actor, Kamal Hasan, Actor, Priyanka Chopra, Actor, Salman Khan, Industrialist, Anil Ambani, Team of popular TV serial “Tarak Mehta Ka Oolta Chashma”, Akhilesh Yadav, Swami Rambhadracharya, Manoj Tiwari, Mohammad Kaif, Deviprasad Dwivedi, Raju Srivastava, Suresh Raina, Kailash Kher, Sri Amitabh Bachchan, Vidya Balan, Amir Khan, Late Sri Rishi Kapoor, Arjun Rampal, Dino Morea, Kiran Vedi.

Objectives

- To assess the impact of Swachh Bharat Abhiyan on males, females, children and senior citizens.
- Role and impact of Nav Ratan nominees by our Prime Minister Mr. Narendra Modi in promoting the Swachh Bharat Abhiyan.

Methodology

This study was conducted in Kanpur district of Uttar Pradesh. A list of different localities would be obtained from the Zones, for the list 30 localities would be selected randomly. A list of respondent would be prepared from the selected localities. From this list total 400 sample size, 100 male, 100 female, 100 children (age of 5-11 years) and 100 senior citizen selected randomly for the study purpose. Dependent and independent variables were selected in this study such as age, sex, education, caste, religion, occupation, income, family type, sustainable, impact, society, adoption, awareness, sanitation, hygiene, knowledge, practices, disease, cause, Community etc. The statistical tools were used as percentage, rank and correlation coefficient.

Results and Discussion

Table 1. Distribution of respondents according to education

N = 400

Education	Male	Female	Children	Senior citizen	Total
Up to high school	-	-	100 (100.0)	2(2.0)	102 (25.5)
Intermediate	52 (52.0)	6 (6.0)	-	6(6.0)	22 (5.5)
Graduation	52 (52.0)	46 (46.0)	-	60(60.0)	158 (39.5)
Post graduate	12 (12.0)	30 (30.0)	-	25(25.0)	67 (16.7)
Professional	26 (26.0)	18 (18.0)	-	7(7.0)	51 (12.8)
Total	100 (100.0)	100 (100.0)	100 (100.0)	100(100.0)	400 (100.0)

(Figures in parentheses indicate the percentage of respective values)

Education is an important tool to adopt any practices. Education creates awareness among people and motivates to adopt new practices. Educated people understand everything very easily.

Table 2. Distribution of respondents according to impact of Swachh Bharat Abhiyan practices in household level

Household level practices	Male		Female		Children		Senior citizen		Total
	Yes	No	Yes	No	Yes	No	Yes	No	
Cleaning of toilets	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Cleaning of house	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Washing of floor	100.0	-	100.0	-	-	100.0	100.0	-	400 (75.0)
Cleaning of kitchen	100.0	-	100.0	-	50.0	50.0	100.0	-	350 (87.5)
Cleaning of utensils	100.0	-	100.0	-	40.0	60.0	100.0	-	340 (85.0)
Cleaning of clothes	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Cleaning of outdoor	100.0	-	100.0	-	20.0	80.0	100.0	-	320 (80.0)
Purification of water	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Use of energy saving devices	20.0	80.0	-	100.0	-	100.0	-	100.0	20 (5.0)
Drainage of water in household level	100.0	-	100.0	-	100.0	-	50.0	50.0	250 (62.5.0)
Uses of dustbin	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Use of waste water	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)

(Figures in parentheses indicate the percentage of respective values)

A city like Kanpur where dusty winds can carry a lot of dirt inside the house especially in the summers, regular home cleaning is a must. Not only is dust an eye sore but it is also harmful. They carry germs which can cause many health related issues to us and our family members. The dirt, clutter and grime that our houses accumulate can do us more harm than we can imagine. Home cleaning should definitely be on the top but professional house cleaning works wonder to disinfect our home and surroundings.

Table 3 Distribution of respondents according to impact of Swachh Bharat Abhiyan practices in community level

Community level practices	Male		Female		Children		Senior citizen		Total
	Yes	No	Yes	No	Yes	No	Yes	No	
Park cleaning	100.0	-	80.0	20.0	50.0	50.0	100.0	-	330 (82.5)
Uses of dustbin in common places	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Sense of responsibility	80.0	20.0	20.0	80.0	-	100.0	100.0	-	200 (50.0)
Roads cleaning	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Demonstration	100.0	-	25.0	75.0	-	100.0	100.0	-	225 (56.2)
Walk to talk	100.0	-	30.0	70.0	-	100.0	100.0	-	230 (57.5)

The significance of cleanliness and hygiene cannot be overlooked by any society. Every faith and civilization stresses the importance of cleanliness. Historically, cleanliness has been considered one of the important factors by which to judge a civilization's or society's development. Throwing garbage in the streets, roads or parks has become a common practice in our society.

Table 4. Distribution of respondents according to knowledge about the Nav Ratan nominees of Swachh Bharat Abhiyan nominated by Prime-Minister

Name of Nine Ratan	Male		Female		Children		Senior citizen		Total
	Yes	No	Yes	No	Yes	No	Yes	No	
Mridula Sinha	5.0	95.0	2.0	98.0	-	100.0	5.0	95.0	12 (3.0)
Sachin Tendulkar	100.0	-	80.0	20.0	100.0	-	100.0	-	300 (75.0)
Baba Ramdev	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Sashi Tharoor	30.0	70.0	10.0	90.0	-	100.0	10.0	90.0	50 (12.5)
Kamal Hasan	40.0	60.0	20.0	80.0	-	100.0	20.0	80.0	80 (20.0)
Priyanka Chopra	100.0	-	100.0	-	50.0	50.0	50.0	50.0	300 (75.0)
Salman Khan	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Anil Ambani	100.0	-	50.0	50.0	60.0	40.0	60.0	40.0	270 (67.5)
Team of Tarak Mehta Ka Oolta Chasma	100.0	-	70.0	30.0	80.0	20.0	100.0	-	350 (67.5)

(Figures in parentheses indicate the percentage of respective values)

Our Prime Minister Narendra Modi invited nine well-known people to join the Swachh Bharat Abhiyan or 'Clean India' campaign on 2nd October, 2014 that he launched in the national capital Delhi and requested each of them to then nominate nine more after completion of their tasks. Very eagerly the nominated personalities jumped into the limelight and were found across India sweeping roads. Call it publicity stunt or even seeking the chanced attention, these personalities made headlines and were covered all across the channels.

Table 5. Distribution of respondents according to knowledge about the Nine Ratan other than involves celebrities in Swachh Bharat Abhiyan

Other celebrities	Male		Female		Children		Senior citizen		Total
	Yes	No	Yes	No	Yes	No	Yes	No	
Sri Amitabh Bachchan	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Vidya Balan	100.0	-	100.0	-	50.0	50.0	100.0	-	350 (87.5)
Amir Khan	100.0	-	100.0	-	100.0	-	100.0	-	400 (100.0)
Rishi Kapoor	40.0	60.0	10.0	90.0	-	100.0	50.0	50.0	100 (25.0)
Arjun Rampal	50.0	50.0	10.0	90.0	-	100.0	50.0	50.0	100 (25.0)
Dino Morea	40.0	60.0	-	100.0	-	100.0	40.0	60.0	80 (20.0)
Kiran Bedi	45.0	55.0	10.0	90.0	20.0	80.0	55.0	45.0	130 (32.5)

(Figures in parentheses indicate the percentage of respective values)

Mr. Narendra Modi selected some other celebrities other than the nine Navaratans, to promote the Swachh Bharat Abhiyan. He chose them because they are very popular among the huge population in India as well as abroad. These celebrities are primitive the mission through advertisement, campaigns, stage shows, reality, shows etc. Pondicherry Governor, Kiran Bedi as a role model for many, so most of the people follows her principles and do what she says.

Table 6. Distribution of respondents according to knowledge and awareness about field criteria extra celebrity in Swachh Bharat Abhiyan

Name of other celebrity	Field criteria	Male		Female		Children		Senior citizen		Total
		Yes	No	Yes	No	Yes	No	Yes	No	
Amitabh Bachchan	Free advertisement toilets - Dettol	100.0	-	100.0	-	-	100.0	100.0	-	300 (75.0)
Vidya Balan	Advertisement toilet	100.0	-	100.0	-	50.0	50.0	100.0	-	350(87.5)
	Smokeless chulha	100.0	-	100.0	-	60.0	40.0	100.0	-	360 (90.0)
Amir Khan	Campaign	100.0	-	100.0	-	65.0	35.0	100.0	-	365 (91.3)
	Providing the gift									
	Waste management									
Rishi Kapoor	Use of name in toilet brand	55.0	45.0	30.0	70.0	10.0	90.0	95.0	5.0	190 (47.5)
Arjun Rampal	Campaign	40.0	60.0	45.0	55.0	-	100.0	30.0	70.0	115 (28.7)
Dino Morea	Campaign	2.0	98.0	-	100.0	-	100.0	40.0	60.0	42 (10.5)
Kiran Bedi	Campaigning	15.0	85.0	2.0	98.0	3.0	97.0	45.0	55.0	65 (16.2)

(Figures in parentheses indicate the percentage of respective values)

Table shows that how the famous personalities are promoting the Swachh Bharat Abhiyan is doing free or the other Sri Amitabh Bachchan is doing free advertising about use of toilets and stopping the use of open defecation in view of women security and health aspects. He is also promoting the use of Dettol hand wash and sanitizers especially for school going children along with use of kitchen waste for making organic manure. Actress Vidya Balan is focusing on establishing toilets in rural households especially for women and girls and for this reason she was chosen as Brand Ambassador by former chief minister Sri Akhilesh Yadav to promote this campaign. She is also focusing on “Saksharta Abhiyan” i.e. literacy campaigns. Amir Khan, is a famous film actor and his films mostly focus on children, so he is chosen for the intension to create awareness among children and make them knowledgeable about a clean and healthy life. The famous actor Rishi Kapoor as he is so popular among the Mumbai slums. In the same content Arjun Rampal is also actively engaged in campaigning and spreading awareness about the Swachh Bharat Abhiyan along with other celebrities such as Dino Morea. Even Kiran Bedi is contributing her best to promote this mission through campaigning and going public aspects.

Conclusion

This was the dream project of our Prime Minister that as soon as becoming the Prime Minister, what can we give to the country on Gandhi Jayanti on 2nd October. For this, according to Gandhi's ideology, he chose cleanliness and on October 2, 2014, the Swachh Bharat Abhiyan was implemented in the whole country and every citizen of the country participated in it and contributed, especially it had more impact on children. The motive of making Nain Ratan a part of this programme was that the celebrities are of an ideal image, due to which everyone accepts their words and follows them. Therefore, whether the filmmakers, chief ministers or singers of the country, everyone participated enthusiastically in it and also motivated the people.

Recommendations

- A chapter on sanitation practices should be included in school curriculum from the first standard itself. In each school and college, a team of students called the 'Swachhta Senani' may be formed to spread awareness about sanitation and cleanliness.
- A dedicated Mission for the Swachh Bharat Abhiyaan may be set up both at National and

State Level for coordination, guidance, support and monitoring of the programme.

- Waste to Energy plants may be set up on PPP mode and the PPP framework may specify the responsibilities of the local body and PPP partner.

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ROLE OF WOMEN IN SAVING WASTE WATER TECHNIQUES AT DOMESTIC LEVEL

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Abstract

The rapid urbanization in the country, there has been a commensurate increase in the need for and the use of water, one of life's most essential necessities. Almost 80 percent of the water supplied for domestic use, comes out as wastewater. In most of the cases wastewater is let out untreated and it either sinks into the ground as a potential pollutant of ground water or is discharged into the natural drainage system causing pollution in downstream areas. So, there is an urgent need for treating.

Keywords : Role, Saving, Techniques

Introduction

Household water treatment and safe storage ensure drinking water is safe for consumptions. Drinking water quality remains significant problems, not only in developing countries but also in developed countries; even in the European region it is estimated that 120 million people do not have access to safe drinking water. Point of use water quality interventions can reduce diarrheal disease in communities where water quality is poor, or in emergency situations where there is a breakdown in water supply. Since water can become contaminated during storage at home (e.g. by contact with contaminated hands or using dirty storage vessels), safe storage of water in the home is also important.

Objectives

- To study the socio-economic status of women and identify the types of accommodation like apartments, own houses and rented houses.
- To assess the source of waste water such as aqua guard, kitchen, washing machine etc. and ways of recycling adopted.

Methodology

The study was conducted in Kanpur district of Uttar Pradesh. Six localities were selected from 6 zones of Kanpur district. Total 300 women were randomly selected in this study. The dependent and independent variables were used such as age, education, religion, technique, brand, knowledge, recycling etc. The statistical tools were used such as percentage, rank and correlation.

Results and Discussion

Table 1. Distribution of women according to education

N = 300

S. No.	Education	Frequency	Per cent
1	High School	10	3.3
2	Intermediate	37	12.3
3	B.A./ B.Sc.	150	50.0
4	M.A./ M.Sc.	95	31.7
5.	Ph.D.	8	2.7
Total		300	100.00

Education plays important roles in our day to day life. If the people are educated than it leads to the better understanding of the water problem. Because educated or the literate people are more conscious about the conservation of water.

Table 2. Distribution of women according to installation of faucet water tap in their kitchen

S. No.	Water tap	Frequency		Per cent		Mean scores	Rank
		Yes	No	Yes	No		
1.	Faucet water tap	95	205	31.7	68.3	1.32	I
2.	Aerator nozzle tap	25	275	8.3	91.7	1.08	II

A fibre washer is used between the connector and the tap tail. Tap tails are normally $\frac{1}{2}$ " in diameter for sinks and $\frac{3}{4}$ " for baths. The same connection method is used for a ball cock. There are used two types of water taps for saving the water. Most automatic faucets are battery powered and incorporate an active infrared sensor to detect hand motion that shut off automatically after hand washing, thereby reducing water waste. Hands-free faucets also reduce the risk of disease transmission. Automatic faucets are common in public washrooms, particularly in airports and hotels, where they are supposed to reduce water consumption and reduce the transmission of disease causing microbes. The aerator acts as a sieve, separating a single flow of water into many tiny streams which introduces the air in to the water flow. Also as there is less space for the water to flow through, the water flow is reduced, resulting in water savings. As the water pressure is maintained, most people do not notice a difference in the amount of water coming out of an aerated faucet yet benefit from the water

efficiency. Some advantages of fit aerator nozzles tap in tap water such as savings on money and water, no more splashing, less noise and no more dirt and debris.

Table 3 Distribution of women according to installation of alarm for safe water for floor water tank

S. No.	Type of Alarm	Frequency		Per cent		Mean scores	Rank
		Yes	No	Yes	No		
1.	Alarm water	45	255	15.0	85.0	1.15	I
2.	Automatic alarm	15	285	5.0	95.0	1.05	II

The water level alarm circuit is a simple mechanism to detect and indicate the level of water in the overhead tank and also in the other containers. Nowadays, all the householders/ owners are storing the water in overhead tanks by using the pumps. When the water is stored in the tank, no one can identify the level of water and also, no one can know when the water tank will fill. Hence there is an overflow of water in the tank, thus there is wastage of energy and water. To resolve this type of problems by using the water level alarm circuit of a 555 timer it helps and indicated the level of water in the overhead tanks. The water level alarm circuits are used in the factories, chemical plants, and electrical substations and also in other liquid storage systems. In present time alarm is necessary to use in water tanks. The alarm use in water tank they save water, electricity and save ceiling the moisture. A simple water alarm can alert to higher than normal moisture. Most major home improvement stores will carry a wide selection of water alarms. The alarms on the simple passive systems are usually loud enough to be heard even when placed in basements or under cabinets.

Table 4. Distribution of women according to their use of techniques to save rain water

Sl. No.	Rain water storage	Yes	No	Mean Score	Rank
1.	Pond	75 (25.0)	225 (75.0)	1.25	II
2.	Tub	125 (41.7)	175 (58.3)	1.42	I
3.	Pits	60 (20.0)	240 (80.0)	1.20	III

(Figures in parenthesis indicate percentage of respective values)

Water is an important natural resource and is the very basis of our life. We use water for drinking, irrigation, industry, transport and for

the production of hydro-electricity. Water is a cyclic resource which can be used again and again after cleaning. The best way to conserve water is its judicious use. Rain water harvesting is one of the most effective methods of water management and water conservation. It is the term used to indicate the collection and storage of rain water used for human, animals and plant needs. There are many benefits to having a backyard garden pond that extend well beyond creating a natural, relaxing and picturesque landscape. Ponds are also tremendously beneficial to local ecosystem. Pond water contains more nutrients than the water from garden hoses. Generally using big tubs for collection of the rain water for harvesting purpose is common. Rain water harvesting is one of the most effective methods of water management and water conservation. It is the term used to indicate the collection and storage of rain water used for human, animal's plant and kitchen garden needs. This is a very useful method for a developing country like India in reducing the cost and the demand of treated water and also economizing the treatment plants operation, maintenance and distribution costs. Pits are made in ground floor and collecting water in rainy seasons and municipal board. Pits storage water is used for kitchen garden purpose.

Table 5. Distribution of women according to use of kitchen faucet water tap

Sl. No.	Tap	Frequency	Per cent
1.	Normal tap	69	23.0
2.	Faucet water tap	200	66.7
3.	Dishwater	31	10.3
	Total	300	100.0

Tap water is the lowest cost per litre of any drink can buy if they consume between 1.6 and 2 litres per day can meet hydration. Encouraging women to develop new, good habits is the ideal solution, but old habits die hard, so one may have to put in a little help in the form of automatic faucets, sometimes called hands-free or touch fewer faucets. A dishwasher is a mechanical device for cleaning dishware and cutlery. Use of dishwashing liquid and powder that is natural, biodegradable, and free of petroleum and phosphates. Most dishwashers today are powerful enough to get the all the gunk off, so a lot of

pre-rinsing by hand is often just a waste of water and time. Most modern dishwashers have booster heaters to heat the water that comes from home's water tank.

