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EFFECTIVENESS OF ESSENTIAL OILS AGAINST THREE STORED GRAIN INSECT IN PLASTIC JARS

Ranjeet Kumar[1]* and P. S. Pandey[2]

[1]Department of Entomology, Veer Kunwar Singh College of Agriculture
Bihar Agricultural University, Sabour, Bhagalpur, Bihar (813210)
[2]Assistant Director General (Education Planning & Home Science) ICAR, New Delhi (110012)
***Corresponding Author Email**-rkipm06@gmail.com

Abstract

The laboratory experiment was conducted to evaluate the efficacy of essential oils against *Sitophilus oryzae, Rhyzopertha dominica and Tribolium casataneum* in wheat stored in plasic jars under laboratory condition. The essential oil of *Chenopodium botrys*, *Citrus reticulata, Lantana camara, and Pinus roxburghii* at 0.4 percent either alone or in combination of *Chenopodium botrys+ Citrus reticulata, Citrus reticulata+ Pinus roxburghii, Lantana camara + Pinus roxburghii Chenopodium botrys + Pinus roxburghii* at 0.2 percent each completely check the feeding and breeding of *Sitophilus oryzae, Rhyzoprtha dominica and Tribolium castaneum* and inhibit 100 percent population in wheat stored in plastic jars. The essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara*, and *Pinus roxburghii* at 0.4 percent either alone or in combination of *Chenopodium botrys+ Citrus reticulata, Chenopodium botrys+ Lantana camara* and *Lantana camara+ Pinus roxburghii* at 0.2 percent each completely check the infestation as compare to untreated control in plastic jars.

Key words: *Sitophilus oryzae, Rhyzopertha dominica ,Tribolium casataneum, Essential oils.*

Introduction

The last four decades serious attempts are being made to find its alternative in plant kingdom and hundreds of plants have been screened to search their fumigation potential. And most interesting so many plants have been identified which are equipped with fumigant properties against insect pests of stored grain. Now it has been proved beyond doubt that under laboratory condition the plant components can suppress feeding and breeding of stored grain insect or even kill them completely within a few hours just like chemical fumigants. Essential oils are secondary metabolites that plants produce for their own needs other than nutrition. Generally they are complex mixture of 20-60 organic compounds that provides characteristic odour and flavor to leaves, flowers, fruits, seeds, bark and rhizomes [1]. Several essential oils have the properties of anti parasitical, bactericidal, fungicidal, virucidal and insecticidal properties [2]. Essential oil from more than seventy five plant species belonging to different families, have been studied for fumigant toxicity against several insect pests of storage grain. In view of above mentioned fact the present study was taken up to determine the effectiveness of essential oils and their combination against *S. Oryzae, R. dominica* and *T. castaneum* in stored wheat in plastic jars by fumigant toxicity test.

Materials and Methods

Culture of the Insect

Pure culture of test insects were developed in the BOD incubator (27°C±1 and 70±5% RH). Plastic jars of 1 kg capacity were used for rearing. At the center of the lid a hole of 1.8 cm dia was made and covered with 30 mesh copper wire net to facilitate aeration in the jar. Adults of *R. dominica*, and *S. oryzae* were reared on the grains of wheat variety HD-2967 and its flour fortified with 5 percent yeast powder used for rearing of *T. castaneum*. Before use, grain was disinfested at 60° C for 12 hr in hot air oven. After disinfestation the moisture content of the grain was measured and raised to 13.5 percent by mixing water in the grains. The quantity of water required to raise the moisture content was calculated by using following formula as described by (3). Oils selected for the study were extracted by steam distillation in the laboratory by Clevenger Apparatus.

Procurement of Essential Oil

The essential oils selected for the study were extracted from the locally available plants by steam distillation with Clevenger Apparatus in Department of Entomology Laboratory, veer Kunwar Singh College of Agriculture, Dumraon, Buxar, Bihar Agricultural University, Sabour. The extracted essential oils were kept in refrigerator at 4° C till experiment.

Preparation of Grain

The experiments were conducted on graded and untreated wheat seed variety HD 2967. Before use, the grain was disinfested and raised moisture content to 13.5 percent as rearing conditions. To ensure the even distribution of water, the grain was spread on a platform and water was sprayed on it by hand sprayer. The grain was then mixed thoroughly and closed in polythene bag for a week for equilibration of moisture content of grain. The Experiments were conducted at same as rearing condition.

Fumigant Toxicity Test

The experiment was conducted to study the fumigant toxicity of four essential oils and their combinations. The experiment was performed under controlled conditions at 27+1 C temperature and 70+ 5 percent relative humidity. Four kilogram of wheat grain variety HD 2967 (moisture 13.5 percent) was filled in 5 Kg capacity of plastic Jars. Fifty pairs of adult insects (0-7 days) of *S. Oryzae, R. dominica*, and *T. castaneum* were released in each plastic Jars. After 24 hours of releasing the adults, required quantity of oil soaked on blank mat was inserted in each vial after which it was closed and sealed with paraffin wax. Each treatment was replicated three times. Observation was recorded after ten months of treatment up to spoilage of grain in untreated control. The homogenous sample of five hundred gram from each replication was taken for calculations of percent inhibition. The Data was analyzed in completely randomized design after suitable log (X + 1) transformation.

Results and Discussion

The number of adults of S oryzae, R. dominica and T. castaneum emerged and percent inhibition due to treatment of treament in stored wheat in plastic jars presented in table 1. The table revel that the essential oil of Chenopodium botrys, Citrus reticulata, Lantana camara, and Pinus roxburghii at 0.4 percent either alone or in combination of *Chenopodium botrys+ Citrus reticulata, Citrus reticulata+ Pinus roxburghii, Lantana camara+ Pinus roxburghii Chenopodium botrys+ Pinus roxburghii* at 0.2 percent each completely check the feeding and breeding of Sitophilus oryzae and inhibit 100.00 percent population as compare to untreated control after ten months of wheat stored in plastic jars. Number of adults of Rhyzopertha dominica and percent inhibition due to treatment of essential oils in wheat stored in Plastic jars, the essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara*, and *Pinus roxburghii* at 0.4 percent either alone or in combination of *Chenopodium botrys+ Citrus reticulata, Chenopodium botrys+ Lantana camara, Chenopodium botrys+ Pinus roxburghii , Citrus reticulata+ Lantana camara, Citrus reticulata+ Pinus roxburghii, Lantana camara+ Pinus roxburghii* at 0.2 percent each were found highly effective against Rhyzopertha dominica as they caused 100.00 percent inhibition as compare to untreated control after ten months of storage. In other words all tested essential oils either alone or in combination at 0.4 percent completely check the feeding and breeding of *Rhyzopertha dominica* after ten months of storage in plastic jars as compare to untreated control.

Table 1. Number of adults of *S. Oryzae, R. dominica, T. castaneum* emerged in wheat grain treated with essential oils in plastic jars

Essential oils	Percent Concentration	Percent Combination	*Sitophilus oryzae*		*Rhyzopertha dominica*		*Tribolium castaneum*	
			Adult Emerged	Percent Inhibition	Adult Emerged	Percent Inhibition	Adult Emerged	Percent Inhibition
Chenopodium botrys	0.4		0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.4		0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara	0.4		0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pinus roxburghii	0.4		0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys+ Citrus reticulata	0.4	0.2E	20.7 (2.8)	87.62	0.0 (0.0)	100.00	0.7 (0.3)	97.46
Chenopodium botrys+ Lantana camara	0.4	0.2E	0.0 (0.0)	100.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys+ Pinus roxburghii	0.4	0.2E	5.0 (1.3)	97.00	0.0 (0.0)	100.00	9.3 (1.1)	95.06
Citrus reticulate+ Lantana camara	0.4	0.2E	5.0 (1.3)	97.00	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulate+ Pinus roxburghii	0.4	0.2E	9.3 (1.1)	95.06	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara + Pinus roxburghii	0.4	0.2E	10.6 (1.5)	96.45	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Untreated control	—-	—-	166.7 (5.1)	0.0	218.7 (5.3)	0.0	149.7 (6.8)	
S. Em. ±			0.37		0.24		0.23	
CD (P=0.05)			1.11		0.89		0.84	

Data in parenthesis indicate Square root (X+1) transformed value, E= Each

The essential oil of Chenopodium botrys, *Citrus reticulata, Lantana camara*, and *Pinus roxburghii* at 0.4 percent either alone or in combination of *Chenopodium botrys+ Citrus reticulata, Chenopodium botrys+ Lantana camara, Chenopodium botrys+ Pinus roxburghii , Citrus reticulata+ Lantana camara, Citrus reticulata+ Pinus roxburghii, Lantana camara+ Pinus roxburghii* at 0.2 percent each were found highly effective against Tribolium castaneum as they caused 100.00 percent inhibition as compare to untreated control after ten months of storage. In other words all tested essential oils either alone or in combination at 0.4 percent completely check the feeding and breeding of *Tribolium castaneum* after ten months of storage in plastic jars as compare to untreated control.

The essential oils of *M. koenigii, C. reticulata, C. citrinus* either alone at 0.2 % or two component combinations found highly effective against *S. oryzae* and *R. dominica* (1). Essential oil of sweet annie, Artemisia annua evaluated by (5) against *T. castaneum* and *C. maculatus* revealed adult repellent and negative correlation between larval or survival and adult emergence of *T. castaneum*. (6) observed fumigant toxicity of essential oil from cumin (*Cuminum cyminum*) against eggs of two *T. confusum* and *Ephestia kuhniella* with 100 % mortality. The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Sitophilus oryzae* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Chenopodium botrys, Curcuma longa, Citrus reticulata, Lantana camara, Pinus roxburghii, Cymbopogon winerianus, Eucalyptus globules,*

Cymbopogon flexuosus, Cymbopogon martini at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against *Rhyzopertha dominica* as they caused hundred percent inhibition as compare to untreated control. The essential oil of *Chenopodium botrys, Citrus reticulata, Lantana camara, Pinus roxburghii* at 0.1, 0.2, 0.3, 0.4 percent were found highly effective against Tribolium castaneum as they caused hundred percent inhibitions as compare to untreated control (8).

Thus, results conclude that the essential oils of *Chenopodium botrys, Citrus reticulata, Lantana camara*, and *Pinus roxburghii* at 0.4 percent either alone or in combination at 0.2 percent were found highly effective against *S. oryzae , R. dominica, T. castaneum* in stored wheat in plastic jars.

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STUDY ON THE EFFECT OF DIFFERENT LEVELS OF READY MIX FORMULATION OF SULFOSULFURON AND METSULFURON-METHYL ON YIELD AND YIELD ATTRIBUTES OF WHEAT

Yogander Kumar, Vedpal Singh and Ashok Yadav

Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar - 125004, India

Abstract

The investigation was conducted during winter season of 2005-06 and 2006-07 at the Agronomy Research Area of the Department of Agronomy, Chaudhary Charan Singh, Haryana Agricultural University, Hisar (India).The growth parameters like plant height and dry matter accumulation of wheat at 30, 60 and 90 DAS and at harvest were significantly higher with the application of sulfosulfuron + metsulfuron @ 40g ha-1 as compared to weedy check. Similarly, various yield attributes (viz. No. of spike m2, spike length, number of grains per spike and 1000 grain weight), yields (grain and straw) of wheat were also significantly higher at 40 g ha-1 as compared to weedy check. Maximum grain (5509 kg ha-1 in 2005-06 and 5674 kg ha-1 in 2006-07) and straw (6943 kg ha-1 in 2005-06 and 7097 kg ha-1 in 2006-07) yields were obtained under @ 40 g ha-1 of sulfosulfuron + metsulfuron-methyl.

Key words: sulfosulfuron, metsufuron-methyl, Sulfosulfuron + metsulfuron-methyl (Ready mix), Weeds, Wheat.

Introduction

Amongst the cereals, wheat (*Triticum aestivum* Linn.) is the most widely cultivated cereal crop of India as well as of the world. In India, it is cultivated over an area 28.0 million hectares with the production of 75.85 million tonnes and productivity of 2710 kg ha-1 (1). In Haryana, it occupies about 2.47 million ha of area with an average productivity 4123 kg ha-1 and production 10.20 million tonnes (1). Among other reasons for low wheat productivity, weeds play an important role. The losses in wheat yield caused by weeds ranges between 25-50 per cent depending upon weed species, density of weeds and the crop, soil moisture and fertility status and emergence pattern of weeds in relation of crop (2). Wheat crop is infested with both the grassy weeds (*Phalaris minor, Avenaludoviciana, Poaannuaetc.*) and broad leaf weeds (*Chenopodium album, Anagallis arvensis, Melilotusindica, Lathyrusaphaca, Vicia sativa, Fumaria parviflora, Rumexretroflexus, Convolvulus arvensis and Cirsium arvense*). *Phalaris minor* is the dominant weed found intensively in rice-wheat cropping system and it alone affects wheat yield up to 40 per cent (7). Isoproturon was the most effective and economical herbicides for controlling Phalaris minor in wheat (7). (18). but with the passage of time and continuous use, isoproturon has not only allowed shift in weed flora in favour of broad leaf weeds, but has also resulted in the evolution of resistant biotypes (10). Among different methods of weed management, herbicides are most preferably used by growers factors which have an impact on persistence of sulfonylurea could be soil type, moisture, temperature, microbes etc. Therefore, it is necessary to evaluate efficacy of ready mix formulation of

sulfosulfuron and metsufuron-methyl and also to study its persistence behaviour in different soils before making any sound recommendation for farmers use.

Materials and Method

Experimental Site and Location

The present investigation entitled, "Studies on the persistence of ready mix formulation of sulfosulfuron and metsulfuron-methyl (Total) applied in wheat" was carried out in two phases. The field experiment was conducted in 2005-06 and 2006-07 at Agronomy Research Area, of the Department of Agronomy, Chaudhary Charan Singh, Haryana Agricultural University, Hisar (India). Hisar is located at 215.2 metres above mean sea level with a latitude of 29º10' North and longitude of 75º36' East.

Weather and Climate

Climate of Hisar is semi-arid with hot and dry dessicating winds accompanied by frequent dust storms of high velocity in summer, severe cold during winter and humid warm monsoon seasons. The mean maximum temperature sometimes exceeds 48ºC during summer while minimum temperature falls to the level of 0ºC accompanied by frost in winter.

The mean annual rainfall is around 400 mm and the total rains as well as its distribution is subjected to great variations. About 85 percent of the total rains are received from South-West monsoon during July, August and early September. A few showers of cyclonic rains also occur during December, January & late spring.

The meteorological data were recorded at the meteorological observatory located near Agronomy Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Meteorological data recorded during the crop season of experiment

Soil Analysis

Chemical Analysis of Soil

For chemical analysis of soil of the experimental field, the soil samples (0-15 cm) were taken from five random places in the field. The samples taken from all places were mixed thoroughly, dried under shade and ground into fine powdery mass and were analysed for chemical constituents. The observation recorded and methods used are presented in table 2

Mechanical Analysis of Soil

For mechanical analysis of the soil, the composite soil samples were analyzed by International Pipette Method (12). On the basis of mechanical composition, presented in table 3, the soil is categorized as sandy loam in texture.

Experimental Treatment Combinations

Herbicide	**Dose (g ha ^{1})**
H1 (sulfosulfurons + metsulfuron) :	0
H2 (sulfosulfurons + metsulfuron) :	20
H3(sulfosulfurons + metsulfuron) :	40
H4 (sulfosulfurons + metsulfuron) :	80
Replications :	Four
Design :	Split Plot
Variety :	WH 711
Gross plot size :	10.0 m x 6.0 m
Net plot size :	9.0 m x 5.5 m

Characterization of Herbicides Used

Total is ready mix formation of sulfosulfuron and metsulfuron methyl. Therefore, the information of sulfosulfuron and metsulfuron methyl individually has been given in table 5 and 6 respectively.

Table 5. Properties of sulfosulfuron

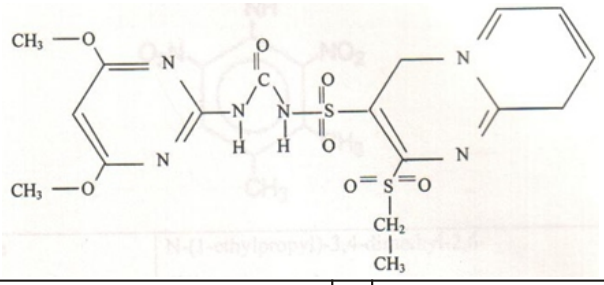
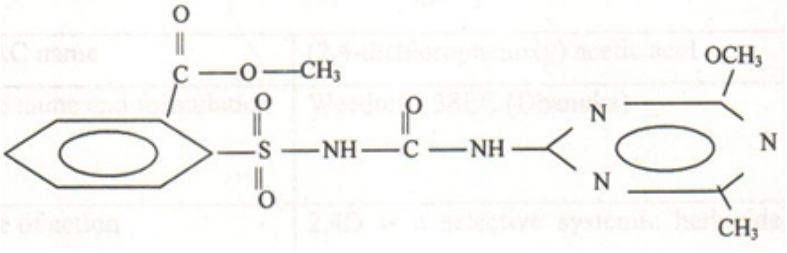
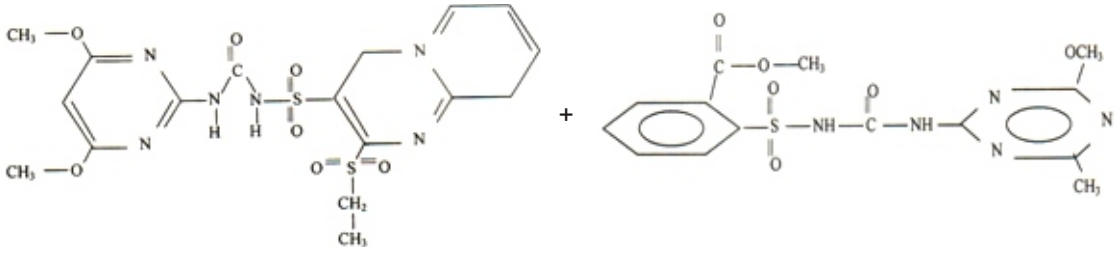
(i)	Common name	:	Sulfosulfuron (ISO proposed)
(ii)	Molecular formula	:	C16H18H6O7S2
(iii)	Chemical structure		
(iv)	IUPAC name	:	1- {2-Ethylsulfonylimidazo- [1, 2-a] pyridine-3-yl) sulfgonyl} 3-(4, 6-dimethoxypyrimidin-2-yl) urea
(v)	Trade name and formulation		Sf-10, 75% WG (UPL) Leader 75% WG (monsento)
(vi)	Mode of action	:	It is mainly used against grassy weeds but also control broad leaf weeds to low extent. It inhibits the ALS enzymes, which is involved in the synthesis of branched chain amino acids (leucine, isoleucine and valine), essential for production of new cells. It is readily absorbed by both roots and foliage and translocated in both the xylem and phloem to the site of action. Affected plants exhibit stunting, interveinal chlorosis, chlorrotic banding on grass leaves, red leaf venation, purpling, root pruning and gradual death.

Table 6. Properites of Metsulfuron-methyl

(i)	Common name	:	Metsulfuron-methyl
(ii)	Herbicide group	:	Sulfonylurea
(iii)	Molecular formula	:	$C_{14}H_{15}N_5O_6S$
(iv)	Chemical structure		
(v)	IUPAC name	:	Methyl-2-[3-(4-methyoxy-6-methyl-1, 3, 5-triazin-2-yl) urediosulfphonyl] benzoate
(vi)	Trade name and formulation		Algrip, 20% WP (Dupont)
(vii)	Mode of action	:	It enters the plant through the root zone and foliage. Inside the susceptible plants it acts by inhibiting the biosynthesis of acetolactate synthase (ALS), a key enzyme required in the biosynthesis of essential amino acids valine and isoleucine, in plants. This results in rapid inhibition of plant cell division and growth.



Sufosulfuron	+	Metsulfuron-methyl
75%	+	5%

Observations

(i) Number of spikes m ^{2}

Number of spikes were counted with the help of one meter quardant placed at three randomly selected places/plot at harvest and their average was computed.

(ii) Number of grains per spike

Twenty five randomly selected spikes per plot were threshed separately by hand and number of grains were counted from each spike and average number of grains per spike were calculated.

(iii) Spike length

Length of twenty five randomly selected spikes was taken at the time of harvest with the help of a metre scale and then it was averaged.

(iv) Test weight

A random sample of grains was taken from each plot and from this 1000 grains were counted and weighed to get test weight.

(v) Grain and straw yield per hectare

The crop of net plot area was harvested and left in the sun for four days to get dry. The weight of the harvested produce was obtained with the help of a portable spring balance to know the biological yield per plot. The crop was threshed plot wise and grain yield was recorded. The straw yield was obtained by deducting grain yield from biological yield. Grain and straw yields per plot were then converted into kg ha ^{1}.

(vi) Harvest index (HI %)

Harvest index was expressed as the ratio of grain yield to total biological yield and was expressed as per cent and calculated as follows:

$$HI \quad \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Statistical Analysis

Data collected during the study were statistically analyzed using the techniques of analysis of variance. The results were tested for treatment means by applying F-test of significance on the basis of null hypothesis suggested by Cochran and Cox (1957). To judge the significance of difference between means of two treatments, critical difference (C.D.) was computed as follows:

$$C.D. \quad \frac{\sqrt{2\,\text{Error variance}}}{n} \times t\,5\%$$

Where

CD = Critical difference

n = Number of replications

t = Value from Fisher's table (1958) for error degree of freedom at 5 per cent level of significance

Results and Discussioin

Number of Spikes

Number of spikes m-2 increased significantly with the increasing irrigation levels during both the years (Table 1). Maximum number of spikes (317.8 and 346.1) were recorded at four irrigation levels whereas minimum number of spikes (293.1 and 378.8) at two irrigation levels during both the crop seasons.

Highest number of spikes m-2 were recorded when sulfosulfuron + metsulfuron was applied @ 40 g ha ^{1} during 2005-06 and 2006-07. Sulfosulfuron + metsulfuron 20 and 40 g ha ^{1} differ significantly in respect to production of spikes during both the years of study (Table 1).

Length of Spike

The length of spike was significantly effected due to different irrigation levels and the maximum length of spike was recorded at four irrigation levels followed by three and two irrigations (Table 1).

The spike length was significantly influenced due to herbicide application. The length of spike was maximum (9.4 and 9.5 cm) when sulfosulfuron + metsulfuron was applied @ 40 g ha-1 followed by 20 g ha ^{1}, whereas minimum spike length (7.1 and 7.4 cm) was recorded in weedy plots during both the crop seasons (Table 1).

Number of Grains Spike-1

Four irrigation levels produced significantly higher number of grains spike ^{1} (55.2 and 57.1) compared to three and two levels of irrigation during both the years (Table 1).

Different herbicidal treatments had varying impact on number of grains spike ^{1}. The number of grain spike ^{1} were maximum (57.7 and 58.2) when sulfosulfuron + metsulfuronwas applied @ 40 g ha ^{1}. The minimum number of grains spike ^{1} (43.1 and 48.9) were found in weedy plots which were significantly lower than that of all herbicidal doses during both the years (Table 1).

1000-grain Weight

The test weight of wheat grains significantly differed due to different levels of irrigation. The maximum test weight was recorded due to four irrigations which was statistically at par with three irrigations during both the crop seasons. The maximum test weight (38.9 and 39.4 g) was observed with sulfosulfuron + metsulfuron @ 40 g ha-1 which was statistically at par with 20 g ha ^{1}. However, minimum test weight (35.3 and 36.2 g) was observed under weedy check (Table 1).

Grain Yield

During both the years, the grain yield was significantly different under different irrigations levels. Four irrigations produced significantly higher grain yield (5595 kg ha ^{1} in 2005-06 and 5899 kg ha ^{1} in 2006-07) compared to two irrigations (4657 kg ha ^{1} in 2005-06 and 4784 kg ha ^{1} in 2006-07) during both the years of study (Table 1).

The grain yield of wheat was significantly higher when sulfosulfuron + metsulfuron was applied @ 40 g ha ^{1} (5509 kg ha ^{1} in 2005-06 and 5674 kg ha-1in 2006-07) followed by @ 20 g ha ^{1} (5252 kg ha ^{1} in 2005-06 and 5397 kg ha ^{1} in 2006-07). Weedy plots produced minimum grain yield (4584 kg ha ^{1} in 2005-06 and 4776 kg ha ^{1} in 2006-07) and it was lower than all herbicidal treatments during both the crop seasons (Table 1).

Straw Yield

Four irrigation levels produced significantly higher straw yield compared to two and three irrigation levels during both the crop seasons (Table 1). The straw yield was significantly higher due to all herbicideal treatments compared to weedy check. The straw yield was maximum with the application of sulfosulfuron + metsulfuron @ 40 g ha ^{1} (6943 kg ha ^{1} in 2005-06 and 7097 kg ha ^{1} in 2006-07) followed by sulfosulfuron + metsulfuron @ 20 g ha ^{1} (6646 kg ha ^{1} in 2005-06 and 6753 kg ha ^{1} in 2006-07) during both the years.