Table 6. Distribution of women according to use of waste water of aqua guard

S.No.	Uses	Frequency	Per cent
1.	Washing cloth	-	-
2.	Washing households utensils	75	25.0
3.	Plants	195	65.0
4.	Drainage	30	10.0
	Total	300	100.0

RO waste water Transferring large quantities of water to the washing machines can be strenuous. Mix waste RO water with tap water and dilute it properly. One can use it to mop floor because plain RO waste water will leave salt particles on the floor. Waste RO water can be used to wash off utensils because salt content in it does not let left food get stick to utensil and using waste RO water for gardening of plants can be ideal; but, it has to be mixed with normal water in equal amount to balance nutrients. Waste RO water can be used for irrigation, which needs to be mixed with normal water to reduce its high TDS level. It is because high TDS puts adverse effects on vegetables and or products to be eaten raw. Waste RO water can be used for brewery purposes at home on balancing TDS content. Waste RO water can also be used in homes to flush toilets. The waste RO water can be used to remove the hard residual water. The waste RO water can be used to clean sewage pipe at home or kitchen because of its saline nature.

Table 7. Distribution of women according to use of waste water from washing machine

S. No.	Uses	Frequency		Per cent		Mean score	Rank
		Yes	No	Yes	No		
1.	Floor cleaning	285	95.0	15	5.0	1.95	I
2.	Wash dustbin	60	20.0	240	80.0	1.20	V
3.	Wash bathroom	240	80.0	60	20.0	1.80	II
4.	Wash kitchen and Washbasin	105	35.0	195	65.0	1.35	IV
5.	Wash roof	210	70.0	90	30.0	1.70	III

Waste water of washing machine can be store and used on the toilet, cleaning of floor, bathroom and wash balcony.

Conclusion

Water is an important requirement in daily life with water used for five basic domestic purposes: namely, drinking and cooking, washing and cleaning, bathing, sacred and therapeutic usage. Securing safe water and reducing the unregulated discharge of wastewater are among the most important factors influencing world health.

Recommendations

- Public awareness campaign must have the priority in the strategic plan for any Waste water treatment plan to achieve the economic benefits from the Waste water treatment plan.
- Proper water conservation measures should be used people should be made aware and trained on the techniques of water conservation.
- Women should be trained as water manager for the better utilization of water.

- Future programmers/projects should be designed, keeping in view the women as water users.
- The school curriculums have to be including wastewater related topics to be learned for the students in all grades

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STOMATAL BEHAVIOUR OF FOUR POTATO CULTIVARS UNDER REPEATED WATER STRESS CONDITIONS

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Abstract

Plant response to water-stress is controlled by plant water status. High stomatal resistance in plants is considered advantageous in water economy and drought resistance. In present study highest increase of stomatal resistance (278% and 256%) was observed in cultivar Desiree when water stress was imposed at tuber initiation stage (T_2) and tuber enlargement stage (T_4). Higher stomatal resistance in Desiree indicated its strategy for water conservation under water stress situations.

Keywords: Stomatal Resistance, Water Stress, Potato

Introduction

Water stress of plants leads to closure of stomates (5), which decreases both transpiration and photosynthesis in potato (3,21). (16) showed that increase in leaf resistance (closure of stomata) and relatively larger increase in the residual (mesophyll) resistance in droughting potato plant were associated with decrease in the rate of photosynthesis. (16) also reported that the rate of photosynthesis of potatoes appeared to be very sensitive to a small increase in leaf and residual resistance in the range of 0 to 5 s cm⁻¹ and 0 to 50 s cm⁻¹ respectively. According to (13) differences in drought tolerance between potato genotypes are partially due to difference in water relations and stomatal behaviour. (12) advocated the relationship between stomatal resistance (RS) and water potential (yw). (7) found values for stomatal resistance of water stressed potato leaves in the range of 4 s.cm⁻¹ whereas for leaves of irrigated plants it was mostly around 2 s cm⁻¹.

(1) observed that total plant resistance was not as good indicator of drought resistance as was stomatal resistance. In potato, correlation existed between diffusive leaf resistance and yield under stress but varied greatly from one season to the next (6). (13) observed no correlation between stomatal conductance and yield as the cultivars with differing values of stomatal conductance produced similar tuber yields under water stress. (2) found that net rates of photosynthesis saturated by irradiance of > 500 $\mu\text{mol m}^{-2}\text{s}^{-1}$ (PAR) were marked by decreased in 35 to 40 day-old water stressed potato. (17) studied photosynthetic efficiency of individual leaves of a potato under field conditions. The 4th leaf, with low stomatal resistance and high net photosynthetic rate was most productive. The high stomatal resistance and low photosynthetic efficiency observed in lower leaves is attributed to ageing. (11) investigated the effect of water stress on rate of photosynthesis. They observed that water stress caused a reduction in the rate of photosynthesis which was more at tuber initiation (40%) than at tuber development stage (30%).

(11), (16) also found decline in photosynthesis associated with decrease in leaf water potential and relative water content (RWC).

Materials and Method

The field experiments were conducted at Research Farm of CPRI Campus, Modipuram, Meerut (U.P.) during rabi season of Ist Year and IInd Year . Forty eight plots were used in a split plot design for accomodating 4 treatments .Field trials were conducted in split plots with three replicates employing the 4 varieties (i.e Kufri Chipsona⁻¹, Kufri Pukhraj, Kufri lauvkar and Desiree) having following treatments:

T₁:Control (well watered plants)

T₂:Water stress at- tuber initiation stage

T₃:Water stress at -tuber enlargement stage

T₄:Water stress at - tuber maturation stage

T₁ control (well watered) plots were irrigated at 6 DAP (days after planting), 27 DAP, 42 DAP, 63 DAP and 80 DAP during the year Ist Year and at 8 DAP, 25 DAP, 44 DAP, 67 DAP and 83 DAP during the year IInd Year . The water stress was imposed by withholding water in T₂, T₃ and T₄ treatments at different growth stages. The growth stage was identified and confirmed by uprooting the plants and by examining the stage of tuber development. Experimental plots were dehaulmed at 90 DAP and harvesting was done 10-15 days after of dehaulming so that tuber skin is matured.

Stomatal resistance is a measure of the resistance to loss of water vapour through the stomata. It is an indicator of the physiological state of the plant. Stomata are sensitive to light, carbon-di-oxide, pollutants, water stress and pathogens. Porometer AP4 (Delta-T, UK) was used to estimate the stomatal resistance during peak stress period in the field.

Results and Discussion

Mean values of treatments showed that stomatal resistance increased with age of crop in well watered control (T₁).Water stress treatment T₂, T₃ and T₄ brought about significant increase in stomatal resistance at various growth stages as compared to control (T₂). Highest stomatal resistance (2.54 and 2.59 s cm⁻¹ during Ist Year and IInd Year respectively) of leaves was recorded when water stress was imposed at tuber maturation stage (T₄) whereas lowest stomatal resistance (0.90 and 0.98 s cm⁻¹ during Ist Year and IInd Year respectively) was recorded when water stress was imposed at tuber initiation stage (T₂).

Maximum percent increase (218% and 212% in respective years) in stomatal resistance in comparison with respective control was recorded when water stress was imposed at tuber enlargement stage (T₃) whereas minimum percent increase (51% and 59% in respective years) was recorded when water stress was imposed at tuber initiation stage (T₂).

The data presented in Table 1 showed that in T₂ (water stress at tuber initiation stage) cultivar Desiree recorded highest stomatal resistance (1.06 and 1.20 s cm⁻¹ during Ist Year and IInd Year respectively) whereas cultivar Kufri Lauvkar recorded lowest stomatal resistance (0.76 and 0.80 s cm⁻¹ during Ist and IInd Year , respectively). Maximum percent increase in stomatal resistance due to water stress at tuber initiation stage (T₂) was found in cultivar Desiree (71% and 88% in respective years) while minimum percent increase in cultivar Kufri Lauvkar (23% and 27% in respective years) in comparison with respective well irrigated control. In T₃ (water stress at tuber enlargement stage) also cultivar Desiree recorded highest stomatal resistance (2.76 and 2.78 s cm⁻¹ during Ist Year and IInd Year respectively) and Kufri Pukhraj recorded lowest stomatal resistance (1.31 and 1.37 s cm⁻¹ during Ist Year and IInd Year respectively).

Table 1. Effect of water stress on stomatal resistance ($s\text{ cm}^{-1}$) of leaves at various growth stages of potato cultivars

Treatment*	Ist Year			IInd Year		
	Growth stage**			Growth stage		
	TI	TE	TM	TI	TE	TM
Kufri Chipsona-1						
T ₁	0.53	0.66	1.03	0.55	0.68	1.07
T ₂	0.83 (+57%)***	0.74	1.12	0.88 (+60%)	0.76	1.15
T ₃	0.55	2.39 (+262%)	1.02	0.54	2.42 (+256%)	1.06
T ₄	0.54	0.68	2.73 (+165%)	0.57	0.70	2.81 (+163%)
Mean	0.61	1.12	1.48	0.64	1.14	1.52
Kufri Pukhraj						
T ₁	0.61	0.65	1.03	0.64	0.67	1.06
T ₂	0.94 (+54%)	0.82	1.09	1.02 (+59%)	0.84	1.12
T ₃	0.60	1.31 (+102%)	1.18	0.63	1.37 (+105%)	1.11
T ₄	0.62	0.67	1.68 (+63%)	0.64	0.70	1.72 (+62%)
Mean	0.69	0.86	1.25	0.73	0.90	1.25
Kufri Lauvkar						
T ₁	0.62	0.63	0.96	0.63	0.64	0.98
T ₂	0.76 (+23%)	0.68	0.99	0.80 (+27%)	0.71	1.02
T ₃	0.61	2.07 (+229%)	0.98	0.63	2.11 (+230%)	1.02
T ₄	0.59	0.61	2.48 (+158%)	0.64	0.65	2.53 (+158%)
Mean	0.65	1.00	1.35	0.68	1.03	1.39
Desiree						
T ₁	0.62	0.73	1.32	0.64	0.78	1.36
T ₂	1.06 (+71%)	0.98	1.25	1.20 (+88%)	1.03	1.28
T ₃	0.61	2.76 (+278%)	1.14	0.66	2.78 (+256%)	1.16
T ₄	0.59	0.74	3.26 (+147%)	0.66	0.77	3.29 (+142%)
Mean	0.72	1.30	1.74	0.79	1.34	1.77
Mean Values of Treatments						
T ₁	0.60	0.67	1.09	0.62	0.69	1.12
T ₂	0.90 (+51%)	0.81	1.11	0.98 (+59%)	0.84	1.14
T ₃	0.59	2.13 (+218%)	1.08	0.62	2.17 (+212%)	1.09
T ₄	0.59	0.68	2.54 (+133%)	0.63	0.71	2.59 (+131%)
CD at 5%						
Cultivar (C)	0.01	0.05	0.09	0.03	0.05	0.08
Treatment (T)	0.02	0.04	0.06	0.02	0.05	0.06
C × T	0.04	0.08	0.12	0.04	0.09	0.11

*Treatments: T₁ = Control (well watered), T₂ = water stress at tuber initiation, T₃ = water stress at tuber enlargement and T₄ = water stress at tuber maturation stage.

**Growth stages: TI = Tuber initiation, TE =Tuber enlargement and TM = Tuber maturation

***Figures in parenthesis are percent (%) change in leaf stomatal resistance due to water stress treatment T₂, T₃ and T₄ as compared with respective control

Maximum percent increase in stomatal resistance due to water stress at tuber enlargement stage (T3) was found in cultivar Desiree (278% and 256% in respective years) while minimum percent increase in cultivar Kufri Pukhraj (102% and 105% in respective years) in comparison with respective well irrigated control.. Similarly in T4 (water stress at tuber maturation stage) cultivar Desiree again recorded highest stomatal resistance (3.26 and 3.29 s cm⁻¹ during Ist Year and IInd Year respectively) and Kufri Pukhraj recorded lowest stomatal resistance (1.68 and 1.72 s cm⁻¹ during Ist Year and IInd Year , respectively). Maximum percent increase in stomatal resistance due to water stress at tuber maturation stage (T4) was found in cultivar Kufri Chipsona-1 (165% and 163% in respective years) while minimum increase in cultivar Kufri Pukhraj (63% and 62% in respective years) in comparison with respective well irrigated control. The interaction between variety and treatments was also found significant at all growth stages during both the years.

Stomatal resistance is a good indicator of water stress (18). In present study water stress caused significant increase in stomatal resistance at different growth stages (Table 1). (2,12 and 16), also found increase in stomatal resistance under water stress conditions. The first symptom of water stress is the restriction of leaf growth which is dependent on cell wall extensibility and turgor pressure (5,8,9,10). Changes in the turgor pressure of guard cells and subsidiary cells bring about changes towards closure in the stomatal aperture (20,14,) which results in increased stomatal resistance (10). Chemical signals from the root system may affect the stomatal responses to water stress (4). Absciscic acid (ABA) is known to play central role in the control of stomatal conductance under water stress in field conditions (22). Besides ABA other signals such as pH and inorganic ion redistribution also appear to play a role in long distance signaling between roots and shoots (19,4). Maximum increase in stomatal resistance (>200%) was observed when water stress was imposed at tuber enlargement stage (T3) and minimum at tuber initiation stage (<60%) (Table 1). At tuber enlargement stage the leaf area

was fully developed and closure of stomata under stress protected the plants against immediate desiccation by reducing transpiration from the well developed leaf area.

High stomatal resistance in plants is considered advantageous in water economy and drought resistance (15). In present study highest increase of stomatal resistance (278% and 256%) was observed in cultivar Desiree when water stress was imposed at tuber initiation stage (T2) and tuber enlargement stage (T3) (Table 1). Higher stomatal resistance in Desiree indicated its strategy for water conservation under water stress situations.

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ON FARM TESTING (OFT) ON ASSESSMENT OF GLADIOLUS (*GLADIOLUS GRANDIFLORUS* L.) CV. PUSA CHANDNI CULTIVATION FOR YIELD AND ECONOMICS IN MEERUT DISTRICT

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Abstract

The present investigation was conducted during 2016-17 and 2017-18 for two years to assess the performance of high yielding gladiolus variety Pusa Chandni cultivation for yield and economics in Meerut district. The improved variety Pusa Chandni was planted along with local variety White prosperity as check in 0.3ha each in the fields of three farmers at Pipli Khera and Lawar villages in block of Kharkounda and Sardhana in Meerut district during October 2016-17 and 2017-18. The results revealed that among the varieties Pusa Chandni recorded significantly higher number of spikes per plant (1.25 no./plant), number of flowers per spike (13.88 no./spike), spike length (56.60cm), and flower spike yield per hectare (128520 no. of spike/ha). The economic parameters viz., benefit cost ratio (2.34:1), marginal benefit cost ratio (28.26) and relative economic efficiency (31.03) were recorded more in Pusa Chandni than White prosperity varieties of gladiolus. The Pusa Chandni variety showed superiority over White prosperity and found suitable for western part of Meerut district of Uttar Pradesh.

Keywords: Efficiency, Flower, Pusa Chandni, White Prosperity, Spikes, Gladiolus, Yield.

Introduction

Bulbous plants constitute one of the most important groups of plants grown for their floral wealth (3). Among bulbous crops, gladiolus (*Gladiolus grandiflorus*), generally called glad (plural gladioli, gladioluses, glads) occupies a prime position among commercial cut flower crops due to high demand in both domestic and international markets. It is called queen of bulbous flowers for its excellent aesthetic value and display life (1). It is also known as the Sword Lily or Corn Lily. It belongs to family Iridaceae. Its fascinating spikes with variety of colours have. This is one of most beautiful flowers blossom from October to March in plains. These plants can be grown both in pots and beds as long as proper sunlight is present (minimum of 10 hours sunlight required for well blooming). Gladiolus is one of the most important flower crop cultivated in Meerut district as cut flower for purpose of making bouquets. Flowers with this variety are brilliant colours (moon), attractive shapes, good sizes, excellent keeping quality. The gladiolus is ideal both for garden and floral decoration. The florets open in sequence over a longer duration and hence have a good keeping quality of cut spike. It is ideal as a cut flower, very good for beds, herbaceous border, for making bouquets and does well in pots. Among the different bulbous plants, the gladiolus top the list in its beauty, glamour keeping quality, various colours and shades, shapes, hence it is called as “Queen of Bulb”.

Gladiolus plants grow very well in warm climatic conditions. Gladiolus is half-hardy in temperate climatic conditions and these plants grow from rounded, symmetrical corms that are bonded with several layers of brownish tunics. Gladiolus flowers are produced in variously colours. Most of the colours are from this variety orange to red. Commercial flower farmers can grow these in polyhouse or greenhouses as well. One can get decent profits under ideal cultivation practices. These flowers can be grown in subtropical and temperate climatic conditions. The temperature range of 25°C – 30°C is ideal for its cultivation. Apart from this, this crop demands full exposure to sunlight and performs well with long day conditions of 10 –12 hour photo-period. Avoid any frost during its growth period as this crop is sensitive to frost conditions. Commercial propagation of Gladiolus plants is done by corms (a rounded underground storage consisting of a swollen stem base covered with scale leaves). Minimum of 5 cm diameter corms are required for propagation. Make sure these corms are healthy and disease free. When it comes to shape of corms, conical shaped corms gives better flowers when compared to flat shaped corms.