Harvest Index

Harvest index was not influenced either by irrigation levels or weed control treatments during both the years (Table 1).

Yield and yield attributing characters namely number of spikes m ^{2}, spike length, No. of grains spike ^{1} and test weight improved to the tune of 8.4, 11.5, 10.1 and 7.5 per cent in 2005-06 whereas, 8.6, 12.9, 10.6 and 8.2 per cent, in 2006-07, respectively with four irrigations as compared to two irrigations.

The yield attributes of wheat were improved because of sufficient moisture supply through frequent irrigations applied at different critical stages to avoid competition for moisture between weeds and crop plants. Further, sufficient moisture available due to three and four irrigations might have enhanced the nutrient supply to the plants and reflected into better growth and more yield attributes (Table 1). More number of spike m ^{1}, grain spike ^{1} and test weight at optimum moisture levels was recorded by (3). The grain as well as straw yield also increased significantly as the number of irrigations increased from two to four in both the years. The per cent increase in grain and straw yield with four irrigations over two irrigations was estimated to be about 20 and 17% in 2005-06 and 23 and 17 per cent in 2006-07. (5). Also found significantly higher grain and straw yield of wheat in high frequency than in low frequency irrigation.

Application of sulfosulfuron + metsulfuron exhibited significant effect on yield and yield attributing characters of wheat in both the years. The per cent increase in grain and straw yield were showed 20, 16 and 19, 15 percent during 2005-06 and 2006-07, respectively (Table 1). Thus, efficient weed control increased the grain as well as straw yield due to improvement in various yield attributing characters of wheat viz. number of spike m-2, spike length, number of grain spike and test weight.

The maximum grain yield of wheat during both the years was attained in the plot treated with sulfosufluron + metsulfuron at 40g ha ^{1}.

Singh et al. (2002) and Singh (2004) also reported the maximum grain yield of wheat with sulfosulfuron @ 45 g ha ^{1}.

Table 1. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on yield and yield attributes of wheat

Treatment	2005-06							2006-07						
	No. of spike (m^2)	Spike length (cm)	No. of grain spike ^{1}	Test wt. (g)	Grain yield (kg ha ^{1})	Straw yield (kg ha ^{1})	HI %	No. of spike (m^2)	Spike length (cm)	No. of grain spike ^{1}	Test wt. (g)	Grain yield (kg ha ^{1})	Straw yield (kg ha ^{1})	HI %
Dose at (SSN + MSN) g ha-1														
0	284.1	7.1	43.1	35.3	4584	5967	43.3	291.9	7.4	48.9	36.2	4776	6168	43.5
20	319.6	8.0	55.0	38.4	5252	6646	44.1	346.9	8.2	55.3	38.9	5397	6753	44.3
40	339.0	9.4	57.7	38.9	5509	6943	44.2	367.8	9.5	58.2	39.4	5674	7097	44.4
80	275.2	7.5	54.8	37.7	5220	6620	44.0	318.1	7.7	55.1	38.2	5322	6646	44.4
SEm±	5.8	0.11	0.9	0.65	88.2	112	1.0	6.4	0.13	0.9	0.6	90.6	114	1.0
CD	17.1	0.39	2.6	1.9	256	326.9	NS	18.5	0.40	2.7	1.9	263	331	NS

Table 2. Chemical composition of soil of experimental field

Components	2005-06	2006-07	Methods employed
Organic carbon (%)	0.35	0.36	Walkley and Black's wet oxidation method (Jackson, 1973)
pH	8.2	8.2	pH meter with glass electrode in 1:2 soil water suspension (Jackson, 1973)
EC (dSm ^{1} at 25°C)	0.43	0.44	Conductivity bridge method in 1:2 soil water suspension (Richards, 1954)
Available nitrogen (kg ha ^{1})	208.0	211.0	Alkaline permanganate method (Subbiah and Asija, 1956)
Available phosphorus (kg ha ^{1})	15.1	16.2	Olsen's method (Olsen et al., 1954)
Available potassium (kg ha ^{1})	407	409	Flame Photometeric method (Richards, 1954)

Table 3. Mechanical composition of soil of experimental field

Components	2005-06	2006-07	Method
Sand (%)	61.58	61.37	International pipette method (Piper, 1966)
Silt (%)	20.32	20.34	
Clay (%)	18.20	18.29	

Conclusion

Various yield attributes of wheat viz., number of spikes, spike length, number of grains per spike and 1000 grain weight were significantly higher under sulfosulfuron + metsulfuron-methyl when applied @ 40g ha ^{1} as compared to weedy check. Maximum grain (5509 kg ha ^{1} in 2005-06 and 5674 kg ha ^{1} in 2006-07) and straw (6943 kg ha ^{1} in 2005-06 and 7097 kg ha ^{1} in 2006-07) yields were obtained under @ 40 g ha ^{1} of sulfosulfuron + metsulfuron-methyl.

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EFFECT OF PLANT GROWTH REGULATORS ON GROWTH AND YIELD PERFORMANCE OF ONION (ALLIUM CEPA L.) CV. PUSA RED

Akshya Kumar[1], Pavitra Dev[1], Jitendra Kumar[1], Krishna Choudhary[1], Vinuj Kumar[2], Bijender Singh[3] and P. S. Pandey[4]

[1]Department of Horticulture, Ch. Charn Singh University, Meerut (U.P) 250004
[2]College of Horticulture, SVP University of Agri. & Tech. Meerut (U.P) 250110
[3]College of Horticulture, SVPUA&T, Meerut, U.P. – 250110
[4]ICAR. New Delhi

Abstract

A field experiment was carried out to study the effect of plant growth regulators on growth and yield performance of onion (*Allium cepa* L) cv. Pusa Red. The field experiment was conducted at Horticultural Research Farm, Department of Horticulture, Chaudhary Charn Singh University Campus, Meerut (U.P) India, during the year 2017-18. The experiment was laid out in randomized block design with nine treatments and three replications. Based on the experimental study, it is clearly indicated that foliar application of gibberellic acid (GA3) and naphthalene acetic acid (NAA) have pronounced effect on onion growth and yield attributing characters. The maximum plant height (53.13 cm), leaf length (51.13 cm), number of leaves per plant (4.66), bulb diameter (7.82 cm), bulb weight (46.76 g) and yield (303.74 q/ha) was recorded with the foliar application of GA3 @ 150 ppm. However, maximum collar length (4.56 cm) had recorded under NAA @ 150 ppm.

Keywords: GA3, IAA, NAA, MH and Onion.

Introduction

Onion is one of the most important bulbs and species vegetable crops. Onion (*Allium cepa* L.; 2n = 16) belongs to the family Alliaceae. A global review of area and production of major vegetables shows that onion ranks second in area and third in production of the total vegetables in the world. Onion is the second after tomato in their importance as a vegetable in India. Onion is the oriented crop and earning valuable foreign exchange for the country. In India, onion is cultivated over 1285 thousand hectares area with 23262 thousand metric tonnes production. Maharashtra has the first rank in area and production of onion with 38.06 % share in the total production of onion. In Maharashtra, onion is grown over about 508 thousand hectares with total production of 8854 thousand tonnes and productivity 17.43 tonnes/hectares. However, Uttar Pradesh has little shares (1.89 %) with 439.64 thousand metric tonnes production of onion but the cultivation area steadily increases in the state (4). Onion is characterized by their rich content of odoriferous sulphur compounds, thiosulfinates, sulphides and sulfoxide etc. Onion bulb and greens onion both are rich in vitamin C, potassium, mineral and folic acid. Onions are rich in calcium and riboflavin but intermediate in protein content. The major constituents of onion are carbohydrate, minerals, vitamins and protein. 100 g of edible onion bulb contains 86.6% moisture, 11.1 g carbohydrate, 1.2 g protein, 0.1 g fat, 0.08 mg thiamine, 0.01 mg riboflavin, 11 mg vitamin, 47 mg calcium and 0.07 mg iron (7). Onion is a vital rejuvenator and revitalizes (16). It is also very important for preventing heart diseases by reducing total cholesterol level and boosting good type

HDL cholesterol. Onion bulbs mainly used for salad as raw and an important ingredient of Indian "Tadka" while green onion used as curing purpose. It is also used for making various processed products like flake, powder, paste, pickle etc.

Plant growth regulators have a contribution to the progress of agricultural science by modifying and controlling the growth behaviour of many crop plants. There has been global realization for important role of plant growth regulator in crop production, better growth of crop and yield (15). Growth regulators exert their influence on foliar transport in a number of ways. These can enhance the absorption by the leaf at the site of application, increase the migration within the leaf and/or stimulate the transport out of leaf in the acropetal and basipetal direction. Onion crop plant growth regulators are successfully utilizing for improving seed germination, leaf length, bulb diameter, bulb weight and seed yield (5 and 24). Among the auxins, NAA and IAA are important to plant for controlling many important physiological processes including cell enlargement and division, tissue differentiation, and responses to light and gravity. NAA has been shown to greatly increase cellulose fiber formation in plants when paired with another phytohormone. The role of gibberellins within plant system is well known to increase cell elongation and cell division. Gibberellins also increase the activities of many key enzymes like carbonic anhydrase (CA), nitrate reductase (NR) (1) and ribulose-1, 5-biphosphate carboxylase/ oxygenase (RuBPCO) (27). The most similarly characteristic effect of GA3 is increased leaf-growth and enhanced apical dominance.

Materials and Methods

The experiment was conducted on onion cv. Pusa Red during Rabi season Horticultural Research Farm, Department of Horticulture, Chaudhary Charan Singh University Campus, Meerut (U.P). The experiment was laid out in randomised block design with nine treatments and three replications in sandy loam soil under irrigated condition. The standard agronomical practices were adopted for raising the nursery and transplanting the seedling during experimentation. Before transplanting the seedling in the main field were treated with Bavistin for 30 minutes. The seeds of onion cv. Pusa Red were sown on the nursery bed on November 5th 2018. Healthy seedlings were transplanted in the main field during December 2018, with row to row 15 cm and plant to plant 10 cm space. The application of plant growth regulators viz. GA3 (100 and 150 ppm), IAA (100 and 150 ppm), NAA (100 and 150 ppm) and MH (150 and 300 ppm) solution and distilled water (control) were sprayed at three stages of growth i.e. 30, 60 and 90 days after transplanting. Data on growth parameters viz. height of plant, leaf length, number of leaves and collar length and yield parameters viz. bulb diameter, bulb weight per plant and yield were recorded.

Result and Discussion

Growth attributes parameters like, plant height, leaf length, number of leaves per plant and collar length were significantly influenced by plant growth regulators (table 1). Among different treatments of plant growth regulators, maximum plant height (53.13 cm) was recorded under the foliar application of GA3 @ 150 ppm followed by GA3 @ 100 ppm while the minimum plant height (44.46 cm) was noted with the control treatment (distilled water). IAA, NAA and MH also exhibited good impact on vegetative parameters of onion. These findings of the study confirmed with the findings of (18, 20) and (21 and 22) while studying impact of different concentrations of growth regulators the growth and development of onion cv. N-53 had also observed significant increase in plant height under the treatment of GA3 @ 50 ppm. The increase in plant height might be due to the positive effect of gibberellic acid which has the physiological role to increase cell division and cell enlargement. (13) and (23) reported the gibberellic acid act by signalling the removal of proteins that repress growth, thus increase cell proliferation and elongation.