Mostly local varieties are cultivated by the farmers of Meerut district. Productivity was lesser due to low yielding local varieties. Many varieties have been introduced in gladiolus by Indian Institute of Agricultural Research (IARI), New Delhi, Indian Institute of Horticultural Research (IIHR), Bengaluru, National Botanical Research Institute (NBRI), Lucknow and various other Agricultural Institutes.

The existing local cultivars are low yielding and give low margin to the farmers. Hence, experiment was conducted to assess suitable high yielding variety 'Pusa Chandni' for commercial cultivation in this district.

Methods and Materials

The experiment has been conducted at farmer's field under Krishi Vigyan Kendra, Hastinapur, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP) for two years during 2016-17 and 2017-18 at six farmer's field in PipliKhera and Lawar villages of Meerut district. Two varieties were used and Pusa

Chandni gladiolus bulbs were supplied to the farmers under treatment T² was Pusa Chandni whereas T¹ was local variety (White prosperity). The improved Pusa Chandni variety has been compared with local variety i.e. White prosperity and the characters of gladiolus varieties were given in table 1. Each experimental plot size was 0.1 ha and the planting was taken up during October, 2016 at three farmer's fields. The observations viz., number of spikes per plant, number of flowers per spike, spike length (cm), flower yield per plant (g) and flower yield per hectare (no./ha) and economic character like cost of cultivation, gross income, net income, marginal benefit cost ratio (MBCR), relative economic efficiency (REE), benefit to cost ratio (BCR) were recorded. The soil type was sandy loam, pH 6.4, and EC was 0.8. The available nitrogen, phosphorus, potassium content were 125, 80, 210 kg/ha respectively. The gladiolus bulbs were planted in single row system with spacing of 120 x 20 × 10 cm. Drip emitters were installed for providing irrigation. Before planting of the gladiolus bulbs were treated with copperoxy chloride (COC) (3g/l). Farm yard manure (10 t/ha), recommended dose of fertilizers NPK– 150:100:80 kg/ha, neem cake 250 kg/ha has been applied as a basal dose. The flowers, spikes and yield data obtained were statistically analysed with SPSS and repeated measures mixed ANOVA is carried out for pooled analysis of three years data with two treatments. The Benefit Cost ratio (B:C ratio), Marginal Benefit Cost Ratio (MBCR) and Relative Economic Efficiency (REE) (8) were calculated by using following formula as given below.

- B:C ratio = Net return/ cost of cultivation
- Marginal Benefit Cost Ratio (MBCR) = $\frac{\text{Gross return of new variety} - \text{Gross return of farmers variety}}{\text{Total variable cost of new variety} - \text{Total variable cost of farmer's variety}}$
- Relative Economic Efficiency (REE) = $\frac{\text{Net return of new variety} - \text{Net return of farmers variety}}{\text{Net return of new variety}}$

Results and Discussion

From the results (Table 1), it was evident that the improved variety Pusa Chandni showed the highest number of spikes per plant (1.25

no./plant), number of flowers per spike (13.88 no./spike), spike length (56.60cm), compared to White prosperity. In Pusa Chandni flower yield per hectare (128520 no./ha) were more compared to White prosperity. Similar results were reported by (7) & (2) in gladiolus. The improved variety Pusa Chandni was well adaptive to different region of the district and there was a significant increase in the yield of the Pusa Chandni compared to that of the local variety i.e. White prosperity (Table 2). The flower yield was significantly higher in Pusa Chandni than the local variety as indicated by the more number of flowers per spike (13.88) with the 38.80 increase percent. The data about interaction effect of year and variety were found non- significant which indicated that during two years both varieties performed in the same way. Further, Pusa Chandni performed well with higher flower yield of 128520 Nos./ha than check variety i.e White prosperity 100140 Nos./ha. Hence improved gladiolus variety Pusa Chandni was most suitable for cultivation. Similar results were reported (9). In table 3, economic impact of Pusa Chandni gladiolus variety over White prosperity variety was calculated and results revealed that by cultivating Pusa Chandni gladiolus variety farmers got more benefit cost ratio (2.34:1) over White prosperity (1.20:1). This may be due to higher yield obtained with Pusa Chandni gladiolus variety compared to farmer's practice. Similar results were obtained by Bhattacharjee et al (2013). Suitability of new variety was assessed with marginal benefit cost ratio (28.26) and economic efficiency was assessed with Relative Economic Efficiency (31.03). The cultivation of Pusa Chandni gladiolus variety gave higher net return Rs.1,82,050/- over two years as compared to White prosperity. The variation in plant height and spike length in different varieties may be due to influence of genetic and environmental factors. As each variety has its own characteristic genetic constitution, which contributes significantly to create variability. Similar observations for plant height, spike length and rachis length also reported by (6), (9), (5)& (10) in gladiolus and (4) in snapdragon.

Table1. Performance of Gladiolus variety at farmer's field during 2016-17 and 2017-18.

S. Nos.	Parameters	White Prosperity (T ₁)			Pusa Chandni (T ₂)		
		2016-17	2017-18	Mean	2016-17	2017-18	Mean
01.	No. of spike/plant	1.01	1.02	1.01	1.23	1.27	1.25
02.	No. of flower/spike	9.50	10.50	10.0	12.80	14.96	13.88
03.	Spike length (cm)	40.12	44.56	42.34	58.93	54.27	56.60
04.	Flower spike yield (Nos./ha)	95240	105040	100140	126050	130990	128520

Table 2. Comparison of means of the parameters with check variety for two years.

S. Nos.	Parameters	Varieties		Percent increase
		White Prosperity (T ₁)	Pusa Chandni (T ₂)	
01.	No. of spike/plant	1.01	1.25	23.76
02.	No. of flower/spike	10.0	13.88	38.80
03.	Spike length (cm)	42.34	56.60	33.67
04.	Flower spike yield (Nos./ha)	100140	128520	28.34

Table 3. Economic impact of Gladiolus variety Pusa Chandni.

Gladiolus-Variety	Cost of cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B. C. ratio	Marginal Benefit Cost Ratio (MBCR)	Relative Economic Efficiency (REE)
T ₁ - White Prosperity	124800	250350	125550	2.00:1	28.26	31.03
T ₂ - Pusa Chandni	139250	321300	182050	2.34:1		

Conclusion

Gladiolus improved variety Pusa Chandni with more number of spikes per plant, more flowers per spike and length of spike gave higher yield and B: C ratio. Hence, the farmers were satisfied with the gladiolus variety Pusa Chandni cultivation. Hence, it was concluded that gladiolus variety Pusa Chandni was most suitable variety for Meerut district of Uttar Pradesh. At present, the area under Pusa Chandni in Meerut district is nearly 35 per cent of the total area under gladiolus.

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STUDIES ON CORRELATION AND PATH COEFFICIENT ANALYSIS FOR QUANTITATIVE CHARACTERS IN PUMPKIN (*CUCURBITA MOSCHATA* L.)

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Abstract

An experiment was conducted at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology; Modipuram, Meerut (U.P.) during *Zayad season*-2020. Twenty-five genotypes of pumpkin were evaluated in randomized block design with three replications for ten quantitative characters. Genotypic correlation coefficients were found to be greater than phenotypic correlation coefficients for more of the characters. Fruit yield per plant was a highly significant positive correlation with the number of fruits per plant followed by the number of leaves per plant, length of vine, number of primary branches and days to first fruits. The harvest implies that these all characters were the main contributing factors to fruit yield per plant. Path coefficient analysis exhibits a highly positive and direct effect on fruit yield per plant was observed for a number of primary branches followed by a number of fruits. per plant, days to first fruit set, number of leaves per plant, length of vine, days to first flower initiation and % of seed germination.

Keywords: Correlation, Path Coefficient, Pumpkin, Characters.

Introduction

Pumpkin (*Cucurbita moschata* L. 2n= 40) belongs to the Cucurbitaceae family. It is a good source of carotenoids and ascorbic acids, which are antioxidants that play an important role in nutrition as pro-vitamin A and vitamin C. A wide variation of total carotenoid contents and yield contributing traits in the Indian germplasm of pumpkin has been recorded (15), whereas, (12) found 0.06 to 7.4 mg α -carotene in Austria pumpkin. It is also consumed as processed and stock feed. Pumpkin is a day-neutral, monoecious, climbing, spreading herb that is mostly grown for its immature and mature fruits. Fruit shape morphology is one of the most diverse traits and depends on geographic origin (*i.e.*, adaptation to environmental factors), cultural traditions, culinary attributes and market characteristics and requirements.

Pumpkin is a strong source of vitamins, particularly high carotenoid colour and minerals, and is quite high in energy and carbohydrates (5). Carotene, lutein both alpha and beta carotene are abundant in pumpkins with yellow or orange flesh. To save money, farmers can grow fluted pumpkins as a single crop or as part of a mixed crop. This is because it provides a substantial sum of money to small agricultural households.(2).

The great extent of natural variation present in various characters among the genotypes of pumpkin suggests good scope for improvement in economic traits through conventional selection techniques (10) & (15). The path coefficient method aids in determining the direct and indirect effect contributions of various components to the total correlation towards yield. The quantum importance of individual qualities is marked based on this research in order to facilitate the selection programme for improved variable benefits (17).

Materials and Methods

The investigation was carried out at the Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut (U.P.) during *Zayad season-2020* to study the correlation and path coefficient analysis for ten characters association in 25 pumpkin genotypes. The experiment was laid out in Randomized Block Design (RBD) with three replications. These genotypes were sowing in each block at a spacing of 3 x 0.5m. All agricultural practices and crop production were adopted to raise a healthy pumpkin crop. For studying different genetic parameters and inter-relationships, ten characters were taken into consideration namely, % of seed germination, days to first flower initiation, days to 50 percent flowering, days to first fruit set, days to first fruit harvest, length of vine, number of leaves per plant, number of primary branches, number of fruits per plant and fruit yield per plant. Genotypic and phenotypic correlation coefficients were obtained using the formula suggested by (11) and path co-efficient analysis was done following the method outlined by (6).

Results and Discussion

Studies indicated that genotypic correlation coefficient (GCC) was found to be greater than phenotypic correlation coefficients (PCC) for more of the characters, indicating a strong inherent association between various characters and significantly presented in Table-1. The oral relationship between plant characters and determines the component character on which selection can be made for genetic improvement of

yield was measured in correlation coefficient analysis. Investigation regarding the presence of components and nature of association among themselves is essential and a prerequisite for improvement in yield. The correlation coefficient provides a clear picture of the extent of association between a pair of traits and indicates whether simultaneous improvement of the correlated traits may be possible or not. The knowledge of the genetic association between yield and its component characters helps in improving the efficiency of the selection by yield by making the proper choice and balancing one component with another.

Genotypic correlations coefficient:

In the present investigation was indicated that % of seed germination has a highly significant and positive correlation with the number of leaves per plant (0.386**) and the positive but non-significant correlation with fruit yield per plant in pumpkin genotypes (0.200) followed by a number of primary Branches (0.109), days to first fruit set (0.085), number of fruits per plant (0.061) and length of the vine (0.016). A significant but negative correlation was recorded with days to first flower initiation (-0.234*) and a non-significant and negative correlation with days to 50% flowering (-0.039) and days to first fruit harvest (-0.006). Days to first flower initiation was a highly significant and positive correlation with days to 50% flowering (0.743**), days to first fruit set (0.585**) and days to first fruit harvest (0.249*). Positive but non-significant correlation with length of the vine (0.154) and the number of primary branches (0.153). It is significant but a negative correlation was found with % of seed germination (-0.234). In the case of the genotypic correlation coefficient, a non-significant but negative correlation was revealed with a number of leaves per plant (-0.205) followed by a number of fruits in the single plant (-0.122) and yield of the fruit per plant (-0.064). Days to 50% flowering was recorded positive and highly significant correlation with days to first flower initiation (0.743**) followed by a number of primary branches (0.477**), days to first fruit set (0.297**) significant positive correlation with length of the vine (0.228*). However, non-significant but negative correlation with days

to first fruit harvest (-0.168) followed by a number of leaves, per plant (-0.111), a number of fruit per plant (-0.100), fruit yield per plant (-0.077), and the percent of seed germination (-0.039). Days to first fruit set in pumpkin genotypes were recorded highly significant and the positive correlation with days to first fruit harvest (0.630**) followed by days to first flower initiation (0.585**) days to 50% flowering (0.297**) and fruit yield per plant (0.292**). Correlation among different characters such as number of leaves per plant (0.219) followed by the length of the vine (0.120), % of seed germination (0.085), number of primary branches (0.064), and number of fruits per plant (0.060) was positive value but non-significant correlation found in this study. Days to first fruit harvest were estimated days to first fruit set (0.630**). found a highly significant and positive correlation followed by fruit yield per plant (0.412**), number of leaves per plant (0.381**) and number of fruits per plant (0.362**). In case of positive and significant correlation was correlated with days to first flower initiation (0.249*) and length of the vine (0.245*) whereas, negative but non-significant correlation with days to 50% flowering (-0.168) followed by number of primary branches (-0.114) and % of seed germination (-0.006). Length of vine highly significant and positive correlation was recorded with a number of fruits per plant (0.699**) followed by fruit yield per plant (0.646**), number of leaves. per plant (0.542**) and a number of primary branches (0.505**). Significant and positive correlation with days to 50% flowering (0.228*) and days to first fruit harvest (0.245*). The positive but non-significant correlation was correlated with days to first flower initiation (0.154) followed by days to first fruit set (0.120) and % of seed germination (0.016). A number of leaves. Per plant exhibits positive and highly significant correlation with a number of fruits per plant (0.749**) followed by fruit yield per plant (0.745**), length of the vine (0.542**), % of seed germination (0.386**), days to first fruit harvest (0.381**) and a number of primary branches (0.314**). Positive but non-significant correlation with days to first fruit set (0.219), however non-significant but negative correlation with days to first flower initiation (-0.205) and days to 50% flowering (-0.111). The number of primary branches had

high. Significant and positive correlation for characters with fruit yield per plant (0.557**) followed by the length of the vine (0.505**), days to 50% flowering (0.477**), number of fruits per plant. (0.439**) and a number of leaves per plant (0.314**).

Positive but non-significant correlation. With days to first flower initiation (0.153) followed by % of seed germination (0.109), days to first fruit set (0.064) while the non-significant and negative correlation with days to first fruit harvest (-0.114). The number of fruit per plant was found positive and highly significant correlation with fruit yield per plant (0.826**) followed by a number of leaves per plant (0.749**), length of vine (0.699**), number of primary branches (0.439**) and days to. First fruit harvest (0.362**). In case positive and non-significant correlation was found with % of seed germination (0.061) and days to first fruit set (0.060) however, non-significant and negative correlation with days to first flower initiation (-0.122) and days to 50% flowering (-0.100). Fruit yield per plant was recorded highly significant and positive correlation with the number of fruit. Per plant (0.826**) followed by a number of leaves per plant (0.745**), length of vine (0.646**), number of primary branches (0.557**), days to first fruit harvest (0.412**) and days to first fruit set (0.292**). Positive but non-significant correlation with % of seed germination (0.200) whereas, non-significant and negative correlation with days to 50% flowering (-0.077) and days to first flower initiation (-0.077). (10), (3) & (8).

Phenotypic correlations coefficient

The work was done at phenotypic correlation among the ten characters. The present investigation for % of seed germination was recorded highly significant and positive correlation in pumpkin genotype number of leaves per plant (0.359**). Positive but non-significant correlation in pumpkin genotype fruit yield per plant (0.182) followed by a number of primary branches (0.111), length of the vine (0.082), days to first fruit set (0.064), number of fruits per plant (0.056), and days to 50% flowering (0.023) whereas, non-significant and negative correlation with days to first flower initiation (-0.215) and days to first fruit harvest (-0.014). Days to first flower initiation has a highly significant positive

correlation with days to first fruit set (0.529**) followed by days to 50% flowering (0.402**) and significant positive correlation with days to first fruit harvest (0.233*) and non-significant positive correlation with the length of the f vine (0.136), number of primary branches (0.132) and non-significant negative correlation with % of seed germination (-0.215), number of leaf per plant (-0.140), number of fruit per plant (-0.101) and fruit yield per plant (-0.031). Days to 50% flowering had positive and more significant correlation with days to first flower initiation (0.402**), number of primary branches (0.356**). Positive but non-significant correlation with days to first fruit set (0.206), length of vine (0.119), % of seed germination (0.023). The characters like days to first fruit harvest (-0.142), number of leaves per plant (-0.122), number of fruits per plant (-0.081), fruit yield per plant (-0.065) was non-significant and negative correlation. Days to first fruit set recorded significant positive correlation with the various traits like days to first fruit harvest (0.600**) followed by days to first flower initiation (0.529**) and significant positive correlation with (0.247*). Positive and non-significant correlation was recorded with days to 50% flowering (0.206) followed by number of leaves per plant (0.205), length of vine (0.096), % of seed germination (0.064), number of primary branches (0.061) and number of fruits per plant (0.051). Positive and high significant correlation was found in present investigation for days to first fruit harvest with days to first fruit set (0.600**) followed by fruit yield per plant (0.370**), number of leaves per plant (0.352**) and (0.341**) however, positive and significant correlation days to first flower initiation (0.233*). Positive but non-significant correlation with length of vine (0.190). Days to 50% flowering (-0.142) followed by number of primary branches (-0.116) and % of seed germination (-0.014) was recorded non-significant and negative correlation. Length of vine was recorded positive and significant correlation for traits, with number of fruits per plant (0.629**) followed by fruit yield per plant (0.559**), number of primary branches (0.488**) and number of leaves per plant (0.475**). Positive but non-significant correlation with days to first fruit harvest (0.190) followed by days to first flower initiation (0.136), days to 50% flowering (0.119), days to first fruit set (0.096) and

% of seed germination (0.086). Number of leaves per plant was recorded more significant and positive amount of correlation was recorded days to first fruit harvest (0.352** days) and number of primary branches (0.301). In case of positive but non-significant with number of fruits per plant (0.760**) followed by fruit yield per plant (0.695**), length of vine (0.475**), % of seed germination (0.359**), days to first fruit harvest (0.352**) and number of primary branches (0.301). Positive but non-significant correlation with days to first fruit set (0.205) whereas, non-significant and negative correlation was observed with days to first flower initiation (-0.140) and days to 50% flowering (-0.122). Number of primary branches was more significant and positive correlation with fruit yield per plant (0.515**) followed by length of vine (0.488**), number of fruits per plant (0.413**), days to 50% flowering (0.356**), number of leaves per plant (0.301**) and days to first flower initiation (0.132) followed by % of seed germination (0.111) and days to first fruit set (0.061) whereas, in case of non-significant and negative correlation with days to first fruit harvest (-0.116). Number of fruits per plant was resulted in case of significant and positive correlation with fruit yield per plant (0.772**) followed by number of leaves per plant (0.706**), length of vine (0.629**), number of primary branches (0.413**) and days to first fruit harvest (0.341**). In case of positive but non-significant correlation with % of seed germination (0.056) and days to first fruit set (0.051) whereas, non-significant and negative correlation with days to first flower initiation (-0.101) and days to 50% flowering (-0.081). Fruit yield per plant was recorded in case of significant positive correlation with number of fruits per plant (0.772**) followed by number of leaves per plant (0.695**), length of vine (0.559**), number of primary branches (0.515**), and days to first fruit harvest (0.370**). In case of significant positive correlation with days to first fruit set (0.247*) and non-significant positive correlation with % of seed germination (0.182). Days to 50% flowering (-0.065) and days to first flower initiation (-0.031) was recorded non-significant and negative correlation. Correlation coefficient provides a clear picture of the extent of association between a pair of traits and indicates whether simultaneous improvement of the correlated traits may be

possible or not. The knowledge of genetic association between yield and its component characters helps in improving the efficiency of the selection by yield by making proper choice and balancing one component with another. (4), (1), (16), (8) & (7).