Table 1. Effect of plant growth regulators on growth and yield performance of onion (*Allium cepa* L.) cv. Pusa Red

Notation	Treatments	Plant height (cm)	Leaf length (cm)	Number of leaves per plant	Collar length (cm)	Bulb diameter (cm)	Bulb weight (g) per plant	Yield (q/ha)
T_1	GA3 (100ppm)	53.2	51.40	4.66	4.26	7.82	45.79	297.67
T_2	GA3 (150 ppm)	53.13	51.13	4.65	4.54	7.84	46.76	303.74
T_3	IAA (100 ppm)	49.63	47.66	4.46	4.32	7.37	42.18	273.77
T_4	IAA (150 ppm)	49.83	48.06	4.40	4.42	7.41	43.41	282.16
T_5	NAA (100 ppm)	51.03	49.03	4.46	4.19	7.41	43.21	280.90
T_6	NAA (150 ppm)	49.86	47.66	4.33	4.56	7.61	42.59	276.87
T_7	MH (150 ppm)	49.56	47.60	4.33	3.77	7.50	41.79	271.65
T_8	MH (300 ppm)	48.86	46.66	4.46	3.61	7.62	42.00	273.01
T_9	Control	44.46	42.23	4.00	3.48	5.93	39.68	257.92
SE+		0.45	0.41	0.08	0.17	0.21	0.35	1.81
CD 5%		1.37	1.24	0.26	0.53	0.64	1.06	5.30

It was evident from the present investigation that foliar supplication of gibberellin and auxins with their different concentration had a significant effect on leaf length and collar length of onion. The maximum leaf length (51.40 cm) was manifested with the foliar application of GA3 100 ppm which was found significantly at par with 150 ppm GA3, but statistically higher than the auxins (IAA and NAA) and MH. On the other hand, the maximum collar length (4.56 cm) was recorded under the foliar application of NAA @ 150 ppm which was found at par with NAA 100 ppm, GA3 (150 and 100 ppm) and IAA (150 and 100 ppm). These results are confirmed with the findings of (20, 21, 22) in onion and (6) in okra. GA3 and NAA at 150 ppm increase the vegetative growth of onion as measured by the leaf length and number of leaves per plant reported by (17). This increment might be due to the stimulating effect of auxins and gibberellins on cell division and cell elongation as reported by many researchers. The mechanism of cell growth mediated through auxins entails its interaction with receptors, membranes and other binding surfaces that could lead to the rapid growth of cells (9)

It was also observed that the different treatments of plant growth regulators influenced the number of leaves per plant. The maximum number of leaves per plant (4.66) recorded under the treatment T1 (GA3@ 100 ppm) which was found statistically similar with all other treatments except controlled plants. GA3, IAA and NAA had good impact to increase number of leaves per plant in onion as reported by (25). (12) also recorded maximum number of leaves per plant under the seedling treatment with gibberellic acid and IAA in case of onion. (3) recorded highest leaf length and number of leaves per plant under the treatment of 200 ppm IAA in onion. The possible reason for the initiation of more number of leaves per plant is attributed to high metabolic activity and precise pattern of the epidermal cells of the developing leaf which controlled by the accumulation of auxins and gibberellic acid in plant. (10) reported the GA3 help to stimulate the activity of sub-apical meristem during new-formed growth and the apical meristem during vegetative bud development.

The effect of different plant growth regulators on onion yield attributing characters was also found significant (table 1). Among different treatments of plant growth regulator, maximum bulb diameter (7.84 cm) was found under the foliar application of GA3 @ 150 ppm followed by GA3 @ 100 ppm. Different concentrations of auxins (IAA and NAA) and MH also had a significant effect on bulb diameter of onion. Plants grown in controlled plots obtained the minimum diameter of bulb (5.93 cm) at the time of harvesting. These findings are confirmed with the results of (8) who reported that GA3 200 ppm increased bulb diameter and bulb weight of onion. Similarly, GA3 100 mg per liter significantly increased equatorial and polar diameter of bulb and finally yield of onion reported by (14). This is might be due to the high rate of metabolic and photosynthetic activity and storage of food material in bulb. Gibberellic acid and IAA have an ability to reduce the chlorophyll loss from lettuce leaves as suggested by (2).

Similarly, the maximum bulb weight per plant (46.76 g) and yield (303.74 q/ha) was recorded under the foliar application of GA3 @ 150 ppm followed by GA3 @ 100 ppm. Auxins (IAA and NAA) and maleic hydrazide also had a good impact on the yield parameters of onion while foliar application of distilled water (control) manifested minimum onion production. Similar findings were reported by (11, 18, 24) in case of onion. (19) proved that foliar spray of 80 ppm GA3 and NAA at 40 and 60 days after transplanting produced significantly higher bulb yield of 316.7 and 311.5 q/ha, respectively. The significant improvement in yield of onion might be due to the effect of cell expansion, high enzymatic activity, balance hormone etc. which leads to expansion of leaves area and number of leaves so as a result plants get larger surface area for photosynthesis. High rate of photosynthesis leads to accumulation of more food material for further growth and development and storage in different organs of plant (bulb) which ultimately increased the onion yield. (26) reported that gibberellic acid stimulate rates of photosynthesis or enhances ultra-structural morphogenesis of plastids and it also helps to enhance the in vitro activity of RUBP-carboxylase. n plants where GA3.

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EFFECT OF DIFFERENT ORGANIC MANURES ON GROWTH AND YIELD PARAMETERS OF RADISH (RAPHANUS SATIVUS L.) CV. JAPANESE WHITE

Krishna Murari Agnihotri[1], Pavitra Dev[1], Jitendra Kumar[1], Krishan Choudhary[1], Vinuj Kumar[2] and Akshya Kumar[2]

[1]Department of Horticulture, Chaudhary Charan Singh University, Meerut, (250004)
[2]Department of Horticulture, SVP University of Agri. & Tech. Meerut (U.P) 250110

Abstract

A field experiment was conducted during the years 2018-19 on radish cv. Japanese White to ascertain the effect of different organic manures on growth and yield parameters. The field experiment was carried out at Horticulture Research Farm, Department of Horticulture, Chaudhary Charan Singh University, Campus, Meerut, (U.P.). The experiment was laid out in randomized block design and replicated three times. The treatments involved in the study were eleven in numbers i.e. T1 (Control), T2 (100% Farm yard manure 24 t/ha), T3 (100% Vermicompost 6 t/ha), T4 (100% Poultry manure 4 t/ha), T5 (100% Neem cake 2.5 t/ha) T6 (50% Farm yard manure + 50% Vermicompost), T7 (50% Farm yard manure + 50% Poultry manure), T8 (50% Farm yard manure + 50% Neem cake),T9 (50% Vermicompost + 50% Poultry manure), T10 (50% Vermicompost + 50% Neem cake) and T11 (50% Poultry manure + 50% Neem cake). All variables parameters regarding growth and yield attributes were significantly influenced by different organic manures. Results revealed that among all the treatments, the soil application of 50% farm yard manure + 50% vermicompost gave the better effect on vegetative and yield parameters viz. plant height (35.55 cm), number of leaves per plant (27.16), leaf width (11.33 cm), weight of leaves (114.66 g), root length (24.01 cm), root diameter (5.76 cm), root weight (233.68 g), and yield (343.77 q/ha) as compared to other treatments.

Keywords: Radish, farm yard manure, vermicompost, poultry manure and neem cake.

Introduction

Radish (*Raphanus sativus* L.) is one of the most popular root crops. Central/Western China is considered as the origin centre of Radish. Radish belongs to the family Cruciferae with chromosome number 2*n* 18. Radish is a popular vegetable in India as well as in the world due to its short growing time with higher productivity. In Hindi, it is called as 'Mooli'. It is mainly cool-season crop and popular in both tropical and temperate regions. In India, the area under radish is 199 thousand hectares with an annual production of 2844 thousand metric tonnes during the year 2015-16 (2). It is cultivated throughout India mostly in West Bengal, Bihar, Uttar Pradesh., Madhya Pradesh, Punjab, Assam, Haryana, Gujarat and Himachal Pradesh. Radish is grown for its young tuberous roots and tender leaves which are eaten raw as a salad or cooked as a vegetable. It is relished for its pungent flavors and is considered as an appetizer. Young leaves are also cooked as vegetables. Radish has refreshing and depurative properties. Radish used for making pickles, which is very popular in the diet of Indians and Japanese. Radish is excellent for nutritive and medicinal values. Radish containing per 100 g of edible

roots contain 93.7 per cent water, 4.2 g carbohydrate, 0.8 g fiver, 0.6 g minerals, 0.06 mg thiamine etc. Radish leaves are also rich in minerals and vitamin A (5 IU) and vitamin C (15 mg) and roots rich in potassium (138 mg) and calcium (50 mg). Radish contains glucose as the major sugar and smaller quantities of fructose and sucrose. Radish preparation is useful in liver and gall-bladder to troubles in homoeopathy; they are used for neuralgic headaches, sleeplessness and chronic diarrhoea. Roots, leaves, flowers and pods are active against gram-positive bacteria. Roots are said to be useful in urinary complaints, piles and gastrodynia. Salt extracted from roots, dried and burnt to white ash is said to be used in stomach troubles.

Due to increasing demands for food supply by the ever-growing population, production systems using chemical fertilizers were adopted. Continuous dependence on chemical fertilizer is causing a nutritional imbalance in the soil and it may lead to instability in productivity, besides depleting the quality of vegetables. So, to maintain sustainability in production and quality, proper use of techniques and inputs may be help to maintain the fertility of the soil (17). One such alternative is organic farming that avoids depletion of soil organic matter and plant nutrients, besides the suppression of some insect-pests and diseases (11). In India, the mixed farming system with livestock is an integral part of crops production. So there is easy availability of livestock-based organic manures like farm yard manure and poultry manure. Similarly, on the advancement of the production system and due to the tremendous benefits of vermicompost, several vermiculture units establish so far. Organic manure not only provides nutrients to plants but also improves the soil texture by the binding effect to soil aggregates. Organic manure increases cation exchange capacity, water holding capacity and phosphate availability of the soil, besides improving the fertilizer use efficiency and microbial population of the soil; it reduces nitrogen loss due to slow release of nutrients. Production of green manure crops seems to be difficult under intensive cropping system. So recycling of different organic wastes in the form of compost would be a good source of organic manures, besides ensuring hygienic disposal of the organic wastes.

Organic manures viz. farm yard manure, vermicompost, poultry manure and neem cakes are a basic source of essential plant nutrients and applied in large quantities. It is well known that organic manures increase humus contain in soil, and high humus helps to easy colonization of beneficial microorganism in soil. Some microorganisms are available in the soil which can fix atmospheric nitrogen in the plant roots. They contain other growth promoting agents like enzymes and hormones. Through the process of decomposition and humidification, they give humus, which helps to improve the physical, chemical and biological properties of the soil. (20) reported that organic acids released during the decomposition of organic manure act to controls certain fungal pathogens and nematode infestation. Use of organic manures not only helps in increasing the yield of crops but acts as storehouse of nutrients for successive crops, besides improving the soil physical condition (4). The organic materials like farm yard manure, crop residues, green manure and vermicompost most commonly used to improve soil condition and soil fertility status reported by several scientists. The benefits of farm yard manure and compost were used for the decreasing of environmental pollution (21). So, keeping in view the above facts in mind, the present investigation was carried out to analysis the effect of organic manures on radish (*Raphanus sativus* L.)

Methods and Materials

The experiments were carried out during the Rabi season, 2018-19 at the Horticulture Research Farm, Department of Horticulture Chaudhary Charan Singh University Campus, Meerut (U.P.). Geographically Meerut city lies about 70 Km. N-E of the national capital New Delhi. Meerut city is located between 29.90 N and 77.430 E longitudes at an elevation of 222 meter above the mean sea level. The climatic condition of this region is subtropical. The topography of the field on which, the experiment was conducted fairly uniform. The soil was found loam with slightly alkaline in pH reaction, low in organic carbon and good in nitrogen, phosphorus and potassium levels. There were a total number of eleven treatments used for experimental purpose. The experiment was laid

out in randomized block design with three replications. A total number of eleven treatments i.e. T1 (Control), T2 (100% Farm yard manure 24 t/ha), T3 (100% Vermicompost 6 t/ha), T4 (100% Poultry manure 4 t/ha), T5 (100% Neem cake 2.5 t/ha) T6 (50% Farm yard manure + 50% Vermicompost), T7 (50% Farm yard manure + 50% Poultry manure), T8 (50% Farm yard manure + 50% Neem cake),T9 (50% Vermicompost + 50% Poultry manure), T10 (50% Vermicompost + 50% Neem cake) and T11 (50% Poultry manure + 50% Neem cake) were involved in the study. All the organic manures such as farm yard manure (FYM), vermicompost (VC), poultry manure (PM) and neem cake (NC) were incorporated in the field before sowing as per the treatments. Radish cultivar Japanese White was used in the experiment. The harmonized seeds of Radish were sown treatment wise by hand dibbling method on 22 cm high ridges to maintain row to row distance of 30 cm and plant to plant distance 10 cm. The seed sowing was done 1.25 cm deep in to facilitate good root production. The data on related to growth and yield parameters namely; plant height, number of leaves per plant, leaf width, weight of leaves, root length, root diameter, root weight and yield were recorded for the analysis. Five plants were randomly selected from each replication to record the data of above mentioned parameters. The data recorded during the course of investigation were statistically analyzed by using analysis of variance (ANOVA) technique (10) for drawing conclusions. Appropriate standard and uniform cultural practices viz. irrigation, weeding, thinning, earthing-up etc. and plant protection measures were adopted for raising healthy crop.