Path Coefficient Analysis

Path coefficient analysis is a powerful tool, which enables portioning of the given relationship in the further component. In other words, it takes into account not only the relationship of component characters with the dependent character but simultaneously takes care of its relationship with another component also. Thus, it helps in understanding the causal system in a better way because it enables portioning the total correlations coefficient into direct and indirect effects of various characters. In the present investigation path coefficient analysis was done for characters using genotypic and phenotypic correlation coefficients in Table-2 and fruit yield was taken as dependable variables.

Genotypic path coefficient

Direct effect

Direct and indirect effects of various contributing traits on fruit yield at genotypic level. The result was recorded positive and direct effect on fruit yield per plant were exhibited for various traits like number of primary branches (0.4187) followed by number of fruits per plant (0.4142), days to first fruit set (0.2864), number of leaves per

plant (0.1479), length of vine (0.1201), days to first flower initiation (0.0905) and % of seed germination (0.0506). Fruit yield per plant was exerted by days to 50 % flowering (-0.4047) followed by days to first fruit harvest (-0.0470) was recorded negative direct effect.

Phenotypic path coefficient

Direct effect

The investigation was resulted in case of direct and indirect effects of different characters on fruit yield per plant at phenotypic level. The data were recorded positive and direct effect on fruit yield per plant was seen for number of fruits per plant (0.4519) followed by number of primary branches (0.3072), days to first fruit set (0.1761), number of leaves per plant (0.1666), day to first fruit harvest (0.0786), % of seed germination (0.0391) and then length of vine (0.0339). The direct negative effect on the fruit yield per plant was recorded in case of days to first flower initiation (-0.0611) followed by days to 50 % flowering (-0.1227). Whereas, the traits namely, on fruit yield per plant (kg) was found highest positive and direct effects in number of fruits per plant. Most of the characters namely, days to first flower initiation (-0.0611) followed by days to 50% flowering (-0.1227) was indicating negative direct effects on fruit yield per plant. At the Phenotypic level also the estimate of direct and indirect were generally similar to those exhibited at genotype level with little variation in magnitude. The magnitude of residual effects at both phenotypic and genotypic was level observed to be low. (1), (8), (9) & (13).

Table-1. Estimates of correlation coefficient for genotypic and phenotypic levels among 10 characters of Pumpkin (*Cucurbita moschata* L.).

Characters		% Of seed germination	Days to first flower initiation	Days to 50% flowering	Days to first fruit set	Days to first fruit Harvest	Length of vine (cm)	No. of leaves per plant	No. of primary branches	No. of fruit per plant	Fruit yield per plant (kg)
% Of seed germination	G	1.000	-0.234*	-0.039	0.085	-0.006	0.016	0.386**	0.109	0.061	0.200
	P	1.000	-0.215	0.023	0.064	-0.014	0.082	0.359**	0.111	0.056	0.182
Days to first flower initiation	G		1.000	0.743**	0.585**	0.249*	0.154	-0.205	0.153	-0.122	-0.064
	P		1.000	0.402**	0.529**	0.233*	0.136	-0.140	0.132	-0.101	-0.031
Days to 50% flowering	G			1.000	0.297**	-0.168	0.228*	-0.111	0.477**	-0.100	-0.077
	P			1.000	0.206	-0.142	0.119	-0.122	0.356**	-0.081	-0.065

Days to first fruit set	G				1.000	0.630**	0.120	0.219	0.064	0.060	0.292**
	P				1.000	0.600**	0.096	0.205	0.061	0.051	0.247*
Days to first fruit Harvest	G					1.000	0.245*	0.381**	-0.114	0.362**	0.412**
	P					1.000	0.190	0.352**	-0.116	0.341**	0.370**
Length of vine (cm)	G						1.000	0.542**	0.505**	0.699**	0.646**
	P						1.000	0.475**	0.488**	0.629**	0.559**
No. of leaves per plant	G							1.000	0.314**	0.749**	0.745**
	P							1.000	0.301**	0.706**	0.695**
No. of primary branches	G								1.000	0.439**	0.557**
	P								1.000	0.413**	0.515**
No. of fruits per plant	G									1.000	0.826**
	P									1.000	0.772**
Fruit yield per plant (kg)	G										1.000
	P										1.000

*, ** significant at 5% and 1% level, respectively

Table-2. Path coefficient analysis showing the direct and indirect effects of 10 characters on fruit yield per plant (kg) at genotypic and phenotypic of Pumpkin (*Cucurbita moschata* L.).

Characters		% of seed germination	Days to first flower initiation	Days to 50% flowering	Days to first fruit set	Days to first fruit Harvest	Length of vine (cm)	No. of leaves per plant	No. of primary branches	No. of fruits per plant	R with Fruit yield per plant (kg)
% Of seed germination	G	0.0506	-0.0212	0.0160	0.0243	0.0003	0.0019	0.0571	0.0454	0.0254	0.200
	P	0.0391	0.0132	-0.0028	0.0113	-0.0011	0.0028	0.0598	0.0341	0.0252	0.182
Days to first flower initiation	G	-0.0118	0.0905	-0.3007	0.1676	-0.0117	0.0185	-0.0302	0.0642	-0.0506	-0.064
	P	-0.0084	-0.0611	-0.0494	0.0931	0.0183	0.0046	-0.0232	0.0406	-0.0458	-0.031
Days to 50% flowering	G	-0.0020	0.0672	-0.4047	0.0851	0.0079	0.0274	-0.0164	0.1999	-0.0414	-0.077
	P	0.0009	-0.0246	-0.1227	0.0364	-0.0112	0.0040	-0.0203	0.1094	-0.0366	-0.065
Days to first fruit set	G	0.0043	0.0529	-0.1203	0.2864	-0.0296	0.0144	0.0325	0.0268	0.0249	0.292**
	P	0.0025	-0.0323	-0.0253	0.1761	0.0471	0.0033	0.0341	0.0187	0.0233	0.247*
Days to first fruit Harvest	G	-0.0003	0.0225	0.0681	0.1805	-0.0470	0.0294	0.0564	-0.0477	0.1499	0.412**
	P	-0.0006	-0.0143	0.0175	0.1056	0.0786	0.0064	0.0587	-0.0356	0.1541	0.370**
Length of vine (cm)	G	0.0008	0.0139	-0.0923	0.0343	-0.0115	0.1201	0.0801	0.2113	0.2897	0.646**
	P	0.0032	-0.0083	-0.0147	0.0170	0.0149	0.0339	0.0791	0.1499	0.2842	0.559**
No. of leaves per plant	G	0.0195	-0.0185	0.0448	0.0629	-0.0179	0.0650	0.1479	0.1313	0.3103	0.745**
	P	0.0141	0.0085	0.0149	0.0361	0.0277	0.0161	0.1666	0.0924	0.3192	0.695**
No. of primary branches	G	0.0055	0.0139	-0.1932	0.0184	0.0054	0.0606	0.0464	0.4187	0.1819	0.557**
	P	0.0044	-0.0081	-0.0437	0.0107	-0.0091	0.0165	0.0501	0.3072	0.1866	0.515**
No. of fruits per plant	G	0.0031	-0.0110	0.0405	0.0172	-0.0170	0.0840	0.1108	0.1839	0.4142	0.826**
	P	0.0022	0.0062	0.0099	0.0091	0.0268	0.0213	0.1177	0.1268	0.4519	0.772**

Resi = 0.137

*, ** significant at 5% and 1% level, respectively

Conclusion

Correlation and path coefficient analysis, number of primary branches, number of fruits per plant, days to first fruit set, number of leaf per plant, length of vine, days to first flower initiation and % of seed germination would be considered as the reliable selection parameters for developing high yielding genotype in pumpkin.

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STUDIES ON VARIABILITY, HERITABILITY, GENETIC ADVANCE IN RADISH (*RAPHANUS SATIVUS* L.) FOR ROOT YIELD AND QUALITY TRAITS UNDER MID-HILLS OF UTTARAKHAND

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Abstract

The present investigation was carried out with 20 genotypes of Radish (*Raphanus sativus* L.) at the Vegetable Research and Demonstration Block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar during rabi season of September 2019 to know the nature and magnitude of variability, heritability and genetic advance as per cent of mean for various horticultural traits. The experiment was laid out in RCBD with three replications. The analysis of variance showed significant variation among different genotypes for all the traits under study. Genotypes Gol Molli, Mino Early White, Hill Queen and Radish Roshni recorded higher root yield and also performed better for other horticultural traits than check cultivar (Japanese White). Genetic analysis indicated that phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) in all the attributes studied. The phenotypic coefficients of variation (PCV) and the genotypic coefficients of variation (GCV) were found high in root weight without leaves (g). High heritability estimates coupled with high genetic gain were found highest for the character root weight without leaves (g), indicated that these traits are under additive gene effects and are more reliable for effective selection.

Keywords: Radish, Genetic Variability, Heritability

Introduction

Radish (*Raphanus sativus* L.) is a prominent vegetable crop grown worldwide for freshly edible roots (hypocotyls) which is eaten as fresh crunchy salad and cooked as vegetable or preserved by brining, pickling, canning and drying, the soft leaves are 'consumed as a leafy vegetable or used for chutney preparation. It belongs to family Brassicaceae having chromosome number $2n = 2x = 18$. It is commonly known as Muli or

Mula which grows in every part of India particularly in Uttar Pradesh, Bihar, West Bengal, Assam, Punjab, Haryana, Himachal Pradesh and Gujarat. Radish also fits well in multiple cropping systems due to its short growing season. The commonly grown radish varieties are classified broadly into two groups; European or Temperate type and Asian or Tropical type. Temperate types are small in size, tastes mild and are mostly raised for salad, whereas tropical types are larger in size, tastes pungent and are mostly raised for salad or also cooked. Seed production of European types is possible only under temperate conditions where chilling temperatures occur. The Asian cultivars with high temperature adaption resist more heat than the European cultivars. Radish is more sensitive to the temperature and photoperiod. The best root shape and higher quality are produced when grown at 15-18 °C (3). The best quality roots are obtained in moderate day length. Bolting is also affected by the day length (7). The genetic parameters such as heritability, genetic advance, genotypic and phenotypic coefficients of variability are effective for the breeders to select a genotype having the most desirable traits for yield. Therefore the present research has been undertaken with the objective to study the relative magnitude of genetic variability, heritability and genetic advance for various traits of horticultural importance in radish.

Materials and Methods

The present investigations were carried out during rabi season 2019 at the Vegetable Demonstration and Research Block Department of Vegetable Science, College of Horticulture, VCSG, UUHF, Bharsar. The experiment was laid out in RCBD method with three replications at spacing of 45 cm × 20 cm. All the recommended cultural practices were followed under irrigated conditions as and when needed. The observations were recorded on five random competitive plants per replication for each genotype of twelve important characters *i.e.* length of whole plant after harvesting, number of leaves at the time of harvesting, root weight with leaves (g), root weight without leaves (g), root length (cm), leaves weight (g), leaf length (cm), root diameter (cm), root yield per plot (kg), per cent dry matter contents (%), ascorbic acid (mg/100gm) and total soluble solids (°Brix).

The analysis of variance was carried out as suggested by (13). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) in percentage was calculated according to (4). Heritability in broad sense (h^2b) is defined as the proportion of the genotypic variance to the total variance (phenotypic variance) will be estimated by using the formula given by (5). Genetic advance was estimated by using the method suggested by (6). The genotypic and phenotypic correlations was calculated as per (1) by using analysis of variance and covariance matrix in which total variation has splitted into replications, genotypes and errors.

Results and Discussion

The analysis of variance indicated that differences among the genotypes were highly significant for all the twelve characters studied. This indicated the presence of appreciable amount of diversity among the genotypes studied. The extent of variability present in the genotypes was measured in terms of range, coefficient of variation, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense heritability and genetic advance (GA). The mean performances of the different traits under study in 20 radish genotypes are shown in Table 1. Significant differences were observed among all the genotypes for all the characters under study. The components of variance, coefficient of variation, heritability and genetic advance value for twelve horticultural characters are presented in Table 2. The magnitude of phenotypic coefficient of variation (PCV) was significantly higher than the corresponding genotypic coefficient of variation (GCV) for all the characters under the study, indicating a considerable influence of environment on their expression. The phenotypic coefficients of variation (PCV) were found high gain for root weight without leaves (g), leaves weight (g), root weight with leaves (g), root yield per plot (kg) and root diameter (cm). This shows greater genetic variability among all the genotypes for these characters. This also indicated broad genetic base, less environmental influence and these traits are under the control of additive genes and hence there is a good scope for the further improvement of these characters through selection. These results are in line with the findings of (15), (8), (12) & (14). Similarly, the

genotypic coefficients of variation (GCV) were high gain for the characters *viz.*, root weight without leaves (g), leaves weight (g), root diameter (cm), root weight with leaves (g) and root yield per plot (kg). Results supported with the findings (16), (11), (17), (14) & (8).

The estimates of heritability (broad sense) were varied from 65.03% to 99.94% for different characters under study. It was found high for the characters *viz.*, ascorbic acid (mg/100g), root weight with leaves (g), root weight without leaves (g), length of plant (cm), number of leaves, leaves weight(g), root diameter (cm), dry matter content (g), root length (cm) and leaf length (cm) and the low heritability were recorded for total soluble solids (°B). This showed high heritability due to less effect of environmental factor on population.

Similar results for different characters have also been reported by (10), (15), (17), (14), (9), (18) & (2).

There was wide range of variations in radish genotypes for all the characters. From the present investigation, it is concluded that four genotypes *viz* Gol Mooli, Mino Early White, Hill Queen and Radish Roshni recorded higher root yield and also performed better for other horticultural traits than check cultivar Japanese White. These genotypes need further testing to be released as a substitute of already existing varieties of radish or they can be involved in further breeding programme for development of superior hybrids or varieties for yield and quality improvement in Radish under mid hill condition of Uttarakhand.