Results and Discussion

A perusal of data (Table 1) revealed that application of plant nutrients through organic manures significantly affected the growth and yield attributes of radish. It was observed that the plant height was significantly increased by various treatments of organic manures. Maximum plant height (35.55 cm) was recorded under T6 (50% Farm yard manure + 50% vermicompost) followed by T7 (50% farm yard manure + 50% poultry manure) and T9 (50% vermicompost + 50% poultry manure). The minimum plant height (25.70 cm) observed under control treatment. Similarly, the maximum leaf width (11.33 cm) was recorded in T6 (50% Farm yard manure + 50% vermicompost) followed by T7 (50% farm yard manure + 50% poultry manure). However, minimum leaf width (7.99 cm) was observed in treatment T1 (control). The findings are also in agreement with the findings of (8, 16, 26). The increase in plant height and leaf width might be due to the stimulated activities likewise cell elongation, cell division, quick multiplication and synthesized more food materials in the plant by the organic manures. Among the organic manure, vermicompost is one of the best which contains growth regulators like hormones which increase the growth and yield of crops (6). Since nitrogen is a major element has a profound effect on plant growth and development and as a constituent of proteins and also its effect on production of plant hormones in plants. So, it helps in increasing plant height and leaf width with the combined application of farm yard manure and vermicompost which are attributed to their fair nitrogen content.

The number of leaves per plant was significantly influenced by the different treatments of organic manure. Maximum number of leaves per plant (27.16) was registered under T6 (50% Farm yard manure + 50% vermicompost) followed by T7 (50% farm yard manure + 50% poultry manure). However, minimum number of leaves per plant (19.50) was observed under treatment T1. The findings are in agreement with the result of (1, 5, 27). The probable reasons for enhanced more number of leaves might be due to effect of macro (particularly nitrogen) and micronutrients on vegetative growth and new vegetative bud initiation by increasing cell division and controlling of the precise pattern of the epidermal cells of the developing leaf. Farm yard manure Similarly vermicompost is enriched with plant available forms of macro (nitrogen, phosphorus and potassium) and micro (iron, copper, zinc, etc.) nutrients as reported by (7).

Table-1 Effect of different organic manures on growth and yield parameters of Radish (*Raphanus sativus* L.) cv. Japanese White

Treatment	Plant height (cm)	Leaf width (cm)	Number of leaves per plant	Weight of leaves (g)	Root length (cm)	Root diameter (cm)	Root weight (g)	Yield (q/ha)
T_1	25.70	7.99	19.50	76.73	16.98	3.56	131.55	241.55
T_2	29.87	9.69	23.76	90.16	21.18	4.30	200.31	311.31
T_3	30.92	9.77	24.86	92.56	21.90	4.63	205.35	316.76
T_4	29.53	9.33	22.26	86.60	20.58	4.00	194.31	306.10
T_5	27.29	8.21	19.93	78.03	18.12	3.63	153.23	263.48
T_6	35.55	11.33	27.16	114.66	24.01	5.76	233.68	343.77
T_7	33.23	10.61	25.85	99.30	23.04	5.13	220.29	330.39
T_8	28.78	9.11	21.81	85.36	20.11	3.96	188.94	298.91
T_9	32.25	10.05	25.40	95.43	22.50	4.96	189.13	323.20
T_{10}	27.71	8.66	20.63	78.70	19.04	3.73	170.46	280.44
T_{11}	27.80	8.89	21.33	82.16	19.58	3.83	181.20	291.18
CD at 5%	1.085	0.107	0.841	2.495	0.522	0.269	5.639	5.440
SEm	0.365	0.036	0.283	0.840	0.176	0.090	1.898	1.831

The maximum weight of leaves (114.66 g) was observed under the treatment T6 (50% Farm yard manure + 50% vermicompost) followed by T7 (50% farm yard manure + 50% poultry manure). However, minimum weight of leave (76.73 g) was observed in treatment T1 (control). These findings are in agreement with the results reported by (3, 12, 25). The possible reasons of increase leaf weight due to retain high water and organic content in leaf by the high rate of metabolic and photosynthetic activities. The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb the nutrients. It is well known that organic manures specially farm yard manures help in increasing water holding capacity of soil (24) and this water easily available to plants. The organic manure facilitates to increase availability of macro and micro-nutrient to the plant, which are ultimately increase the metabolic activity of plants.

50% Farm yard manure + 50% vermicompost was recorded as the best treatment to increase the root length (24.01) and root diameter (5.76 cm) followed by T7 (50% farm yard manure + 50% poultry manure). While the lowest root length (16.98) and root diameter (3.56 cm) were recorded with control. Similar results have been reported by (13, 22, 25). Increase in root length and root diameter is associated with the storage of food material in the root of radish. Food synthesis capacity of plants depends on the photosynthetic and metabolic activity. Farm yard manure and vermicompost plays an important role for improving the available nutrients elements to the plants, which are responsible to increase nutrient status in leaf. The photosynthetic capacity is strongly regulated by leaf nitrogen concentration reported by (9). Organic matter content is the key components that increase soil water holding capacity (24) and water availability influences leaf phenology (19) and photosynthetic rate (18). Moreover organic manures helps in decrease bulk density and increase porosity of soil which facilitate for attaining the full size of roots of radish.

Significantly maximum root weight (233.68 g) and yield (343.77 q/ha) was observed with T6 (50% Farm yard manure + 50% vermicompost) followed by T7 (50% farm yard manure + 50% poultry manure). However, minimum root weight (131.55 g) and yield (241.55 q/ha) were manifested under control. Finding corroborates with their results obtained by (5, 14, 18). This might be due to the application of major nutrients, through different organic manure in various levels, increased the photosynthetic activity, chlorophyll formation,

nitrogen metabolism and auxins contents in the plants which ultimately improving the root weight and yield of plant. Farm yard manure increase crop yield by releases the soil compactness and improves the aeration in addition to the supply of essential plant nutrients and organic matter in soil. (23) also reported that farm yard manure is regularly applied to many root crops for higher yield. Vermicompost improve beneficial soil microbes; nitrogen-fixing and phosphate solubilizing bacteria, actinomycetes and plant growth regulators like auxins, cytokinins and gibberellins as reported by (7) which helps in better yield production.

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A REVIEW ON POTATO DISEASE DETECTION USING IMAGE PROCESSING

Kumar Sanjeev[1]*, Narendra Kumar Gupta[2], Rajendra Kumar Isaac[3], Suneeta Paswan[4]

[1]Department of Computer Science & Information Technology,

Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj-211007, India

[2]Department of Computer Science & Information Technology,

Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj- 211007, India

[3]Department of Irrigation and Drainage Engineering, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj- 211007, India

[4]Krishi Vigyan Kendra, Saharsa-852201, India

***Corresponding Author Email**-Ksanjeevmca@gmail.com

Abstract

This paper gives the survey on different diseases of potato using image processing techniques. This paper contents are related with Ph.D. research work on major diseases of potato crop. We are putting all relevant data and facts related to Ph.D. research work. Authors have reviewed different research papers regarding potato disease detection using image processing. This paper reviewed on image segmentation, feature selection and classification techniques that can be used for potato plant disease detection and an algorithm used for automatic detection.Potato (*Solanum tuberosum* L.; Family: Solanaceae) is one of the four major food crops of the world.In many countries, potato serves as their major staple food because of its excellent nutritional content. It can supplement the food needs of the country in a substantial way as it produces more dry-matter food, has well balanced protein and produces more calories from unit area of land and time than other major food crops.Crop diseases are a major threat to food security, but their rapid identification remains difficult in many parts of the world due to the lack of the necessary infrastructure. Agriculture operation needs automation, among this one disease control. The image processing is the tool used for the recognition and control of diseases.

Key words: Potato, Disease, Classification, Image Processing.

Introduction

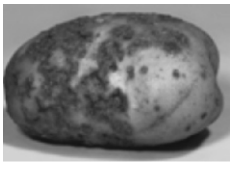
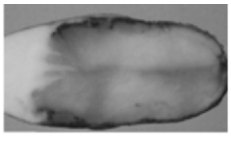
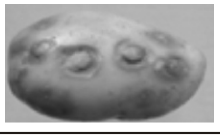
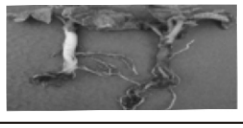
India is an agricultural country; wherein about 70% of the population depends on agriculture. Farmers have wide range of diversity to select suitable Cereal, Fruit and Vegetable crops. However, the cultivation of these crops for optimum yield and quality produce is highly technical. It can be improved by the aid of technological support. The management of crops requires close monitoring especially for the management of diseases that can affect production significantly and subsequently the post-harvest life (10). Crop diseases are a major threat to food security, but their rapid identification remains difficult in many parts of the world due to the lack of the necessary infrastructure. The combination of increasing global smartphone penetration and recent advances in computer vision made possible by deep learning

has paved the way for smartphone-assisted disease diagnosis (9). Potato (*Solanum tuberosum* L.; Family: Solanaceae) is one of the four major food crops of the world. The potato originated from South America, most likely from the central Andes in Peru. The potato was domesticated and has been grown by indigenous farming communities for over 4,000 years. Introduced into Europe in the sixteenth century, the crop subsequently was distributed throughout the world, including Asia. Worldwide, the potato comes fourth in terms of production after wheat, maize, and rice. In many countries, potato serves as their major staple food because of its excellent nutritional content. It can supplement the food needs of the country in a substantial way as it produces more dry-matter food, has well balanced protein and produces more calories from unit area of land and time than other major food crops.Now a days, agriculture is a field which requires automation in its various applications. New advanced technology is used in the agriculture operation due to labour shortage increase in labour cost etc. Agriculture operation needs automation, among this one disease control. The image processing is the tool used for the recognition and control of diseases.

Common Diseases of Potato Crop

Table 1: Tabular list of potato disease, casual organism, type of organism, effected part of plant and their images presented below

Sl.No.	Name of Diseases	Casual Organism	Type of organism	Effected Part of Plant	Images
i.	Early Blight	Alternariasolani	Fungus	Leaf	
ii.	Late Blight	Phytophthora infestans	Fungus	Leaf	
iii.	Alfalfa Mosaic Virus	Alfamovirus	Virus	Leaf	
iv.	Potato Virus Y	Potyvirus	Virus	Leaf	
v.	Tomato Spotted Wilt	Wilt tospovirus	Virus	Leaf	

Sl.No.	Name of Diseases	Casual Organism	Type of organism	Effected Part of Plant	Images
vi.	Rhizoctonia canker and Black Scurf	Rhizoctonia solani	Fungus	Tuber	
vii.	Erwiniasoft rot of tubers	Erwiniaspp.	Bacteria	Tuber	
viii.	Common Scab	Streptomyces scabies	Bacteria	Tuber	
ix.	Pink Rot	Phytophthora erythroseptica	Fungus	Tuber	
x.	Tomato Spotted Wilt Virus	Wilt ospovirus	Virus	Tuber	
xi.	Potato Virus Y	Potyvirus	Virus	Tuber	
xii.	Root knot nematodes	Meloidogyne spp.	Nematode	Tuber	
xiii.	Black leg of stems	Erwiniaspp.	Bacteria	Stem	
xiv.	Rhizoctonia canker and Black Scurf	Rhizoctonia solani	Fungus	Root	

(Source: USDA Sanitary Phytosanitary Project, ipmimages.org and Purdue University)

Review of Literature

Authors explained in their research work that potatoes (*Solanum tuberosum* L.) have been in production for a number of years, premature vine death and declining yields are often a problem. This syndrome, called "early maturity wilt" or"potato early dying" (PED), is a factor limiting production in many areas. The primary cause of PED is the soil fungus Verticillium. Two species,

V. albo-atrum and *V. dahliae* are involved. Selection of control strategies for PED must be based on an understanding of the biology of the pathogens and the efforts of various agricultural practices[13].Researchers overviewed the various aspects of the Potato Operation project, and presented different approaches to realize a complete autonomous system. Concerning the computer vision, the first approach proposed (3-D image analysis), allowed the problems due to the high variability of natural objects to be overcome. But improvements are still needed: the error rate has to be decreased by 2% in order to fulfill the constraints given on this system and the current implementation is not fast enough for practical use. The algorithms are now being implemented on a PC, using dedicated hardware in order to speed up the analysis. In the second computer vision approach (thermography), the results obtained are equally good, but the main problems are the cost of a thermal apparatus and the necessity of cooling the whole apparatus. To conclude, the particular domain of application as well as the interdisciplinary nature of this project make it a very challenging and interesting endeavor[8].Authors proposed and developed a prototype expert system (ES) to investigate the potential of ES's for managing seed potato production. The prototype addressed one component of production management, emulation of human expertise in potato disease diagnosis based on various symptoms. The ES was developed with the shell (Software Artistry, Inc.) PC Expert Professional and is operable on PC-compatibles. Its 127 rules diagnose eleven pathogenic diseases and six non-pathogenic diseases, and it utilizes eight knowledge bases (KB's) accessed via an agenda in a Pascal environment[3].Researcher explained in their work that Potato Spindle Tuber Viroid (PSTVd) in Avocado trees growing at several location in Peru by using nucleic acid spot hybridization arrays. Sequence analysis of cDNAs obtained using polymerase chain reaction with primers to PSTVd indicated the presence of 3 different sequence variants of PSTVd in the Avocado trees. The PSTVd infection were often latent, but some trees coinfected with Avocado sunblotch viroid shows systems that included bunchiness of the inflorescences, decrease in both fruit size and number and eventual decline and death. This is the first report of the isolation of PSTVd from a natural host other than potato[12].Authors worked on potato virus by Amultiplex reversetran scriptionpoly merase chain reaction (M-RT-PCR). They were developed for thesimultaneous detection of three major potato viruses, Potato virus X (PVX), Potato virus S (PVS) and Potato leaf roll virus (PLRV), in potato leaves and tubers (stored and dormant). Primers were designed from the coat protein gene of all three viruses and were able to detect virus in leaf RNA dilutions of 1:1024 to 1:4096 and from tuber RNA dilutions of 1:256 to 1:1024. The sensitivity of virus detection in leaves was higher than in tubers. All three viruses were successfully detected from tissues sampled from the tuber cortex, peri-medulla and pith, with all PCR bands being strongest from cortex tissues[11]. This work is the first step towards a potatoes quality control system based on computer vision. Potato segmentation has been performed by image processing techniques, specially taking into account color and projections. Then, features have been extracted from HSV and RGB channels from every segmented potato, using histogram and co-occurrence matrix texture characteristics, creating a learning set. A classifier has been developed by using 1-NN algorithm. This classifier has been optimized with an ad-hoc GA that selects the most discriminant features subset. With this optimization, the dimensional complexity of the classifier has been decreased so that it will be possible to build a faster final application, because useless calculations have been removed[5]. Authors described that Potatoviraldiseases, particularly PLRV, PVA, PVM, PVS, PVX and PYV, are a limiting factor for sustainable production of potato in China because of the significant tuber yield losses theycause. Over the last several decades, great efforts have been made to develop various methods, such as meristem culture to produce virus-free plants and certification schemes. Use of certified seed tubers in China has already increased tuber yield from 30 to 50%. However, the high frequency of viruses detected in both in vitro virus-free stocks and basic in vitro virus-free plants indicates that the procedures used to confirm virus freedom after meristem culture require further evaluation, and that more sensitive detection methods may be

required[18]. In this paper, Authors proposed a novel histogram-based Scab Diseases Detection of Potato. Using, the histogram approach and colour image segmentation technique to exact intensity pattern. to Scab disease accordingly it is then possible to analyze the different potato diseases. Here there is more scope to reduce the various errors which will be occurred during the simulation, that can be minimize as the more no of input is provided accordingly. The consequence from the preliminary study indicated that the proposed strategy is effective to assess disease intensity by the plant pathologist more accurately[14]. Authors proposed an algorithm to determine the severity of Potato Late Blight disease using image processing techniques and neural network. The proposed system takes images of a group of potato leaves with complex background as input which are captured under uncontrolled environment. In this proposed approach decorrelation stretching is used to enhance the color differences in the input images. Then Fuzzy C-mean clustering is applied to segment the disease affected area which also include background with same color characteristics. The proposed algorithm achieves an accuracy of 93% for 27 images captured in different light condition, from different distances and at different orientations along with complex background[2]. The aims of Authors to develop a quick, automatic and accurate system for disease identification and classification for potato leaves. The potency (related to) of the system is the capability to extract the diseased portion in the query images. Implementation is carried out using the MATLAB Image Processing and Bioinformatics Tool Box. The results showed that BPNN could effectively detect the disease spots and classify the particular disease type by mentioning name of disease, cause of disease and pesticides to be to prevent the diseases with accuracy of 92%[1]. In this paper, Authors described image segmentation with multiclass SVM is utilized to develop an automated and easily accessible system. The most significant diseases in potato, late blight and early blight, are identified with a little computational effort. Their approach will offer farmers a feasible, efficient and timesaving way of disease identification. They are planning to integrate a greater number of diseases of various species of plant into the system. They will dedicate our future works on automatically estimating the severity of the detected disease[6]. Author studied in their research; a type of potato tuber soft rot disease early detection method based on electronic nose technology was introduced. An optimized bionic electronic nose gas chamber and a scientific and reasonable sampling device was designed, and changes of volatile substances of infected soft rot disease of potato tubers were detected. The RBF neural network algorithm and the SVM algorithm were utilized to detect and identify infection with soft rot disease of potato tuber samples, and the results shown that the proposed bionic electronic nose system can be used for early detection of potato tuber soft rot disease; Via comparison and analysis, the recognition rate via SVM algorithm reached up to 89.7%, and the results were superior to the RBM NN algorithm[4].Researchers proposed use of sensors and back propagation algorithm for the prediction of potato late blight disease. Temperature and humidity sensor probes placed on the potato farms were instrumental in monitoring conditions for potato late blight disease. These parameters constituted abiotic factors that favour the development and growth of Phytophthora infestants. Back propagation neural network model was suitable for the prediction of potato late blight disease. The developed model achieved an accuracy of 93.89% while the precision obtained was 0.949. The recall ratio from the neural network was 0.968 and an F-measure of 0.964[16]. Authors explained different methods for management of late blight of potato. Management strategies includes; forecasting, cultural, biological, varietal and chemical management. Forecasting is the better option for management of late blight, if accurately forecasted and promptly information reaches to the end users. As infected potato tubers cause the primary sources of infection in next season. The cultural practices will also helpful in reducing inoculum load and managing the disease. The host resistance is best option for management of this disease.Nowadays biological control is gaining importance due to its eco-friendly in nature[7].

Factors Affecting Diseases

In summary for any plant disease to occur three factors must be present and conducive for the plant i.e. there must be a susceptible host (e.g. potato plant), a conducive environment and a pathogen must be present. These three elements, pathogen, host, and environmental conditions, make up the disease triangle. (Shahbaz & Safdar, 2016).

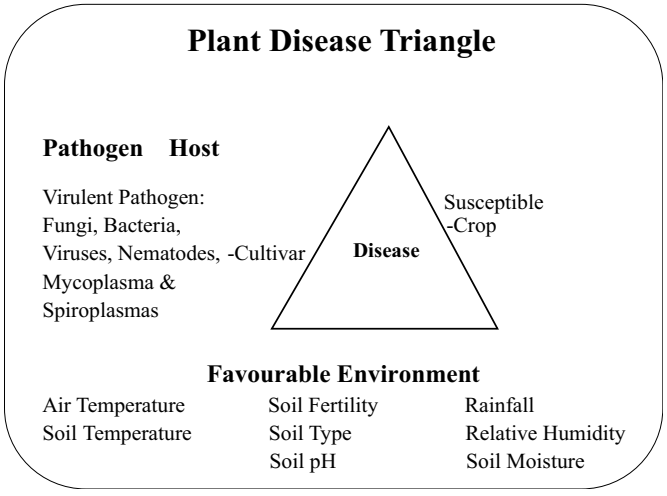


Fig.1: A potato disease triangle.

Models Used in Potato Late Blight Forecast

According to (2017), there are a number of models used in prediction of potato late blight disease. Summary of mostly used models for Late blight of potato Forecast.

- **Blitecast:** BLITECAST is a computerized forecast model for potato late blight developed by Krause and colleagues at Pennsylvania State University. BLITECAST works by using two late blight forecasting techniques i.e. the concept of blight favorable days and the severity values for potato late blight forecasting inPennsylvania State.
- **PhytoPRE:** PhytoPRE is a computer-based information and decision support system for potato late blight in Switzerland which consists of anepidemiological forecast model, a set of decision rules and an information system.
- **JHULSACAST:** JHULSACAST is a computerized forecast of potatolate blightin WesternUttar Pradesh forrainy and non-rainy year. Weather data included temperature, relative humidity and rainfall on hourly basis.

Image Processing Techniques

The image processing can be used in agricultural applications for to detect diseased leaf, stem, fruit, to quantify affected area by disease, to find shape of affected area, to determine color of affected area, to determine size & shape of fruits. The image processing technique has Image Acquisition, Image Preprocessing, Image Segmentation, Image Representation and Description, Image Recognition steps.

Image Acquisition

Various image databases available world-wide along their name, description and applications. The image acquisition is required to collect the actual source image. An image must be converted to numerical form before processing. This conversion process is called digitization.

Image Preprocessing

The principle objective of the image enhancement is to process an image for a specific task so that the processed image is better viewed than the original image. Image enhancement methods basically fall into two domains, spatial and frequency domain.

Spatial domain: as the name suggests in this approach different methods are used, which will affect the manipulation of pixel values of an image

Frequency domain: in this method first, a Fourier transform of the image is computed and then different operations are performed on them and finally results are obtained by getting the inverse Fourier transform of the image.

Image Segmentation

Segmentation subdivides an image into constituent regions or objects. The level to which that subdivision carried out is a problem specific. The simplest method among all segmentation methods is threshold-based method, whose volume uses either a manually or automated generated threshold values for segmentation.

Image Representation and Description

Representation and description almost always follow the output of a segmentation stage. The first decision must be made whether the data should be represented as a boundary or complete region. Boundary representation is appropriate when the focus is on external shape characteristics whereas regional representation is focusing on internal properties, such as texture and skeletal shape.

Image Recognition

Classification is a usual process used to recognize image. Classification is needed to distinguish a plant species with other species based on the data obtained from feature selection. Artificial neural network (ANN), Support Vector Machines (SVM), KNN and Fuzzy logic are the most commonly techniques used in classification.

Methodology and Model Accuracy of Reviewed Papers

Table 2: Tabular list of names of reviewed paper, their methodology and Model accuracy % is presented below

	Paper	Methodology	Accuracy %
i.	(2) Severity Identification of Potato Late Blight Disease from Crop Images Captured under Uncontrolled Environment.	Fuzzy C-mean clustering	93
ii.	(1) Potato Leaf Diseases Detection and Classification System.	ANN, BPNN	92
iii.	(4) Bacterial Infection Potato Tuber Soft Rot Disease Detection Based on Electronic Nose.	RBF Neural Network algorithm and the SVM	89.7
iv.	(16) A Model for early detection of potato late blight disease: a case Study in Nakuru County.	Back propagation neural network	93.89

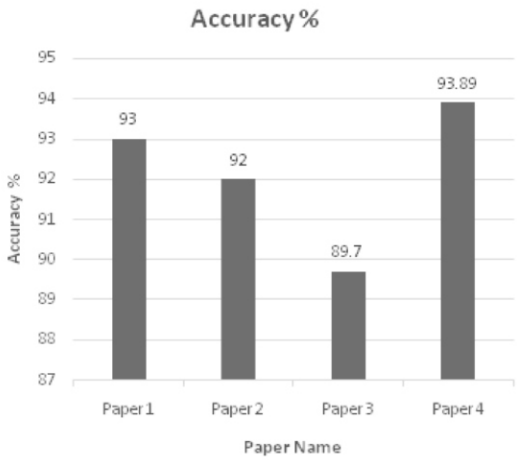


Fig.2: Graphical representation of accuracy values of reviewed paper.

Here is a tabular list presented in table 2 according to the accuracy value and methods that has been used to achieve that accuracy level. Also, the figure 2 represents accuracy values with respect to paper number in this literature review work.

Conclusion

This paper gives the survey on different diseases of potato using image processing techniques. This paper contents is related with Ph.D. research work on major diseases of potato crop. We are putting all relevant data and facts related to Ph.D. research work. Authors have reviewed different research papers regarding potato disease detection using image processing. This paper reviewed on image segmentation, feature selection and classification techniques that can be used for potato plant disease detection and an algorithm used for automatic detection.Therefore, related diseases were taken for identification. With very less computational efforts the optimum results were obtained which also shows the efficiency of algorithm in recognition and classification of the potato diseases. Another advantage of using these methods is that the potato diseases can be identified at early stage or the initial

stage. To improve recognition rate in classification process different models like Artificial Neural Network, SVM, Fuzzy Logic can also be used.

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Conflict of Interest

The authors do not have any conflict of interest.