Table.1 Mean Performance of twenty two genotypes for the characters under study Radish

S.No	Genotypes	LWP	NOL	RWWL	RWWL	LW	RL	LL	RD	AA	DMC	TSS	RYPP
1	Japanese White	62.17	15.47	360.67	244.67	116.00	28.65	32.32	2.87	13.40	7.26	5.02	2.04
2	Pusa Himani	58.18	13.00	270.67	182.07	88.60	32.26	25.92	3.03	13.67	7.16	5.11	1.76
3	White Icicle	57.94	7.13	153.92	116.31	37.60	32.55	25.75	2.63	19.47	7.18	6.40	1.24
4	Radish Red White Tipped	37.03	9.47	151.25	163.20	46.93	12.13	25.23	4.45	21.09	6.68	6.45	1.11
5	Pusa Chetki	62.63	11.67	309.56	104.32	95.33	24.07	38.68	3.07	14.35	9.08	5.70	2.02
6	Local Collection, Bageshwar	62.82	16.67	327.33	233.00	94.33	32.97	29.85	2.75	15.27	7.22	5.81	2.02
7	Local Collection (Bharsar)	60.83	14.20	345.00	273.93	98.67	27.75	32.91	2.64	14.43	7.46	6.00	1.73
8	Mino Early White	63.93	14.47	382.33	251.47	126.40	32.59	31.33	3.41	14.87	7.44	5.89	2.17
9	Lambi Vilayti	68.96	13.00	332.33	194.67	138.00	26.18	42.78	3.53	13.47	7.16	5.08	1.89
10	40 Days	53.35	10.80	256.00	154.00	101.33	22.17	31.17	2.26	15.75	8.13	4.88	1.39
11	Chandani	50.67	12.33	252.33	113.00	139.33	24.55	25.99	2.63	20.67	8.75	6.23	1.11
12	Arka Nishant	70.69	11.00	239.13	153.33	86.13	24.71	45.99	3.43	17.51	8.12	5.71	1.43
13	Hill Queen	56.14	14.40	332.00	229.33	102.89	29.05	28.25	3.62	16.41	7.30	5.84	2.06
14	Chetki Long	58.04	14.07	257.67	162.00	94.33	25.57	32.72	2.36	13.71	8.09	7.06	1.56
15	Ganga	64.27	13.13	365.00	236.67	128.33	27.74	36.53	2.59	15.47	5.45	6.07	1.83
16	Gol Mulli	73.22	16.73	394.47	277.13	117.33	34.35	38.89	5.17	14.88	8.07	5.82	2.21
17	Agri Long White	47.83	8.87	156.53	97.27	55.93	19.44	28.39	2.15	18.40	7.11	5.28	1.01
18	Radish Roshni	58.98	12.73	345.00	247.87	97.13	29.25	29.74	2.39	12.46	6.45	5.04	2.47
19	Local Collection, Nainital	57.69	13.33	221.33	137.62	83.71	27.65	30.04	2.14	15.62	6.84	5.20	1.19
20	Radish Rupali	60.68	12.60	262.53	160.73	101.80	25.03	35.52	2.21	20.46	6.48	5.81	1.52
	Mean	59.30	12.75	285.75	186.63	97.51	26.93	32.40	2.97	16.07	7.37	5.72	1.69
	Max	37.03	7.13	151.25	97.27	37.60	12.13	25.23	2.14	12.46	5.45	4.88	1.01
	Min	73.22	16.73	394.47	277.13	139.33	34.35	45.99	5.17	21.09	9.08	7.06	2.47
	SE(d)	1.01	0.52	4.90	4.30	2.31	0.76	1.11	0.05	0.06	0.06	0.32	0.12
	C.D. at 5%	2.05	1.05	9.96	8.73	4.69	1.55	2.25	0.11	0.11	0.12	0.64	0.25
	C.V. (%)	2.08	4.97	2.10	2.82	2.90	3.47	4.18	2.24	0.42	0.99	6.77	8.82

*, ** significant at 5% and 1% level, respectively

LWP = Length of whole plant after harvesting (cm), NOL= Number of leaves, RWWL= Root weight with leaves (g), RWWL = Root weight without leaves (g), LW= Leaves weight (g), RL= Root length (cm), LL = Leaf length (cm), RD= Root diameter (cm), AA= Ascorbic acid (mg/100g), DMC= Dry matter content (g), TSS= Total soluble solids (°B) and RYYP= Root yield per plot (kg).

Table 2: Estimates of phenotypic and genotypic coefficient of variability, heritability, genetic advance and genetic gain for different traits.

Genotypes	Mean	Min	Max	Heritability (%)	Genetic advance	GA as % mean	GCV (%)	PCV (%)
Length of whole plant (cm)	59.30	37.03	73.22	99.17	16.64	28.06	13.68	13.74
Number of leaves	12.75	7.13	16.73	93.61	4.84	37.91	19.02	19.66
Root weight with leaves (g)	285.75	151.25	394.47	99.37	155.17	54.30	26.44	26.53
Root weight without leaves (g)	186.63	97.27	277.13	99.20	120.05	64.33	31.35	31.48
Leaves weight (g)	97.51	37.60	139.33	98.95	56.06	57.50	28.06	28.21
Root length (cm)	26.93	12.13	34.35	96.88	10.56	39.21	19.34	19.65
Leaf length (cm)	32.40	25.23	45.99	94.71	11.48	35.44	17.68	18.17
Root diameter (cm)	2.97	2.14	5.17	99.30	1.62	54.63	26.61	26.71
Ascorbic acid (mg/100gm)	16.07	12.46	21.09	99.94	5.45	33.89	16.46	16.46
Dry matter content (g)	7.37	5.45	9.08	99.25	1.71	23.26	11.33	11.38
TSS(°Brix)	5.72	4.88	7.06	65.03	0.88	15.33	9.23	11.44
Root yield per plot (Kg)	1.69	1.01	2.47	88.73	0.81	48.03	24.75	26.28

The phenotypic coefficients of variation (PCV) were recorded higher for root weight without leaves (g), leaves weight (g), root weight with leaves (g), root yield per plot (kg), root diameter (cm), while genotypic coefficient of variation were recorded higher for root weight without leaves (g), leaves weight (g), root diameter (cm), root weight with leaves (g) and root yield per plot (kg). High heritability estimates coupled with high genetic gain were observed for root weight without leaves (g) and moderate for leaves weight (g), root diameter (cm), root weight with leaves (g), root yield per plot (kg), root length (cm), number of leaves, leaf length (cm), ascorbic acid (mg/100g) and low for TSS (°B). Hence selection can prove effective for improvement in root yield.

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STUDY OF GENETIC DIVERGENCE IN TOMATO (*SOLANUM LYCOPERSICUM* L.) GENOTYPES

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Abstract

The present investigation was conducted at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) 250110 during rabi season in 2018-19. During the study the analysis of variance for 36 genotypes of tomato in the randomized block design and revealed significant difference for all the 10 characters, this indicated the presence of wide spectrum of variability among the genotypes. The analysis of genetic divergence through Mahalanobis D² statistics revealed that a considerable genetic diversity was found among genotypes. 36 genotypes of tomato were grouped into 7 clusters. Out of the 7 clusters, Cluster I had four genotypes, Cluster II had three genotypes, Cluster III had eight genotypes, Cluster IV had six genotypes, Cluster V had ten genotypes, Cluster VI had only one genotype and Cluster VII had four genotypes. Maximum inter cluster distance (9.303) was determined between clusters I and cluster VI so cross among genotypes of cluster I like VRT-29, VRT-52, VRT-58 and VRT-67 and genotype of cluster VI i.e. VRT-53 can be made as a parent for getting better hybrids.

Keywords: Tomato, Genetic Divergence, Cluster Analysis

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important solanaceous vegetable crops grown widely all over the world. It is a very versatile vegetable for culinary purposes. Ripe fresh tomato fruit can be consumed fresh as salads, after cooking and utilized in the preparation of range of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (an antioxidant), ascorbic acid and beta carotene and valued for their colour and flavors. (1&3)

Generally diverse heterozygous population are expected to give high hybrid vigor, making it necessary to study of genetic divergence among the germplasm collection for identification of parents for further breeding programme. A number of studies have been carried out to study genetic diversity within the tomato germplasm, including wild and cultivated species, using various approaches. The breeder needs to isolate the suitable genotypes on the basis of genetic divergence for the hybridization purpose,

Mahalanobis D^2 statistics techniques based on multivariate analysis of quantitative among the group. It also pins-points suitable genotype for their utilization in hybridization programmes.

Materials and Method

The field was conducted at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) 250110 during *rabi* season 2018-19. The experimental material comprised of 36 diverse genotypes of tomato as listed in table 1. Out of these, 35 tomato genotypes were from Indian Institute of Vegetable Research, Varanasi U.P. and 1 *i.e.* Pusa Ruby genotype was from Indian Agriculture Research Institute, New Delhi. The genotypes were studied for 10 different growth and yield characters *i.e.* Days to 50% flowering, Days to first fruit set, Days to first fruit maturity, Days to first fruit harvest, Number of primary branches, Plant height, number of fruits per plant, Fruit yield per plant, average Fruit weight and Fruit yield per hectare.

Table 1. List of tomato genotypes

Sl no.	Variety name	Sl no.	Variety name	Sl no.	Variety name
1.	VRT- 4	13	VRT-26	25	VRT-62
2.	VRT-05	14	VRT-27	26	VRT-63
3.	VRT-07	15	VRT-29	27	VRT-65
4	VRT-10	16	VRT-50	28	VRT-66
5	VRT-11	17	VRT-52	29	VRT-67
6	VRT-16	18	VRT-53	30	VRT-70
7	VRT-17	19	VRT-54	31	VRT-71
8	VRT-18	20	VRT-56	32	VRT-74
9	VRT-20	21	VRT-57	33	VRT-76
10	VRT-21	22	VRT-58	34	VRT-77
11	VRT-23	23	VRT-60	35	VRT-78
12	VRT-24-1	24	VRT-61	36	Pusa ruby

The genetic divergence in genotypes was estimated using Mahalanobis D^2 statistic (1936) following Rao (1952).

Inter and intra-cluster distances were calculated by Tocher's method as suggested by Rao (1952) to form the clusters. This criterion was based on the principles that any two populations belonging to the same cluster should at least on the average show smaller D^2 than those belonging to different clusters.

Results and Discussion

All the genotypes were grouped into different clusters on the basis of genetic distance among the genotypes. The distribution pattern of genotypes, cluster mean for different clusters, intra and inter cluster divergence (D^2) value and contribution percentage of various traits towards genetic divergence are presented in the Table 2, 3, 4 and 5 respectively.

1. Clustering pattern

The 36 genotypes taken for genetic divergence analysis differed significantly with regard to the characters studied and displayed marked divergence and grouped into seven clusters following Torcher's method (Table 2.). the highest number of genotypes were found in Cluster V which had ten genotypes namely VRT-11, VRT-17, VRT-18, VRT-20, VRT-24-1, VRT-27, VRT-71, VRT-74, VRT-76 and VRT-77 followed by Cluster III had which eight genotypes namely VRT-16, VRT-23, VRT-50, VRT-54, VRT-56, VRT-57, VRT-63 and VRT-65, Cluster IV had six genotypes VRT-05, VRT-07, VRT-10, VRT-21 VRT-62 and VRT-66, Cluster I had four genotypes VRT-29, VRT-52, VRT-58 and VRT-67 and Cluster VII also had four genotypes VRT-04, VRT-70, VRT-78 and Pusa Ruby, Cluster II had three genotypes VRT-26, VRT-60 and VRT-61 and Cluster VI had only one genotype VRT-53. Based on present investigation, it was concluded that in general, there was parallelism between genetic and geographic diversity. This view point has been supported by the work of (13), (14), (16), (12), (2), (7), (10), (19) and (15).

Table 2. Clustering pattern of 36 genotypes of tomatoes on the basis of genetic divergence

Clusters	No of genotypes	Genotypes
I	4	VRT-29, VRT-52, VRT-58 and VRT-67,
II	3	VRT-26, VRT-60 and VRT-61
III	8	VRT-16, VRT-23, VRT-50, VRT-54, VRT-56, VRT-57, VRT-63 and VRT-65,
IV	6	VRT-05, VRT-07, VRT-10, VRT-21 VRT-62 and VRT-66,
V	10	VRT-11, VRT-17, VRT-18, VRT-20, VRT-24-1, VRT-27, VRT-71, VRT-74, VRT-76 and VRT-77,
VI	1	VRT-53
VII	4	VRT-04, VRT-70, VRT-78 and Pusa Ruby

2. Cluster Means for Different Characters

In the present study, cluster mean value for all the ten characters have been presented in Table 3. Cluster V took the least days to 50% flowering (51.93) and cluster VI took the maximum days to 50% flowering (73.67). Cluster V took the least days to first fruit set (77.70) and cluster VII took the maximum days to first fruit set (111.67). Cluster I took the least days to first fruit maturity (128.17) and cluster VII took the maximum days to first fruit maturity (186.58). Cluster I took the least days to first fruit harvest (134.92) and cluster VII took the maximum days to first fruit harvest (186.58). Highest number of primary branches was found in cluster I (7.66) and minimum number of

primary branches was found in cluster VI (4.13). Highest plant height was found in cluster II (125.24 cm) and minimum plant height was found in cluster VI (54.33 cm). Number of fruits per plant was highest in cluster I (121.45 gm) and minimum was in cluster VI (5.93 gm). Fruit yield per plant was highest in cluster I (1584.97 gm) and minimum in cluster VI (223.07 gm). Average Fruit weight was highest in cluster VI (48.37 gm) and minimum in cluster I (11.96 gm). Fruit yield per hectare was highest in cluster I (285.51 Q) and minimum in cluster VI (55.77 Q). It may be due to the potential of different germplasm falls in similar cluster. (1), (7), (8), (17) and (6) also found the similar results in their studies.

Table 3. Cluster mean

Cluster		Days to 50% flowering	Days to first fruit set	Days to first fruit maturity	Days to first fruit harvest	primary branches	Plant height (cm)	fruits per plant	Fruit yield per plant(g)	Fruit weight(g)	Fruit yield per hectare(Q)
I	Mean	58.33	89.00	128.17	134.92	7.66	85.77	121.45	1584.97	11.96	285.51
II	Mean	70.89	90.00	129.00	135.67	7.44	125.2	42.47	834.76	20.94	181.17
III	Mean	54.46	102.71	157.13	162.71	7.04	94.66	38.93	1181.09	30.59	265.72
IV	Mean	64.33	87.11	141.89	147.89	5.57	81.23	33.38	656.68	21.86	169.41
V	Mean	51.93	77.70	136.00	143.00	7.52	83.77	39.09	704.54	19.78	177.57
VI	Mean	73.67	106.00	151.00	155.67	4.13	54.33	5.93	223.07	48.37	55.77
VII	Mean	65.17	111.67	179.25	186.58	6.80	60.58	22.30	481.75	21.76	120.76

3. Intra and Inter Cluster Distances

The mean intra and inter cluster D² values among the seven clusters are given in (Table 4). The intra cluster D² value ranged from 1.001 (Cluster VI) to 2.029 (Cluster III). The chance of developing good segregants by crossing the genotypes of the same cluster showing low value for intra cluster distance are very low. Therefore, it would be logical to attempt crosses between the genotypes of clusters separated by larger inter cluster distances. The maximum inter cluster distance was revealed between cluster I and VI (8.303) followed by cluster I and VII (6.368), cluster VI and cluster V (6.063), cluster II and cluster VI (6.022), cluster III and cluster VI (5.758). 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 programs of tomato for improving fruit yield. The minimum inter cluster distance was recorded between cluster V and IV (2.407). The lowest inter cluster distances indicate

that the genotype of these clusters had close relationship and hence, may not be emphasized upon to be used in hybridization programs. These findings are in confirmation with the findings of (2), (18), (1), Mitul *et al.* (2016), (10), (15), (16) and (7).

Table 4. Average of inter and intra cluster distances

Clusters	I	II	III	IV	V	VI	VII
I	1.921						
II	4.176	1.751					
III	4.198	3.572	2.029				
IV	4.652	2.781	3.132	2.004			
V	3.984	2.945	3.080	2.407	1.993		
VI	8.303	6.022	5.758	4.340	6.063	1.001	
VII	6.368	4.879	3.786	3.508	4.365	4.603	1.623

4. Contribution Percentage of Each Character towards Total Divergence

The contribution percentages of traits under studied towards total divergence are tabulated in Table 5. The highest contribution in

the manifestation of genetic divergence was exhibited by days to first fruit harvest (15.30) followed by number of primary branches (13.75), days to 50% flowering, days to first fruit set (11.17), fruit weight (8.89), plant height (8.39), fruit yield per plant (8.36), days to first fruit maturity (7.71), number of fruits per plant (6.98) and lowest in weight of the fruit per hectare (6.41). Similar result was obtained by (11), (3), (5) and (4)

Table 5. Contribution of various characters towards total genetic divergence

Sl. No.	Character	Contribution %
1	Days to 50% flowering	13.05
2	Days to first fruit set	11.17
3	Days to first fruit maturity	7.71
4	Days to first fruit harvest	15.30
5	Number of primary branches	13.75
6	Plant height (cm)	8.39
7	Number of fruits per plant	6.98
8	Fruit yield per plant (g)	8.36
9	Fruit weight (g)	8.89
10	Fruit yield per hectare (q)	6.41

Conclusion

Genotypes from the different geographical regions fall into different cluster and vice versa. This suggested that the selection of parent for hybridization should be on genetic diversity rather than on the geographical area. Maximum inter cluster distance was determined between clusters I and cluster VI so cross among genotypes of cluster I like VRT-29, VRT-52, VRT-58 and VRT-67 and genotype of cluster VI i.e., VRT-53 can be made. Intra cluster distance was determined highest for cluster III therefore, genotypes in cluster III i.e., VRT-16, VRT-23, VRT-50, VRT-54, VRT-56, VRT-57, VRT-63 and VRT-65 can be crossed among themselves to get better result in the breeding programme.

In heterosis breeding, genotypes of diverse cluster are known to play an important role of potential parents and when each genotype of different cluster are inter-crossed, they are likely to produce very good heterotic combinations. Based on cluster analysis the selected genotypes expecting to bring the improvement in the germplasm and also serve as potential hybrids, as well as evaluation of genotypes for quality purpose.

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PRECISION FARMING IN VEGETABLE CROPS : A REVIEW

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Abstract

Smart farming concepts like precision agriculture can be aptly deployed to achieve this goal. Precision farming is an integrated crop management system which uses remote sensing (RS), GPS, and geographical information system (GIS) to monitor the crop field at ground level. The disparities in crop or soil properties within a field are recorded and mapped. Then management decisions are taken as a result of continuous assessment of the spatial variability within that field. In the Indian agricultural scenario, it can be described as the precise utilization of agricultural inputs depending upon the crop, soil, and weather requirement to optimize the use of fertilizers, pesticide, and irrigation requirements for maximum productivity.

Keywords : Precision Farming, Vegetable, Robot, GPS, GIS, VRT.

Introduction

The demand for vegetable crops is continuously increasing. Sustaining this demand requires the infusion of technologies for efficient utilization of sources for deriving higher result per product of inputs with a superb quality of produce. It will be possible only through the deployment of hi-tech applications and precision farming. Precision agriculture is among the most modern technologies for sustainable agriculture, which has gained impetus in the 21st Century. Precision farming consists of using products and principles to control temporal and spatial variability regarding all factors of gardening generation for bettering crop performance and setting quality(3). Precision farming calls for effective management of resources through location unique hi-tech interventions. Precision vegetable farming provides a new solution using a systems treatment for today's farming issues, such as the necessity to balance efficiency with ecological problems .It offers to describe and model variation in soils and plant species combining farming methods to meet up with website specific needs. It seeks to improve economic return shipping and delivery and lessen the power feedback and the environmentally friendly impact of farming. Precision agriculture approaches can help both large scale farmers as well as small farm holders. Moreover, precision vegetable farming offers the promise of enhancing productivity while reducing production costs .With the precision vegetable farming describing the variability is going to be the primary key concept. Primarily, it is affected by variation within each region. In comparison, hi-tech horticulture will be the deployment of today's technology that is capital intensive, much less environment-dependent, capable of enhancing the output and quality of produce. Utilization of these interventions orchestrated together, keeping the goal of obtaining higher output in granted time results in precision vegetable farming, which is knowledge-driven(5). Precision vegetable farming aims to enhance crop performance and setting quality.

The actual benefit of precision vegetable farming is that the farmer can conduct much more regular tillage, adjust sowing rates, fertilizer application based on soil conditions, plan even more crop protection programmes with increased precision, and understand the yield variation area. These benefits may improve the real cost-effectiveness of harvest production; nonetheless, the grower should be prepared to make changes in his management types to work. Precision vegetable farming is a modern-day procedure utilized to improve crop productivity using the newest technologies, cloud computing, information technology (IoT), WSN, i.e., artificial intelligence (AI) machine learning (ML). Thus far, the majority of research suggests that PF-based methods possess a good impact on productivity and sustainability. Nevertheless (2, 4).

Precision Farming

Precision farming or precision agriculture is about doing the right thing, in the right place, in the right way, at the right time. Managing crop production inputs such as water, seed, fertilizer etc to increase yield, quality, profit, reduce waste and becomes eco-friendly. The intent of precision farming is to match agricultural inputs and practices as per crop and agro-climatic conditions to improve the accuracy of their applications.

Precision agriculture technologies help growers to better manage inputs to meet the needs of vegetable crops. Benefits of precision agriculture include maintaining uniformity across the crop, reduced costs associated with inputs, and greater knowledge of in-field variation to inform decision-making and management. Technologies currently available to vegetable growers include a range of tools that aid in on-farm sensing and monitoring such as variable rate application and controlled traffic farming. Important considerations when thinking of using precision agriculture in your vegetable production system include:

- (i) Get the fundamentals right;
- (ii) Know what you're going to use the technology for;
- (iii) Find technology that operates with your existing equipment;
- (iv) Invest time and effort up front; and
- (v) remember not all technologies are right for every farm.

Why Precision Farming?

- Yield mapping/monitoring – used to understand the variations in crop health in specific areas of a field and provide information for decision-making. Prevents soil degradation in cultivable land.
- Reduction of chemical use in crop production
- Nutrient/water monitoring – used to understand the variations in nutrient/water uptake and flow, and provide information for decision-making
- Dissemination of modern farm practices to improve quality, quantity & reduced cost of production in agricultural crops
- Variable rate controllers – technology that allows varied amounts of inputs to be applied to specific areas needed, such as water and fertilizer

Objectives of precision farming

1. **Increased profitability and sustainability:** Maximum profit can be obtained in each zone or site in a field by balancing precise amounts of inputs (seeding rate, variety, herbicide and insecticide) with crop needs, which can be determined by weather, soil characteristics (nutrient availability, texture and drainage) and historic crop performance. At the very same time, precision farming aims at sustaining this profitability.
2. **Optimizing production efficiency:** In general the aim of precision farming is to optimize returns across a field. Unless a field has a uniform yield potential (and therefore, a uniform yield goal), the identification of variability in yield potential may offer possibilities to optimize production quantity at each site or within each “zone” using differential management.
3. **Optimizing product quality:** Precision farming also aims at optimization of product quality by way of using sensors which detect the quality attributes of the crop and thus inputs are to be applied accordingly. In production systems where quality premiums exist, this may alter the amount of input required to optimize profitability and agronomic response.
4. **Most efficient chemical and seed use:** PA involves efficient use of inputs i.e. chemicals, seeds etc. according to the yield potential of the soil.
5. **Effective and efficient pest management:** One goal of precision farming is to cut crop

production inputs, which result in cost and environmental savings. Whereas conventional farming methods apply herbicides, insecticides etc. to the entire field, site-specific variable rate application puts these chemicals (i.e. herbicides, insecticides) where the problem appears.

6. **Energy, water and soil conservation:** A comprehensive approach to PA begins from crop planning and thus includes such tillage practices which conserve the soil or disturb the soil to its minimum. Besides, water is efficiently applied by using techniques like drip irrigation etc. In all these cases, very less energy is used and thus PA leads to conservation of energy also.
7. **Surface and ground water protection:** PA aims at safeguarding the environment by way of efficient use of inputs like chemicals etc. This prevents their leaching through ground water or as runoff through surface water.
8. **Minimizing environmental impact:** If better management decisions are being made to tailor inputs to meet production needs then by default there must be a decrease in the net loss of any applied input to the environment. This is not to say that there is no actual or potential environmental damage associated with the production system, however, the risk of environmental damage is reduced.
9. **Minimizing Risk:** Risk management is a common practice today for most farmers and can be considered from two points of view – income and environmental. In a production system, farmers often practice risk management by erring on the side of extra inputs while the unit cost of a particular input is deemed 'low'. Thus a farmer may put an extra spray on, add extra fertilizer, buy more machinery or hire extra labour to ensure that the produce is produced/ harvested/sold on time thereby guaranteeing a return.

Benefits of using Precision Farming in vegetable production

Precision Farming technologies have the potential to benefit a wide range of vegetable production systems through reducing costs associated with labor, being more precise with the application of inputs, and having a greater knowledge of the in-field variation in different Parts of your farm. As mentioned, PF shouldn't be thought of as a silver bullet in dealing with all problems, rather as something that will assist you in being more efficient with your current systems.

Benefits to production systems can include:

1. Increased accuracy of bed formation
2. Reduced compaction
3. Greater knowledge of drainage Patterns
4. Greater knowledge of soil structure/types
5. Increased input efficiency (e.g. water, fertilizers)
6. More effective control of pests, weeds, and diseases
7. Increased consistency of crop development
8. Increased marketable yield
9. Increased hygiene standards.

The use of PF technologies, with existing agronomic knowledge, has the potential to result in a more productive and profitable vegetable business.

Robots in vegetable production

Due to increasing issues with labour availability and rising input costs, there has been a focus to develop autonomous robots to perform a range of weed and crop monitoring, sensing, and harvesting tasks in vegetable production. These technologies have been gaining rapid traction over the past few years, with a range of technologies emerging both in Australia and internationally. RIPPF (Robot for Intelligent Perception and Precision Application) and its cousin, Ladybird, are autonomous robots that have been designed through the Horticulture Innovation Centre for Robotics and Intelligent Systems (HICRIS) at the University of Sydney's Australian Centre for Field Robotics (ACFR). Funded through Hort Innovation using vegetable industry levies and funds from the Australian Government, these new technologies aim to increase sensing, automation and decision-support on farm. RIPPF, which is currently still under development, has the ability to:

1. Identify and mechanically remove weeds
2. Detect and remove foreign objects in-field
3. Monitor crop and soil health
4. Administer precise amounts of herbicides to specific target weeds
5. Monitor crop growth.

Similar to RIPPF, there is a long list of robotic systems that have been designed to assist vegetable growers in producing more with less. Large companies like Bosch, Yamaha and John Deere, have been involved in developing new

robotic systems, as well as smaller start-up companies like Ecorobotix and Blue River Technologies overseas.

Adoption of precision farming technology

PF technologies have been used extensively throughout agricultural industries since the early 1990s; however, the rates of adoption have varied across different industries. This variability can be attributed

to a range of factors which commonly involve the complexity of the products, interoperability problems with different hardware/software devices, and the initial costs of some of the equipment. Due to the potential savings on inputs and increased productivity involved with the adoption of PF technologies, there have been initiatives set out to try and increase the adoption rates of PF technologies in Australia. Organizations like the Society of Precision Agriculture Australia (SPFA), have aimed to help growers and others in the industry understand the benefits of PF in agricultural systems. Similarly, a current project run by the Queensland Department of Agriculture and Fisheries aims to focus on adoption rates in Australia by taking commercially available PF technologies and implementing them on vegetable farms. The project, which has demonstration sites located all over Australia, takes a wide range of different technologies based on the needs of different growers, and implements them on-farm to demonstrate how they have the ability to improve production. This includes EM38 mapping to identify soil constraints, variable rate irrigation in centre pivot systems, as well as yield monitoring and mapping in different crops.

Important considerations

PF has the potential to benefit a range of growing systems, there are however several important things to consider when thinking of using PF technologies in your production system. When determining whether you need PF technologies for your farm, think back to the basics of production, and work out how you will benefit from using these technologies. Keep in mind that PF technologies won't help solve problems related to the fundamentals of production, rather it will assist in making your current practices more

efficient and precise. Remember to follow these important principles:

1. **Get the fundamentals right:** make sure you're doing everything correctly in your production system before you spend money on additional technology.
2. **Know what you're going to use the technology for:** some technology can be expensive, if you have any existing PF technology, make sure you're using it to its full potential before investing in any more. Have a clear purpose.
3. **Try and find technology that is able to interact with one another:** to reduce interoperability problems, make sure the software/hardware you invest in is compatible.
4. **Invest time and effort:** make sure you invest the time and effort into learning how to use the technology, so you get the most out of it. Document information on how to use the technology so it's easier the second time round, and for your employees to use
5. **Not all technologies are right for every farm:** every production system is different and requires different tools and technologies. What works for one farm may not work for another.

Elements of precision farming

- A) Information
- B) Technology
- C) Decision support (management)

A) Information includes data on

- Crop characteristics like stage of crop, crop health, nutrient requirement etc.
- Detailed soil layer with physical and chemical properties, depth, texture, nutrient status, salinity and toxicity, soil temperature, productivity potential etc.
- Microclimate data (season and daily) about the canopy temperature, wind direction and speed, humidity etc.
- Surface and sub-surface drainage conditions
- Irrigation facilities, water availability and other planning inputs of interest.

B) Technology

Precision Farming is a combination of application of different technologies. All these combinations are mutually inter related and responsible for developments. The same are discussed below:

1. **Global Positioning System (GPS):** It is a set of 24 satellites in the Earth orbit. It sends out radio signals that can be processed by a ground receiver to determine the geographic position on earth. It has a 95% probability that the given position on the earth will be within 10-15 meters of the actual position. GPS allows precise mapping of the farms and together with appropriate software informs the farmer about the status of his crop and which part of the farm requires what input such as water or fertilizer and/or pesticides etc.
2. **Geographic Information System (GIS):** It is software that imports, exports and processes spatially and temporally geographically distributed data.

Role of geographic information system (GIS) in precision vegetable farming

The advance GIS solutions enable checking, picture, and analyzing geographical contents to facilitate information consumption. Furthermore, the mobile version will allow farmers to keep informed about all their plots through information on soil analysis, the crop's problem, and the managing of evapotranspiration. With using remote sensing, GPS and GIS, farmers might be preferred to see site-specific demands of the farms. With this information, they can formulate and implement control techniques that will ensure the perfect use of inputs to enhance their output and profits. Therefore, geospatial technologies give you a farmer with an information resource that he/she can use generating educated decisions that guarantee effective and efficient managing of the farm to enhance its efficiency. Thus, growers need to understand and implement these ways together with their expertise and experience getting the best advantages of their farms. GIS has a hardware-software repository unit used to capture, store, enter, influence, analyze, screen, map as sort, and spatially referenced geographical information. GIS maps are energetic. On the computer display screen, map computer users can check out a GIS chart in almost any program, zoom in or out, and modify the characteristics of the information discovered within the chart. The capability of GIS to evaluate and imagine farming environments and work has shown to be genuinely beneficial to each of those connected with the agriculture business. GIS is a crucial element of automated field operations, known as precision agriculture or possibly satellite farming. Using

info collected from remote receptors and sensors installed on farm machinery, farmers have raised decision-making abilities to cook their growing to enhance yields. Last crop yields, surfaces particulars, natural material content, pH, moisture, and nutrient quantities of the grime most help in appropriate preparation for real farming. Combine harvesters constructed with GPS tracking devices are able to evaluate crop yields along with crop quality values as grow water content and chlorophyll levels in time which is genuine and at the particular place in the region from which they are harvested. Adjustable velocity engineering (VRT) will be the element of accuracy agriculture, which really allows the info being placed right to apply. It joins farm machinery, management methods, and application products to don precise amounts of cultivating inputs at specific times or locations. Precision farming with VRT has both economic and environmental benefits. Applying seed, fertilizer, nutrients, and perhaps insecticides, only where and when they are needed, might have sizable cost savings due to the farmer and boost revenues. Furthermore, harmful environmental impacts from overusing of numerous synthetic materials are relieved, and the use of specific chemical compounds might probably be eliminated wholly based on data analysis. Persistent dilemmas as nitrogen program may additionally be dealt with, helping the farmer obtain the appropriate length between excessive and insufficient. Public, individual, together with non-profit sectors, use GIS to handle public utilities to control the movement and the dispersion of goods and services(6, 8).

3. **Grid Sampling:** It is a method of breaking a field into grids of about 0.5-5 hectares. Sampling soil within the grids is useful to determine the appropriate rate of application of fertilizers. Several samples are taken from each grid, mixed and sent to the laboratory for analysis.
4. **Variable Rate Technology (VRT):** The existing field machinery with added Electronic Control Unit (ECU) and onboard GPS can fulfill the variable rate requirement of input. Spray booms, the Spinning disc applicator with ECU and GPS have been used effectively for patch spraying. During the creation of nutrient requirement map for VRT, profit maximizing fertilizer rate should be considered more rather than yield maximizing fertilizer rate.

Role of Grid soil sampling and Variable-rate fertilizer (VRT) application in precision vegetable farming

The usual soil test P or K of control strips frequently was less or perhaps optimum in responsive areas. When GIS strategies were used to analyze yield responses on the consistent P or K program, an incredibly high yield reply variation became obvious. Approximately these outcomes show an exceptionally high potential in numerous fields for dense soil sampling to identify areas with contrastingly several soil tests values. The outcomes also demonstrate an excellent chance for VRT, because this technology place on the strips, hardly ever there's undoubtedly a statistically significant (2, 6).

The standard amount of P or K fertilizer applied per acre by each method varied considerably among fields but generally was a lot less for just about any variable-rate method. Many factors might explain infrequent, small, in addition to inconsistent differences observed between uniform and variable fertilization methods, very possibly for minimal testing field areas. Nevertheless, it might just explain an absence of distinction between application methods for the 1st harvest (because extra P or K likely was utilized by every method) however, not for the following harvest. Therefore, disparities in small field places will be diluted by no response or random differences in larger area areas. Hence, although varying rate program hardly ever improved harvest yield in contrast to a consistent application, it did offer with P application significantly better. The results endorse that adjustable-rate P method will reduce P loss from places compared to a regular application over low-testing or high-testing field areas and may wind up in much better water quality. Moreover, these on-farm trials' results say that the most significant problem to utilize variable-rate fertilization effectively is the dirt sampling method and the soil test chart exactly where it should be seated. The results suggest that a major issue is if the significant small-scale P and K variation can really be calculated cost-efficiently. The convenience of increased cost sampling and fertilizer application methods increases profitability advances only if the view of

fertilization is converted to a much more demanding effect-based philosophy. Nevertheless, outcomes indicating VRT does reduce both fertilizer applications.

5. **Yield Maps:** Yield maps are produced by processing data from adapted combine harvester that is equipped with a GPS, i.e. integrated with a yield recording system. Yield mapping involves the recording of the grain flow through the combine harvester, while recording the actual location in the field at the same time.
6. **Remote Sensors:** These are generally categories of aerial or satellite sensors. They can indicate variations in the colours of the field that corresponds to changes in soil type, crop development, field boundaries, roads, water, etc. Aerial and satellite imagery can be processed to provide vegetative indices, which reflect the health of the plant.
7. **Proximate Sensors:** These sensors can be used to measure soil parameters such as N status and soil pH) and crop properties as the sensor attached tractor passes over the field.

Role of sensor technologies in precision vegetable farming

Optical and thermal sensors will be the most favored sources in plant phenotyping. Sensors are classified based on the amount and wavelength selection of measured wavelengths, the taller the detection ability. The more comprehensive the band range assessed around a specific wavelength, the diminished the measurement reliability because of the overlap of different wavelengths, even if several indices will most likely be steadier when estimated in broader bands. For a clear understanding of how sensors fixes are positioned to complement breeders' needs in vegetable crop phenotyping, it looks like far more valuable to describe the different PRSs, contemplating their working principles distant relative to how plant life speaks with the electromagnetic light. The use of the evaluation and stereo system camera rigs by computer programs of photographs taken by several angulations enable drawing sophisticated versions because of the reconstruction of growing constructions in 3D. Nevertheless, sensors reliant on reactance measurement can provide a lot more valuable information to develop physiology studies. Multispectral imaging consists of computing leaf reactance at numerous wavelengths, thus providing details for calculating

important vegetation indices. In Solanaceae, numerous scientific studies say hyperspectral sensing items for early detection of various symptoms relating to biotic stresses. Results indicated how spectral imaging is a lot more suitable for classifying ripeness stage, lessening the error as an outcome of variations which are easy in ripeness. These studies demonstrate hyper spectral items' power to choose parameters and plant diseases related to quality, thus enhancing synthetic substances in horticulture in the various phases of the supply chain. Spectrophotometer was also utilized to assess chlorophyll concentration. These two phenomena are related to the development of H₂O, which is free in the tissue and mild penetration. Results evidenced how lettuce has a drop-in plant growth triggered by severe salinity, while no improvement rate decrease was confirmed under temperature stresses. Data gathered from sensors will better offer smallholder farmers, various other stakeholders, and extension workers with updated information about their plant life to enhance productivity. Improved data and information will optimize farming inputs and time invested by farming extension employees along with different actors on the floor, ultimately leading to great utilization of electrical power and cost savings. Finally, information is necessary to allow the private sector and various other intermediaries to make decision-making methods that might get smallholder farmers like financial and insurance applications. Consequently, leaders, technology vendors, farming businesses, academics and funders should commit to coming also and together finding the potential for these technologies. Agricultural receptors gather a significant quantity of info, but they usually must run in shallow connectivity environments when applied to the developing world. Agricultural details are being collected through satellites, weather stations and ground sensors. Yet these options do not consult one another, and therefore there is just no centralized method to level data. For the info being genuinely useful in decision making, know-how vendors need to work toward interoperability and discover efficient ways to integrate it. Examples of sensor technologies used for the precision vegetable farming are presented in Table 1.