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NANOTECHNOLOGY APPLICATIONS IN ADVANCING AGRICULTURE AND FOOD TECHNOLOGY

Pushpendra Singh[1]*, Subhash Kumar[2] and Prem Prakash Sharma[3]

[1]Helix Bio Genesis, Noida -201301, Uttar Pradesh,
[2]Dept. of Botany CCR(PG) College, Muzaffarnagar (U.P.)
[3]Laboratory for Translational Chemistry and Drug Discovery,
Hansraj College, Uni. of Delhi, Delhi 110007 INDIA
***Corresponding Author Email**-psbbn22@gmail.com

Abstract

Nanotechnology has the potential to make agriculture significantly moreproductive, reduce drudgery and more profitable. NT towards agriculture and food biotechnology has received substantial attention due to its innovative and advanced applications over the conventional agriculture and food processing approaches. Although, the applications of nanotechnology in the field of chemistry and physics are well studied as a result several products are already in the market, the significance of nanotechnology in the area of agriculture and food is relatively novel and therefore, not so widely known. Slow but significant progress towards the nanotechnology implementing in agriculture and food has been made both in the developed and developing countries across the world. The highlights the nanomaterial applications to agriculture and food industries describingrecent trends and future perspectives considering smart agriculture, processing, packaging, security, and storage.

Key words: Nanotechnology, Agriculture -Farming, Nano-devices, Food-Tech.

Introduction

The word nanotechnology (derived from 'nano', meaning 'dwarf in Greek language) is generally used for a technology, which makes use of materials that are 0.1 to 100 nanometers (nm = $10\text{-}9^{m}$) in size. Therefore, the main focus of nanotechnology (NT) is on special properties of materials emerging from their nanometer size. These materials and devices, having new or unique properties, are developed either through a top down approach or through a bottom up approach (13,29,30).

NT applications in the fields of health care, textiles, information and communication and energyis well known(29). Indeed, NT has brought a revolution in several of these areas including sterile baggage, clear sunscreen creams, stain-resistant fabrics, safe and scratch resistant paints, and self-cleaning windows. However, the use of nanoscience (Ns) and NT towards agriculture and food industries is relatively new and is fast growing (3,13,34). It is believed that NT has the capability to transform agriculture and food sectors that ultimately help the poor farmers. In United Nations Johannesburg Summit on Sustainable Development 2002, following five major areas collectively known as WEHAB were identified, where nanotechnology may improve i) energy; ii) water; iii) health sector and environment; iv) agriculture sector; and iv) ecosystem and biodiversity management(5).

Research in exciting new agriculture and food production areas has also showed potential of NT through its uses in the following sectors; i) genetic engineering of plants and animals; (ii) in plants and

animals, the delivery of genes and drug molecules to particular location at cellular levels; and iii) Gene technologies focussed on nano-array for gene expresses in plants and animals under stress conditions. The potentials of NT in agriculture and food sectors are increasing with suitable techniques. Sensors for the meticulousness farming, natural resource protection, and early detection of contaminants in food items are being fabricated, devices for the distribution of agrochemicals such as fertilizers and pesticides for the food production, packaging. Other fields such as agricultural and food safety monitoring are also being monitored using NT based devices. Thus, ultimately, NT will become the main driving force for developments in agriculture and food industry, and the benefits occurring from this technology will certainly reach to the consumers, manufactures, farmers, environment, and the general society at large. This short review presents the applications of nanomaterial towards agriculture and food industry describing the recent trends and future perspectives in India.

NT Aided Food Industry

With impressive advancements in NT over the past decade of present century, fast and non-invasive methods for the development of better, safe and good quality foods have been widely using(18). In the world, both developed and developing countries are investing and exploring NT to revolutionize the industrial sectors. Applications of recent research in NT in the sector of food technology and agriculture, including nanoemulsion, nano-composites, nanosensors, nano-encapsulation and food processing in the production of agri-food NT (Fig. 1). Instead, nanotechnologists are more optimistic about the potential of NT, by selected additives, to modify the current method of food managing and create a healthy food society in order to guarantee the quality of food products; they also expect to increase the nutrient value of food and to improve the way food is digested and consumed by the body(13). Not only does the use of NT for food packaging secure food by prolongs the shelf-life, unleash vitamins, flavours, antimicrobials, antioxidants and nutraceuticals, it also overcomes the environmental issues associated with the use of plastics(18). Most packaging materials are not degradable and there are low barriers and mechanical properties in common biodegradable films.

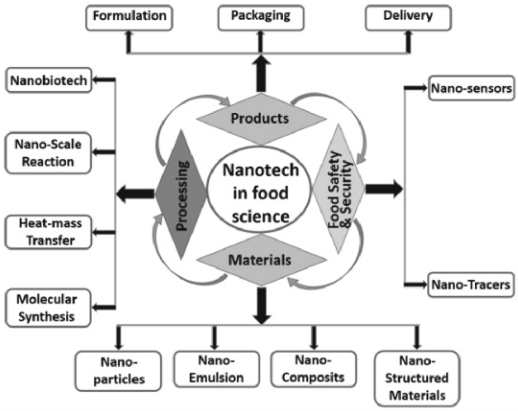


Fig. 1. Illustration of Nanotechnology in food science and technology [reproduced from ref. 1 1]

NT will deliver solutions such as: (i) changing foil permeation behaviour; (ii) increasing barrier properties (mechanical, thermal, chemical and microbial); (iii) enhancing mechanical and heat resistance properties; (iv) creating active antimicrobial and antimicrobial surfaces; and (v) detecting and major improvements in microbiology and biochemistry(13). Shankar and Rhim developed nanomaterial film composed of polybutyleneadipate-co-terephthalate and silver nanoparticle, having significant tensile strength, water vapor permeability, UV-screening and biocidal activities which make it promising material to be used in food packaging(28). Commercial nanomaterial is Durethan® KU2-2601 (nanoclay-engineered polyamide film), which is marketed under Lanxess Deutschland. It is a lighter, stronger and more heat resistant over those are available ones in the market (13,22). Photocatalytic reaction of ZnONP and TiO_2NP leads to the formation of reactive oxygen species, contributing to bacterial cell cytoplasm oxidation and cell death. ZnONP has also been stated to be comparatively more effective and desirable than AgNPs because of its lower toxicity and cost-effectiveness(22). The hybrid film-containing silicate NPs reduces the oxygen arrival and other gases and the escape of humidity, thereby protecting food from decaying(13). Alternatively, an active oxygen scavenging film, Busolo and Lagaron researched nanoiron-containing kaolinite

integrated into High density polyethylene films, along with polyolefin nanocomposites(19). A high oxygen scavenging ability is present in the active kaolinite clay. The limitation of plastics and glass in shiping of breweries, NT play great role in breweries industries(9). Bottles prepared with clay nanoparticles called imperm, are Lighter and stronger than glass, used for breweries storage13. These nanomaterial maintains reduced environment of beer bottle by minimizes the loss of carbon dioxide from the. Further plastic bottles (called Durethan) developed with incorporation of nanoclay which makes the plastic lighter, stronger and more heat-resistant, are able to block oxygen, carbon dioxide and moisture from reaching fresh meats or breweries(17). Similarly, in their 1-6 liter Hite Pitcher beer bottle, Hite Brewerey Co in South Korea uses 'Aegis' nylon 6 as a barrier sheet(13).

Food products have high nutrient content, resulting in microorganisms quickly contaminated them which results into several disease in human. Loss in food quality is not only limited to microbial contamination but also there are food adulterations. These causes food poisoning or even death in human. NT may also give advancements in the sensitivity of identification of food contaminants and adulterations. In food products, pathogenic bacterial identification is accomplished predominantly by recognizing the bacterial genetic material or the whole bacterial cell(32). To separate DNA from the milk pathogenic bacterium *Listeria monocytogenes*, magnetic iron oxide nanoparticles have been used(10). AgroMicron has created the Nano bioluminescence Identification Spray that incorporates a luminescent protein engineered to bind to the surface of microbes such as *Salmonella syphimurium* and *E. coli*(13). When bound, it releases visible light, allowing infected food or liquids to be easily recognized. The greater the light intensity, the higher the contaminants would be. Anti-aflatoxin antibodies encapsulated gold nanoparticles have been implemented to detect aflatoxinB1 present in *Aspergillus* spp. contaminated food(32). Similarly, gold nanoparticles functionalized with anti-aflatoxinM1 antibodies, used for detection of aflatoxinM1 in milk sample(4). The electrochemical enzyme biosensors developed by nanostructure augment the process of electron transfer between the enzyme redox center and the electrode surfaces1. The portion of the biosensor's nanomaterials continues to lower the overpotential related to electroactive compounds

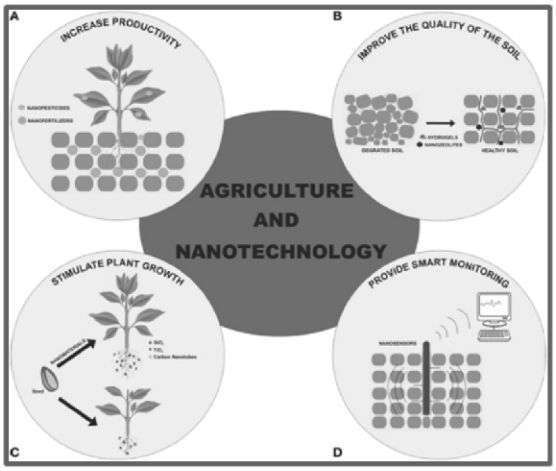


Fig. 2. Applications of NT in agriculture. (A) Increase the productivity using nanopesticides and nanofertilizers; (B) Improve the quality of the soil using nanozeolites and hydrogels; (C) Stimulate plant growth using nanomaterials (SiO_2, TiO_2, and carbon nanotubes); (D) Provide smart monitoring using nano sensors by wireless communication devices [reproduced from ref. 15].

that decrease the sample's interference(26). There are several commercially available enzyme-based nanobiosensors for pesticide detection26. Nanotechnology may also play great role in efficient delivery of nutrients according to body's requirements. In this context, nanocapsules are being designed to allow the attachment of nanoparticles to existing foods to facilitate improved nutrient absorption13.

NT Aided Agricultural Sustainable Development

NT has the potential revolutionize agriculture(6,16,20) with new tools for a variety of purposes including the following; i) plant protection (detection of diseases and protection of crops from these diseases); for this purpose, smart sensors and smart delivery systems are being developed, which will help the agricultural industry to combat viruses and other crop pathogens; ii) enhancement of water use efficiency and nutrition use efficiency; nano-fertilizers are being developed for slow release and efficient use of fertilizers; iii) enhanced efficiency of pesticides and herbicides through the use of nano-structured analysis, allowing lower doses to be used; and iv) protection of the atmosphere indirectly by the use

of green energy sources, pollution-reducing catalysts and environmental clean-up by eliminating current pollutants. The great potential of nanoparticles (NPs) has been exploited to a significant degree in a vast variety of areas, such as cosmetics, medical, environmental rehabilitation, and electronics for the benefits of society.

The maximum potential of NT in agricultural field is still evolving and still to be investigated. Following an impractical solution to the green revolution, the NPs-based policy has recently gained significant popularity due to its unusual agricultural biopesticides properties, opposed to contributing to the nano-revolution to preserve sustainability in agriculture (Fig. 2). In agriculture, NT is undeniably field that is projected to grow in the coming years(16).

Nanoparticles and their Functions

Carbon Nanotubes: As two dimensional graphene turned into either single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). The properties like mechanical, electronic, thermal, optical, elastic, etc. makes them suitable for its applicability in many types of nanodevices. CNTs have a potential to absorb toxic dichlorobenzene from water (15). Compared with conventional organic dyes, QDs have special spectral properties, so they have recently been used as a new generation of fluorophores in bioimaging and biosensing(11). Encapsulation is characterized as a process in which the object is surrounded by a coating or enclosed in a homogeneous or heterogeneous matrix, resulting in capsules with many useful properties such as protection of substances/objects from harmful environmental conditions as well as its release in controlled and specific manner(12,21,24). These encapsulated nanoparticles (NPs) have shown great potential to improve bioavailability of food contents and also nutraceuticals21. These encapsulation also facilitate nanoemulsions formation are kinetically stabled small droplet size system having potential application food sector(14).

NT Aided Precision Farming

NT is also being used for precision farming, which is a practice that is being increasingly used now across the world(15). Precision farming can be defined as the practice that involves gathering of information about spatial and temporal variation within a field. This information is then used to inputs and practices in farming in such a manner that one achieves maximum output with minimum input, In other word, precision farming is a system that maximizes crop yields with minimum use of chemicals. This is achieved by monitoring environmental factors and applying targeted intervention accordingly. Precision farming makes use of computers, global (satellite) positioning system and remote sensing devices at to measure highly localized environmental conditions. This allows identification of the nature and location of problems for a crop to grow at maximum efficiency(23). GPS-devices are being employed in precision farming for field mapping, farm planning, crop scouting, soil sampling, yield mapping, and tractor guidance etc(31). NT allows construction of tiny sensors and monitoring systems, which make the GPS receivers. This will have an impact on potential methodologies for the precision farming. The expanded use of autonomous sensors connected to a global positioning system (GPS) for real-time monitoring would be one of the main roles for NT enabled devices.These nanosensors may be spread in the field where soil conditions and crop growth can be tracked. In some parts of the USA and Australia, wireless sensors are already being used for these applications(31).