Table 1. Non-destructive compact sensors for field use and data procreation in vegetables

Vegetable	Character	Instrument with Sensors
Solanum lycopersicum	Leaves damaged by leaf miner	Nexus FT-NIR spectrometer
Solanum lycopersicum	Ripeness	ImSpector V9
Leafy vegetables	Chlorophyll content	ASD Fieldspec FR spectroradiometer
Spinacia oleracea	Crop canopy under water	Specim V10 spectrometer
Citrullus lanatus	Lycopene, -Carotene, and Total Soluble Solids	NIR On-Line® X-One
Lactuca sativa	Plant traits under extreme temperature and salt treatments	Series VNIR Micro-Hyperspec Sensor; Fluor MF
Solanum lycopersicum	Harvest time	AgroSpec VIS-NIR spectrophotometer
Cichorium intybus	Cold stress	CF Imager
Phaseolus vulgaris	Photosynthetic traits, morphological parameters architecture	Growscreen Fluoro
Brassica rapa subspecies	Quality	FluorPenFP 100 fluorimeter
pekinensis and chinensis		
Cucumis melo	Grafting compatibility	Imaging-PFM fluorometer
Leafy vegetables	quality in post-harvest storage	SPFD-502; Agriexpert CCN 6000
Solanum melongena	Fruit morphology and shape	Scanner imaging

1. **Computer Hardware and Software:** In order to analyze the data collected by other Precision Agriculture technology components and to make it available in usable formats such as maps, graphs, charts or reports, computer support is essential along with specific software support.
2. **Precision irrigation systems:** Recent developments are being released for commercial use in sprinkler irrigation by controlling the irrigation machines motion with GPS based controllers. Wireless communication and sensor technologies are being developed to monitor soil and ambient conditions, along with operation parameters of the irrigation machines (i.e. flow and pressure) to achieve higher water use efficiency.
3. **Precision farming on arable land:** The use of PF techniques on arable land is the most widely used and most advanced amongst farmers. CTF (controlled Traffic Farming) is a whole farm approach that aims at avoiding unnecessary crop

damage and soil compaction by heavy machinery, reducing costs imposed by standard methods. Controlled traffic methods involve confining all field vehicles to the minimal area of permanent traffic lanes with the aid of decision support systems. Another important application of precision agriculture in arable land is to optimize the use of fertilizers especially, Nitrogen, Phosphorus and Potassium.

A. Decision support (management)

Just having information about variability within the field does not solve any problems unless there is some kind of decision support system (DSS) in order to make VRT recommendations. Russo and Dantinne (1997) [7] have suggested the following steps for a DSS:

1. Identify environmental and biological states and processes in the field that can be monitored and manipulated for the betterment of crop production.
2. Choose sensors and supporting equipment to record data on these states and processes.
3. Collect, store and communicate the field recorded data.
4. Process and manipulate the data into useful information and knowledge.
5. Present the information and knowledge in a form that can be interpreted to make decisions.
6. Choose an action associated with a decision to change the identified state or process in a way that makes it more favorable to profitable crop production.

Steps involved in precision agriculture adoption

1. **Purchase a mapping programmed:** The first and most essential acquisition will be an entry level mapping programmed, which will allow to import, overlay and manage spatial data. This software will enable to develop a geographically referenced database for the operation
2. **Collect spatial data:** Look for existing geographically referenced data on the Internet. These and other layers of information will form the basis of the farm's geographic database.
3. **Map field boundaries:** Service providers will map your fields for a nominal fee, or you can obtain a digital global positioning system (DGPS) receiver and a laptop or hand held PC do it yourself.
4. **Keep records:** Farm records should be organized on a field by field basis. These records should include:

- a. Historical yields (whole field)
- b. Field boundary locations
- c. Soil test values
- d. Management history, including past fertility, tillage, pest management practice and financial records. To the extent possible, these records should be archived electronically in the mapping system.
5. **Obtain remote images:** Aerial or remotely sensed images of the fields should be obtained one or more times during each growing season. These images can be used to identify management problems that cannot be seen from the ground e.g., we can locate areas where inputs such as nitrogen have been misapplied. It may also be possible to detect moisture or pest stresses
6. **Purchase a yield monitor:** A yield monitor on the combine will allow determining total yields for fields or areas within fields without a weigh wagon or scales. This yield information will make it possible to do side by side comparisons of hybrids or management practices. In addition, the dynamic yield indicator in the combine's cab will enable the combine operator to observe quantitative differences in yield throughout the field.
7. **Purchase a DGPS receiver:** We can greatly expand what a yield monitor can do if we add a differential global positioning system (DGPS) receiver. The yield monitor will record DGPS position along with yield, enabling to create yield maps and evaluate how the yields vary according to location.
8. **Generate yield maps:** With the yield monitor in place and a DGPS receiver connected, we are ready to create yield maps. Most yield monitors have companion software that will create yield maps from field data. The mapping programmed can also create yield maps.
9. **Use yield maps for scouting:** One of the fundamental uses of yield maps is to locate trouble spots in a field. The yield map will help to locate problems we may not have been aware of. Once we identify them, we can decide if they can be profitably corrected.
10. **Generate profit maps:** If we have been keeping good records, including accurate yield maps, we will then be ready to get the field's profitability. Use yield information along with the cost of all inputs and field treatments, such as tillage, to generate a profitability map of the field. Locate areas of high and low profitability.

11. **Use yield and profit maps for land – use decisions:** A land use decision is the first decision most farmers make about a tract of land. We can use PA technologies to identify certain areas of the field that are low yielding or unprofitable year after year and remove these areas from production and/or enroll them in government programmers, such as the CRP. We can also combine profit maps with other field information, such as soil types, to identify areas suitable for different crops or rotations.
12. **Take site-specific soil fertility samples:** Both grid and directed sampling are used to describe soil properties for management of variable rates of fertility. In either system, collect at least five or six subsamples from each cell or zone and mix them into one sample container. When soil fertility data is returned from the soil testing lab, we can enter the data into the mapping programme to create fertility maps.
13. **Manage subfields:** Once fertility maps have been created, we can use them to make spot applications in parts of fields that are especially low in pH or other plant nutrients. This relatively crude application can be accomplished without specially equipped machines.
Simply look at the fertility map and try to make applications in the deficient areas. If we have a DGPS receiver and computer, we may be able to increase our accuracy of application by following the cursor on the field map.
14. **Adopt variable rate technology (VRT):** Variable rate management is the continuous adjustment of inputs to match local field conditions. Variable rate controllers are required on application equipment for automatic control of application or seeding rates in the field. They are used along with a task computer (a laptop PC) and DGPS receiver. In addition, the software must be able to generate application files to control the process.

Conclusions

In vegetable farming, probably the latest quick adoption of precision agriculture, approaches provide growers with quality solutions and notice food quality and security issues. With automation products recording parameters concerning product quality such as color, size, shape, external defects, sugar content, acidity, and other inner characteristics. Additionally, checking field functions as synthetic substances sprayed and

fertilizers can easily provide complete vegetable and fruit processing methods. This information might be disclosed to clients for risk management and food traceability and makers for precision agriculture being much better quality and larger yields with enhanced inputs. Recently many new methods were developed that consider the specific size of the tree, the crop issue, and the ecological variables. Vegetable quality and yield maps are of excellent worth during crop to avoid mixing grapes of several potential wine qualities. Precision vegetable farming will continue to be a concept in many developing nations, and strategic guidance from the public and private sectors is essential to promote its quick adoption. Successful adoption, nevertheless, comprises at least three phases as execution, evaluation, and exploration. Precision vegetable farming can focus on both economic and environmental issues that surround modern farming practices nowadays. Queries remain about cost-effectiveness and the most remarkable techniques to use the technical resources we today have. However, the thought of “doing the best thing in the correct area on the appropriate time” offers an excellent intuitive appeal. Ultimately, precision agriculture’s success hinges largely on how properly and how easily the information should point the new solutions might be found. Precision vegetable farming provides a new choice utilizing systems utilized for current-day agricultural issues, such as the necessity to balance efficiency with ecological problems. It is reliant on sophisticated information technologies. The polygons that stand for different ownership or municipalities can impart values in various approaches, most regular being a changing style ramp. GIS can help a farmer change to these different variables, monitor specific plants’ health, appraisal yields originating from a particular region, and enhance crop production. There are many choices for GIS info at no cost as well as for a rate. Colleges, federal organizations, and individual business owners tend to be repositories of spatial information. But, based on the development of country resources and reach some precision farming approaches are more frequently used than others (Figure 2).



Figure 2. Most frequently used precision vegetable farming approaches.

Using land-use and primary food crop information, together with info collected by mobile devices and satellites to identify locations in need root causes of food insecurity, GIS is essential to end around the world hunger. Satellites, drones, plus human-crewed aircraft are used for remote sensing, in addition to that's the gathering of information about the planet's surface area by scanning it from high altitudes. Based on the exterior temperature, the intensity of the wavelengths created by different vegetation types and various manmade and natural landscapes differs. The captured info is transformed into explicit electronic imagery and maybe set on to popular objectives like managing water for watering consumption or planting disease detection. It's competent to besides, be placed onto objectives like analyzing the maturity

of fresh fruit. It offers to describe and model variation in soils and plant species and mix farming methods to meet up with website specific needs. It seeks to increase monetary return delivery and lessen the considerable feedback and the environmentally friendly impact of farming.

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STUDIES ON BIOLOGICAL ASPECTS OF COMPLEXES OF TRANSITION METAL (COPPER) WITH ACTIVE SULPHUR DONOR LIGAND-THIAZOLE

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Abstract

Thiazoles belong to the group of azole heterocycles. They are aromatic five-membered heterocycles containing one sulfur and one nitrogen atom. In recent years thiazoles, their derivatives, and isomers have gained considerable attention because of their broad applications in different fields, such as agrochemicals, industrial, and photographic sensitizers. Also, they have pharmaceutical and biological activities that include antimicrobial (sulfazole), antifungal (abafungin), anticancer (tiazofurin), antidiabetic, anti-inflammatory, anti-Alzheimer, antihypertensive, antioxidant, and hepatoprotective activities. The compounds containing thiazole moieties are a prominent structural feature in a variety of natural products, such as vitamin B and penicillin. Thus, in this chapter several types of thiazole-based heterocyclic scaffolds such as monocyclic or bicyclic systems synthesis and their biological activities studies are presented. Furthermore modification of thiazole-based compounds at different positions to generate new molecules with potent antitumor, antioxidant, and antimicrobial activities is described.

Keywords : Thiazoles, Fungicidal Activities, Metal Ligand Complexes

Introduction

There are number of compounds known which contain thiazole nucleus shows herbicidal, fungicidal^{1,2} bactericidal³, virucidal⁴ and pesticidal⁵ activities. Thiazole and its derivatives have shown a lot of interest because in addition to nitrogen atom, they have sulphur atom as a potential donor sites, while the ring constitute the active site of vitamin D viz., thiamine pyrophosphate^{6,7}. From the therapeutic point of view, thiazole derivatives are of considerable interest, since their utility in the treatment of diseases have been firmly established^{8,9}. They contain thiourea moiety and therefore like urea derivatives can possibly act as hypo/hyper glycaemic agent^{10,11}. Thiazole and its derivatives are among the most active classes of compounds that are known for their broad spectrum of activity, e.g., antibacterial¹² antifungal¹³ antimalarial¹⁴ antitubercular¹⁵ antiviral¹⁶ anti-inflammatory¹⁷ antidiabetic¹⁸ anthelmintic¹⁹ anticonvulsant²⁰ antioxidant²¹ anticancer²² and cardiovascular activities²³, and known as new inhibitors of bacterial DNA gyrase B²⁴.

The role of metal ions in biological system is usually perceived in connection with enzymes, polypeptides and amino acids, they act as enzyme reacting catalysts by coordinating through certain ligand atoms. Large number of reports appeared in the literature about the importance of mixed ligand complexes in the field of medicinal²⁵, analytical²⁶ and industrial chemistry²⁷. The role of mixed ligand

complexes in biological process has also been recognized²⁸ the preparation of some metal complexes with 2-Amino-4-(p-methoxy/ethoxy phenyl) thiazole. The newly synthesized complexes were characterised by their elemental analysis mp etc. I.R. electronic, magnetic studies were also done to know the bonds and structure. Complexes were also screened for their fungicidal activity against different fungi at different concentrations.

Experimental

[A] SYNTHESIS OF LIGAND : Ligands were prepared according to the process reported in the literature^{29,30}.

A mixture of methoxy acetophenone (0.1 mole), thiourea (0.2 mole) and bromine (0.1 mole) was mixed together and the slurry formed was heated on a water bath for 60 hrs. It was cooled and kept in contact with ether for 24 hrs. the ether was removed and the residue washed several times with 10% hypo solution followed by water. The residue was boiled with water and filtered and the filtrate made alkaline with conc. Ammonia yielding a solid mass, which was filtered, washed with water and recrystallized from ethanol (95%), as a condensing agent..

Ligand	% found / calculated			
	C	H	N	S
C ₁₀ H ₁₀ N ₂ OS	58.30 (58.25)	4.90 (4.85)	13.60 (13.59)	15.36 (15.53)

: 2-Amino -4- (p-methoxy phenyl) thiazole complexes

DICHLORO/DINITRATO AND DIACETATO BIS (2-AMINO -4- p-METHOXY/ETHOXY PHENYL) THIAZOLE Cu (II) COMPLEXES

These complexes were prepared following the above method. Elemental analysis correspond to the molecular formulae given below :

Complex	% found/Calculated				
	C	H	N	S	Cu
[Cu (C ₁₀ H ₁₀ N ₂ OS) ₂ Cl ₂]	43.86 (43.88)	3.68 (3.66)	10.28 (10.24)	11.72 (11.70)	11.74 (11.70)
[Cu (C ₁₀ H ₁₀ N ₂ OS) ₂ (NO ₃) ₂]	40.02 (40.0)	3.38 (3.33)	14.50 (14.0)	10.65 (10.67)	10.65 (10.67)
[Cu (C ₁₀ H ₁₀ N ₂ OS) ₂ (CH ₃ COO) ₂]	48.50 (48.49)	4.40 (4.38)	9.46 (9.43)	10.72 (10.78)	10.72 (10.78)

Results and Discussion

Analytical data show 1 : 2 metal to ligand stoichiometry for Cu (II) complexes.

Infra Red Spectral Studies

Thiazole, which is formally derived from imidazole by replacement of -NH by sulphur in position one makes it a better p-acceptor due to the availability of empty d- orbitals on sulphur atom. Because of complex formation all the absorption frequencies are affected but the absorption due to -NH₂ group C=C and C-S vibration are affected the most. The main absorption bands lie in the region 3510-3400, 3330-3300 cm⁻¹ assigned to g (NH) asymmetric and symmetric vibration respectively at 1625 cm⁻¹ attributed to g (C-H) vibration while the bands due to stretching (1610-1550 cm⁻¹) and pulsating (910-870 cm⁻¹) vibration characterizes the thiazole ring system.

The bands in the region 1530-1600, 1495, 1400, 1020-800 cm⁻¹ are characteristic of five membered thiazole ring. Where as those near 1700-1470 cm⁻¹ are due to conjugated cyclic -C=C-N=C- system and at 1125-1040 cm⁻¹ is attributed to 2, 4-disubstituted thiazole ring deformation vibrations. -N=C-S group vibration lie in the region 1560-1395 and 1170-960 cm⁻¹. The characteristic aromatic ring vibration appear near 1600-1360 cm⁻¹ and generally form bands around 1615, 1585, 1485 and 1455 cm⁻¹ are observed in the ligands³¹. For phenyl 1600-1590 cm⁻¹. For the structure outlined for thiazole, it is expected that on coordination through sulphur or nitrogen, g (C-S) stretching vibrations with slightly decrease while g (C=N) vibration remain almost unaltered. Thus, the shift in g (C-H) to higher g (C=C) to higher and g (C-H) out-of-plane made to lower wave numbers indicate that either there is slight increase in bond order of C=C bond, or the strain in the ring system is reduced after complexation. During complexation the g (C=N) frequencies occurring at 1641-1630 cm⁻¹ in the free ligands remains practically unchanged, suggesting there by that N-atom of the ring does not take part in complex formation³². In the free ligands the band at 655 cm⁻¹ assigned to asymmetric g (C-S) is attributed to symmetric g (C-S) either disappear or is reduced in intensity, indicating that ring sulphur is involved in coordination⁴². The g (N-H) frequencies also decreases appreciably due to the interaction of the lone pair of electrons on nitrogen atom of the amino group with p-electron system of the conjugated system, which reduces the N-H

bond strength, thus giving an idea about the point of attachment with the metal ion^{33,34}.

The ν (N-H) asymmetric and symmetric stretching frequencies appear in the regions 3510-3400 and 3330-3300 cm^{-1} respectively while N-H bonding vibration occur at 1610-1655 cm^{-1} in the free ligands. Assignments are based on related amino complexes³⁵. A number of medium strong bands were present in the region 300-325, $\sim$ 330, 288-330, 282-340, 280-305, cm^{-1} which can be assigned to ν (Cu-N), vibrations respectively^{36,37}.

A number of new bands in the spectra of complexes appear in the region 210-280 cm^{-1} which many be attributed to ν M-S vibrations respectively³⁸. The frequencies are well within the range corresponding to different geometries of the metal ions³⁹.

Infra Red Spectra Of Chloro Complexes

In the present complexes bands due to M-Cl are compared with the analogous halogen complexes^{40,41}. Cu (II) complexes are six coordinated, possessing chloride bridge structure⁴². Which is supported by the presence of Cu-Cl (short band) at 270-320 cm^{-1} and Cu-Cl (long band) at 240-262 cm^{-1} .

Infra Red Spectra Of Nitrate Complexes

Nitrate complexes of Cu (II) exhibit bands at 1410-1375, 1350-1275, 990-1020, and 825-790 cm^{-1} attributable to asymmetric NO_2 , symmetric NO_2 stretch, NO stretch and out of plane NO_2 , rocking vibrations respectively. While free NO_2 ion exhibits ν_a (NO_2) and ν_s (NO_2) stretch at 1260 and 1345 cm^{-1} respectively. Thus ν_a (NO_2) shifts markedly to higher frequencies while ν_s (NO_2) changes very little on coordination. The separation of frequencies of about 125-160 cm^{-1} are compatible with the monodentate coordination of the nitrate group⁴⁰ which is further confirmed by the magnitude of splitting of bands found in the region 1750-1770 cm^{-1} ⁴³.

Infra Red Spectra of Acetate Complexes

The present acetate complexes of Cu (II) complexes exhibit weak bands at 1550-1588 and 1410-1430 cm^{-1} assignable to ν (COO) ν_a and ν (COO) ν_s stretching vibrations, respectively indicating ionic nature of the acetate group^{44,45}.

Magnetic Moment and Electronic Spectral Studies

Following discussion summarizes the magneto-chemical coupled with spectral studies of thiazole metal complex Cu (II) Complexes

The room temperature magnetic moments for the present Cu (II) complexes lie near 1.84-2.10 B.M. except Cu (II) acetate complexes where it lies as $\sim$ 1.70 B.M. corresponding to the distorted octahedral and square planar configuration respectively. Square-planar complexes of Cu (II) ions exhibit larger separation between the ground $^2B_{1g}$ and the component of $^2T_{2g}$ term, which seems to be responsible for the lower magnetic moment values of planar complexes⁶⁶ while complexes of perfect tetrahedral geometry have these higher than that of planar or octahedral complexes due to spin-orbit coupling and are temperature dependent⁴⁶.

The electronic spectra of the present acetate Cu (II) complexes have square – planar environment which is confirmed by the nature of absorption appearing in region 15000-15450 and 18000-18300 cm^{-1} assignable to $^2B_{1g} \rightarrow ^2A_{1g}$ and $^2B_{1g} \rightarrow ^2E_g$ transitions respectively. A maxima has been observed to lie around 13150 cm^{-1} which is characteristic of a planar geometry while all the other Cu (II) complexes exist in distorted octahedral symmetry. Since the $3d^9$ configuration of Cu (II) ion gives rise to 2D free ion term which splits in a regular octahedral field into a double E_g level and an upper triplet T_{2g} level. However d^9 configuration is highly Jahn-Teller unstable and the resulting tetragonal distortion (D_{4h}) leads to further splitting of E_g , T_{2g} levels into B_{1g} , A_{1g} , B_{2g} , and E_g levels respectively.. Thus these transitions $B_{1g} \rightarrow ^2A_{1g}$, and $^2B_{1g} \rightarrow ^2E_g$ occur at 15650 and 18650-20050 cm^{-1} respectively in Cu (II) complexes. Because of low intensity of $^2B_{1g}$, this band is usually not observed with conformity. The position and nature of the bands are however suggestive of distorted octahedral geometries for the Cu (II) complexes^{44a}.

Fungicidal Activities

Thiazole derivatives have gained prominence as pharmacologically important compounds. Most organic compounds which are capable of functioning as biological alkylating, arylating or

phosphorylating agents possess reactive centres with low electron densities, while the compounds possessing a variety of functional groups are capable of forming covalent bonds with essential metabolites and thus display biological activities. However this property itself is not sufficient to result in compounds to be useful as fungicides. Diethyl sulphate and diazomethane are biological alkylating agents but they are protoplasmic poison and non specific in their action. To be useful as fungicides, a compound must posse selective activity and must not be phytotoxic and

The fungicidal activities of the ligands (APMT) and its copper metal complexes were evaluated against Phoma – exigua, Macrophomia.-Phaseoli Colletotrichum – Capsici at concentration 100, 50 and 20 (Table 1)

The results indicate that the fungitoxicity of the 2-amino-4-(p-methoxy phenyl) thiazoles depends on the thiazole ring -NH₂ group as well as on the metal ions. It seems that the thiazole ring opens to yield a thiocyanate unit which catalysis the iodine – azide reaction. Vinyl Isothiocyanate so obtained from cleaved thiazoles exhibit considerable fungicidal activity. The effect of amino group as substituents at position-2 will give a thiourea a derivative on the cleavage of thiazole ring. These cleaved products interacts with the active constituents of the living tissues and destroy their contribution to life process.

Thus, the group -N=C-S- is considered to be essential for biological activity. In these chelated ligands the metal is coordinated though S and N donar atoms, utilizing both the valencies of metal ions, Cu (II) have been utilized in the formation of chelate compounds. Thus, in complexes the groups responsible for antifungal activity are coordinated with the central metal atom and are not free, so decrease in activity is exhibited by such complexes. It can be concluded from the growth inhibition date for fungi that the ligands APMT possess good fungicidal activity.

The fungitoxicity of these complexes varies with the fungus species. The polar substituent i.e. the -NH₂ group at position two of both the ligands play an important role in toxicity possibly by serving as ligands in chelates formation. However, the toxicity of the ligands decreased on coordination to the metal ions. Although the nature of anions associated with the metal ions

does not influence fungi-toxicity appreciably, yet they may also be considered important present in protein by virtue of which heavy metal ions

Table 1 : Fungicidal screening; Growth responses of phoma-exigua, Macro phomina-phaseoli and Colletotrichum-capsici (After 168 hours at 25 ± 1° on Czepeck's Dox Agar Medium) at different concentration (in ppm) in relation to the ligand. 2-Inino 1-4-(p-methoxy phenyl) -Δ⁴ - Thiazole (AMPT) and its metal complexes.

	Average percentage inhibition after 168 hours								
	Phoma-exigua			Macrophomia-phaseoli concentration used in ppm			Colletotrichum-capsici		
	100	50	20	100	50	20	100	50	20
[Cu (L) ₂ Cl ₂]	71.4	51.4	30.1	74.5	36.2	30.5	70.5	49.6	21.5
[Cu (L) ₂ (NO ₃) ₂]	62.8	40.8	30.5	64.4	35.8	30.2	66.4	30.8	20.4
[Cu (L) ₂ (CH ₃ COO) ₂]	61.2	40.0	30.4	62.8	35.6	30.0	64.2	30.2	20.2

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EFFECTS OF 24 HOURS PRETREATMENT OF SEEDS WITH DIFFERENT ONCENTRATIONS OF MANAGANESE ON THE GROWTH OF CUCUMISMELO CULTIVAR PUNJAB HYBRID SEEDLING IN DARK

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Abstract

Manganese is essential micronutrient for the growth of seedling and metabolism of higher plants. As a trace element it regulates the development and growth and is not replaced by any other element in its function. The studies on pretreatment of seeds with different concentrations of Manganese the germinations and seedling growth of **Cucumis Melo** CV. Punjab hybrid seedling in dark. There is general inhibition (at all higher concentration) and promotion at the lower concentration i.e. 1 and 10 ppm) of germination and seedling growth of cucurbits. Out of certain factor responsible for the reduced growth in the presence of higher Manganese concentration is increased uptake of heavy metals which portably interfere with the growth mechanism. Organ specific crop based on differences in response to manganese concentration was observed in present studies.

Keywords: Cucumis Melo hybrid Manganese heavy metal seedling growth environmental pollution.

Introduction

The committee on pollution national academy of sciences, U.S.A. defined pollution as “an undesirable change in the physical chemical and biological characteristics of our air water and soil that may or will harmfully affect human or plant life.”

Suggested that pollution is caused by all those environment, which damage the ecological balance and causes harm to human health. It is proposed in common usage that the term pollution be restricted to certain human activities. For instance affluent industrialized countries are dumping a lot of materials and waste in their immediate environment.

The problems of environmental pollution by heavy metals has attracted much attention in recent years. The metals having density greater than 5 g, cm⁻³ an atomic number greater than 23 with the exception of rubidium and strontium are accumulated into environment through various human activities such as discharge through industrial effluent/emission, use of fertilizers automobile exhaust etc. Being non degradable, the heavy metals persist in the environment and accumulate in living organisms through the food chain out of all the pollutants some such as Cd and Hg are not the constituent of living organism but become hazardous when their presence exceeds a certain level.

Vegetable and fodder crops are generally grown around the cities and are frequently manured with town refuse, sewage sludge etc additionally the farmers around most cities irrigate their crops with sewage water drawn mostly from Nullah and perennial stream flowing along the town and used as a sink for the disposal of sewage waster and industrial effluents of the city.

A large number of industrial effluents are passed in to such perennial streams. The water of such streams is thus, likely to have high amounts of toxic metals along with essential nutrients and organic matters. This is why its use in low concentration results in unpredictable yield response to manures and fertilizers as well as nutritional disorder in plant, like increase in total heavy metals.

Toxic effects of high concentration Mn in field and garden crops summarized Manganese toxicity in cotton also worked out (Adam and wear, 1957) Souto and Doberneiner (1971) summarized Mn toxicity in some legumes. Accumulation of Mn in tomato and onion seeds also reported (Traverse and Rickeless, 1973) vlamis and Williams (1973) reported toxic effect of Mn in lettuce. Toxic effects of Mn also worked out in soyabean (Brown and jones 1977).

Toxic effect of high concentration of Mn have also been summarized in certain plants (Strong et al. 1985). Toxicity of Mn in Musk melon also described (6) Thus it is obviously a deceptive pollution hazard. Thus in view of those observations the present investigation therefore was undertaken to study the effects of heavy metal pollutant manganese (Mn^{++}) on certain crop plants.

Bhargava El Singh (1982) found that seedling grown of certain cucurbits and legumer was promoted at lower concentrations and inhibited at higher concentrations of Ni and Zn given as $NiSO_4$ and $ZnCl_2$ respectively.

Goel (1992) studied the physiological effects of polluted river water containing heavy metals on certain legumes, cucurbits and cereals.

Eenink and Garretsen (1977) showed that in lettuce, Mn tolerance is reportedly controlled by on to foud genes, depending on the particular species of lettuce involved Brown and Devine (1980) reported in soybean the control of tolerance to excess Mn appeared to be multi generic rather than controlled by a one gene locus.

Cucurbits

The seed germination and subsequent seedling growth was also studied in three cucurbits species ie. Cucumismelo, Linn = Roxb. Cultivar Punjab Hybrid Cucumis utillissimus,Roxb. Cv. Lakhnavi and Luffaaegyptiaca.

Mill CV. PusaChikney. Observations show that all cucurbits in general shows promotion at 10 mg/1 Mn concentration and inhibition at 50 and 100 mg/1 Mn concentration for germination and seedling growth. However, the extents of inhibition are more at higher concentrations.

The dose response curve of 5^m day old seedlings of the cucurbits studies. It is noted that there is an increase in radicle and hypocotyl/length at lower concentrations and gradual decrease in these length at both higher concentrations. However the pattern of both radicle and hypocotyl growth inhibition are nearly similar in higher manganese pretreatment to seeds.

Cucumis Melo

Tables and figure show the effects of various concentrations of manganese on germination and subsequent seedling growth of Cucumis Melo Linn CV. Punjab hybrid in dark.

Table

Effect of Manganese on germination percentage of Cucumis Melo CV. Punjab hybrid seedling grown in Dark.

Concentration of Manganese mg/l				
Cultivar	0	10	50	100
PH	80.00	86.50	76.40	72.10

Germination

Table show the effects of Manganese pretreatment to seeds on germination of CucumisMelo Linn CV. Punjab hybrid in dark.

Table indicate that there is a general inhibition in germination percentage in this cultivar in higher concentration and promotion in lower concentration. However the extent of inhibition increases with increasing concentrations. Thus germination percentage in this Cv in dark is 108.1%, 95.8% and 90.1% of control respectively in 10, 50 and 100 mg/1 and Mn concentration.

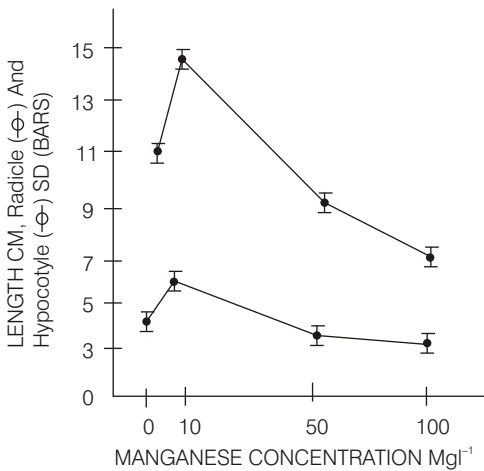
Seedling Growth

Table and figure show that like germination seedling growth is also promoted at lower concentration and inhibited at higher concentration of manganese. However, the extent of inhibition is being more at 100 mg/1 Mn concentration Thus on 5th day in dark grown seedlings radicle and hypocotyl lengths are 127.1% and 125.0% of control respectively in 10 mg/1 Mn

concentration similarly on the 5^m day radicle and hypocotyl fresh weight are 135.5% and 155.5% of control respectively in dark grown seedlings in 10 mg/1 Mn concentration Unlike promotion an extent of inhibition in seedling growth is observed at higher concentrations of manganese. thus in dark grown seedling on 5^m day radicle length inhibited by ca 23% and 34% respectively in 50 and 100 mg/1Mn concentration like wise in similar condition at the same day hypocotyl length is inhibited by ca 20% and 39% respectively in the same concentration of manganese similarly these promotion and inhibition are also borne with fresh weight of radicle and hypocotyl in lower and higher manganese concentration.

Table shows the pattern of dry matter transfer from cotyledons and distribution in the seedling parts as affected by manganese in dark grown seedlings observations indicate that the increase in dry weight of radicle and hypocotyl is paralleled by the decrease in the dry weights of cotyledons from 3rd to 7^m day of germination in control as well

as manganese pretreated sets in CucumisMelo cultivar. Further retention of dry matter in cotyledon is more at higher concentration than the lower concentration of manganese.



Dose response curve of 5 day old seedlings of cucumis melo cv. Punjab hybrid in different concentrations of Manganese

Table effects of 24 hours Pretreatment of seeds with different concentrations of manganese on the growth of Cucumis Melo CV. Punjab Hybrid seedling in Dark

Seedling Part		Concentration of Manganese Mg/Lt									
		10			50			100			
		Days After Radicle Emergence									
3	5	7	3	5	7	3	5	7	3	5	7
LENGTH CM SD											
Radicle											
3.20	4.50	5.02	3.84	5.15	7.60	3.00	3.12	4.76	2.54	2.67	3.42
0.32	0.58	1.13	0.20	0.38	1.40	0.26	0.42	0.90	0.34	0.30	0.46
Hypocotyle											
8.07	11.21	13.01	9.50	14.02	18.50	5.61	9.05	11.04	4.70	6.70	8.60
1.04	1.60	2.10	0.74	0.98	2.80	0.50	1.23	1.34	0.34	1.02	1.12
FRESH WEIGHT, MG SD											
Radicle											
15.9	28.2	40.6	22.50	38.0	56.0	13.5	19.0	26.01	11.04	15.10	18.0
3.60	6.1	8.1	2.52	3.4	5.10	1.3	1.30	4.14	1.20	1.52	3.82
Hypocotyle											
95.5	135.0	178.0	115.61	210.0	250.0	70.4	105.4	130.4	55.5	80.4	92.01
9.40	32.0	40.0	9.76	22.1	36.1	8.12	15.20	17.13	7.42	13.32	16.88
Cotyledon											
86.40	82.50	71.50	147.0	117.6	93.00	81.20	67.21	62.00	70.00	66.00	47.00
2.34	2.07	5.10	9.10	12.06	6.50	6.10	7.18	2.02	5.10	4.05	12.72
DRY WEIGHT MG SD											
Radicle											
6.70	9.20	12.00	7.60	10.80	15.00	5.01	7.41	10.05	4.25	5.60	9.05
0.82	0.60	1.30	1.01	0.94	1.20	0.60	0.90	0.98	0.38	0.80	0.89

Hypocotyle											
10.21	26.45	34.25	14.20	31.50	40.08	8.50	15.40	21.55	7.86	13.54	18.50
2.80	2.94	1.40	2.20	3.24	1.62	1.60	2.10	2.80	1.36	1.40	1.20
Cotyledon											
39.85	18.50	6.40	34.65	18.30	3.80	41.70	30.88	20.14	42.01	33.41	25.36
0.68	0.74	0.80	0.46	0.60	0.88	0.92	0.98	0.70	1.02	1.08	0.90

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