Another innovative approach aims to make the plants use water, pesticides, herbicides and fertilizers more efficiently, to reduce pollution and to build eco-friendly agriculture(7). As we know, Integrated Pest Management (IPM) combines traditional and biological pest control methods and becoming popular in world8. In upcoming time, nanoscale devices with novel features could be used to make agricultural systems 'smart'(25). Encapsulation and controlled release of pesticides and herbicides have also impacts towards green and smart agriculture.

Indian Scenario of Nanotechnology towards Agriculture and Food Industry.

India is Asia's third largest country as well as the world's seventh largest country with the second highest population. Agriculture remains primary source of economy and livelihood for various villagers. India has improved in many aspects in agriculture practices but still there are huge scope for improvement and modernization. Throughout India, the soil quality and weather vary tremendously. Irregularities in surface quality as well as height of land made it difficult to constructs universal irrigation systems in India(27). In several crop plants, the nanoparticles have shown significant effects such as improved germination percentage and rate; root and shoot size, and their ratio, vegetative biomass of seedlings, physiological activities including photosynthetic activity and nitrogen metabolism, and mRNA expression, etc(2). It is necessary to evaluate the possible opportunities and challenges in order to realize the potential of NT in Indian agriculture. NT can provide viable solutions in various areas of Indian agriculture: (i) nano-fertilizers for gradual release and effective use of plant water and fertilizers; (ii) nano-fertilizers (pesticides encapsulated in nanoparticles) for controlled release; (iii) nano-emulsifiers for higher efficiency; (iv) nano-particles for soil conservation; (v) nutrient and drug distribution for livestock and fisheries; vi) nano-brushes and water purification as well as washing of fishponds; and (vii) nanosensors to monitor the quality of soil and plant health(13,33).

Present and Future Scenario

Agriculture is a complex and high risk activity, the risk is higher in smallholders. Nanotechnology is yet to be imagined to minimise the risk of farmers and insure that affordable and diverse diet comprising nutritious food. The nanotechnology is rising globally but developing continents like Asia, there is need to give more attention to explore its scope. As agriculture is a strong pillar in economy, similarly, nanotechnology will have a strong position in economy development in next few years. NT is showing promising role in the development of pesticide, herbicide, fertilizers as well as packaging industry. The growth of NT in India is parallel to the world, which may be very much due to the investment by Indian government to utilize its applications popularize various industries including like pharmaceuticals, IT, and biotechnology. Also at the global level, the use of NT to food and agriculture sectors is at its preliminary stage, and its progress would be dependent on its ultimate stakeholder approval.

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CORRELATION AND PATH ANALYSIS OF YIELD AND YIELD CONTRIBUTING TRAITS IN MUNGBEAN [*VIGNA RADIATA* (L.)] GENOTYPES

Ajeet kumar, Aditya Singh*, S.S. Goarav and Ajeet Singh

Department of Genetics and Plant Breeding, C.C.S. University, Meerut, Uttar Pradesh, India

***Corresponding Author: Email**-adi9219@gmail.com

Abstract

A study was undertaken to estimate the correlation coefficient and path coefficient analysis of yield and yield contributing traits in 18 mungbean cultivars grown in randomized block design with three replications at Research Farm, Department of Genetics and Plant Breeding, CCS University, Meerut, during rabi season 2015-16. Yield, a complex polygenic trait has a large number of other contributing component traits. Correlation analysis reveals the relationship of dependent variable yield with its independent variables, thus association of various traits would determine their relative significance to improve yield. Seed yield per plant exhibited positive correlation with clusters per plant (0.839), pods per plant (0.756), biological yield per plant (0.531), harvest index (0.440) and branches par plant(0.341) indicating their importance in increasing yield. The critical evaluation of path coefficient for agronomic traits, indicate that harvest index had the highest direct and positive effect on seed yield per plant followed by the biological yield per plant (0.552), harvest index (0.531), clusters per plant (0.439), 1000 seed weight (0.237) and pods per plant (0.159) are major component traits for the improvement of grain yield.

Keywords: Mungbean, correlation and path coefficient analysis.

Introduction

India is the largest producer and consumer of pulses in the world accounting for 37 per cent of world area and 28 per cent of production. The total area covered under moong in India was 34.50 lakh hectares with a total production of 15.91 lakh tones. The coverage of area and its production was maximum in Rajasthan (32.76% and 30.61%) followed by Maharashtra (11.95% and 10.58%) of the total area and production. Karnataka ranked third in area (8.81%) and Tamilnadu is on third position for production (7.63%). The highest yield was recorded by the state of Panjab (845kg/ha) followed by Jharkhand (704 kg/ha) and Andhra Pradesh (696 kg/ha). The National yield average was 461 kg/ha. The lowest yield observed in the state of Karnataka (227 kg/ha) followed by C.G. (326 kg/ha) and Odisha (237 kg/ha) Annual report (2016-2017). Mungbean which is also known as green gram is one of the important pulse crops in India. It is cheap and rich source of vegetable protein and commonly used as supplement to the normal diet. Mungbean occupies an important position due to its high seed protein content (22-24%) and it has the ability to restore the soil fertility through symbiotic nitrogen fixation (9). It is rich in essential amino acids specially lysine, which is deficient in most of the cereal grains. Being a short duration crop, it fits well into the intensive rice-wheat cropping system of Indo- Gangetic plains of India (4). Its can also be grown as intercrop with sugarcane, pigeonpea, poplar and orchards. Thus, there is a great scope of increasing area

and production of summer mungbean (12), however, the productivity of mungbean is still very low. Maximization of yield is major objective in all the crops. Yield is a complex character associated with various contributing characters which are interrelated among themselves. Studies on the phenotypic and genotypic correlation of the yield components and their contribution to yield through path analysis provide information to design appropriate breeding strategy towards improvement of the crop.

Materials and Methods

The present investigation was carried out in the experimental farm Department of Genetics and Plant Breeding, CCS University, Meerut, during rabi season 2015-16. The materials comprised of 18 mungbean cultivars, the experiment was laid out in Randomized Block Design with three replications. Row to row and plant to plant distance was 30 and 10 cm respectively and per plot number of rows were 5. Row length was 3 meters. Observations were recorded on five competitive and randomly selected plants in each replication for all the genotypes. Phenotypic and genotypic correlation and path coefficients of variation were computed as per the method given by (5).

Results and Discussion

Yield, a complex polygenic trait has a large number of other contributing component traits. Correlation analysis reveals the relationship of dependent variable yield with its independent variables, thus association of various traits would determine their relative significance to improve yield. In the present investigation, the correlation coefficients were estimated among twelve characters at phenotypic and genotypic levels. The genotypic correlation coefficient was, in general observed to be higher than that of phenotypic correlation coefficient, indicating the existence of strong inherent association for the various characters studied however, the phenotypic expression of the correlation was influenced by the environmental factors. Grain yield showed significant stable positive association with number of clusters per plant (0.830), number of pod per plant (0.756), biological yield per plant (0.531), plant height (0.440) and number of branches per plant (0.341) at phenotypic level (Table 1). These results are in conformity with (7) for number of pods per plant, (2) for number of pods per plant, (3) for plant height, pods per plant, (8) for plant height, number of pods per plant, number of pods per plant and branches per plant, (13) for number of pods per plant.

Results on the phenotypic and genotypic path coefficient exhibited high positive direct contribution of biological per plant (0.552, 0.616), harvest index (0.531, 0.537),clusters per plant (0.439, -0.110), 1000 seed weight (0.237, 0.629), pods per plant (0.159, 0.671), plant height (0.132, 0.943), seeds per pod (0.096, 0.059), pods per cluster (0.049, -0.373), pod length (0.032, 0.166), branches per plant (-0.037, -0.651) and days of flowering (-0.009, 0.299) towards grain yield (Table 2). Similar results were also reported by (11) for harvest index, biological yield per plant, 100 seed weight, pod length, pods per plant, (10) for harvest index, biological yield, seed per pod, (6) for plant height, number of pods per plant and 100 seed weight, Gadhak et al., (2013) for harvest index, biological yield per plant and number of seeds per pod and (13) for harvest index, pod length, plant height and seeds per pod.

Table 1. Phenotypic and genotypic correlation coefficients among various characters in mungbean

charecters		Days of Flowering	Plant Height(cm)	Branches/ Plant	Clusters / Plant	Pods/ Cluster	Pods/ Plant	Pod Length(cm)	Seeds/ Pod	1000 Seed Weight(gm)	Biological Yield (gm)	harvest Index	Seed Yield/ Plant(gm)
Days of Flowering	P	**1.000**	0.071	0.188	0.011	0.115	0.009	-0.047	-0.126	-0.180	0.003	-0.093	-0.099
	G		0.164	0.094	0.648	0.133	-0.591	-0.944	0.357	-0.521	0.011	-0.601	-0.761
Plant Hieght (cm)	P		**1.000**	0.314**	0.490**	0.123	0.354**	-0.116	0.139	-0.228	0.586**	-0.445**	0.440**
	G			0.649	0.848	0.588	0.744	-0.266	0.681	-0.212	0.785	-0.654	0.750

Branches/ Plant	P			**1.000**	0.456**	0.160	0.493**	0.086	0.008	-0.032	0.299**	-0.206	0.341**
	G				0.630	0.437	0.518	0.359	0.151	0.437	0.618	-0.598	0.506
Clusters/ Plant	P				**1.000**	0.121	0.785**	0.172	-0.132	-0.022	0.569**	-0.170	0.830**
	G					0.301	1.168	-0.109	0.041	-0.130	1.070	-0.702	0.640
Pods/ Cluster	P					**1.000**	0.182	-0.197	-0.034	0.146	0.007	-0.014	0.162
	G						0.164	-0.697	-1.143	0.542	0.286	-0.225	0.226
Pods/ Plant	P						**1.000**	0.029	-0.065	-0.024	0.472**	-0.066	0.756**
	G							-0.022	-0.433	0.175	0.913	-0.407	1.093
Pod Length (cm)	P							**1.000**	-0.183	0.236	0.142	-0.027	0.186
	G								0.177	0.361	0.440	-0.444	-0.074
Seeds/ Pod	P								**1.000**	-0.227	-0.050	-0.027	-0.056
	G									-1.289	-0.073	0.320	0.186
1000 Seed Weight (gm)	P									**1.000**	-0.110	0.218	0.244
	G										-0.323	0.424	-0.070
Biological Yield (gm)	P										**1.000**	-0.727**	0.531**
	G											-0.720	0.822
Harvest Index	P											**1.000**	0.042
	G												-0.212
Seed Yield/ Plant In (gm)	P												**1.000**
	G												

Table 2. Direct and indirect path effects of different characters on seed yield per plant in mungbean

Charecters		**Days of Flowering**	**Plant Height(cm)**	**Branches/ Plant**	**Clusters / Plant**	**Pods/ Cluster**	**Pods/ Plant**	**Pod Length (cm)**	**Seeds/ Pod**	**1000 Seed Weight(gm)**	**Biological Yield (gm)**	**harvest Index**
Days of Flowering	**P**	**-0.009**	-0.001	-0.002	0.000	-0.001	0.000	0.000	0.001	0.002	0.000	0.001
	G	**0.299**	0.049	0.028	-0.194	0.040	-0.177	-0.283	0.107	-0.156	0.003	-0.180
Plant Hieght (cm)	**P**	0.009	**0.132**	0.041	0.064	0.016	0.047	-0.015	0.018	-0.030	0.077	-0.059
	G	0.155	**0.943**	0.612	0.799	0.555	0.702	-0.251	0.642	-0.200	0.740	-0.616
Branches/Plant	**P**	-0.007	-0.012	**-0.037**	-0.017	-0.006	-0.018	-0.003	0.000	0.001	-0.011	0.008
	G	-0.061	-0.423	**-0.651**	-0.410	-0.285	-0.337	-0.234	-0.098	-0.284	-0.403	0.390
Clusters/Plant	**P**	0.005	0.215	0.200	**0.439**	0.053	0.345	0.076	-0.058	-0.010	0.250	-0.075
	G	0.071	-0.093	-0.070	**-0.110**	-0.033	-0.129	0.012	-0.004	0.014	-0.118	0.077
tPods/Cluster	**P**	0.006	0.006	0.008	0.006	**0.049**	0.009	-0.010	-0.002	0.007	0.000	-0.001
	G	-0.050	-0.220	-0.163	-0.112	**-0.373**	-0.061	0.260	0.427	-0.202	-0.107	0.084
Pods/Plant	**P**	0.001	0.056	0.078	0.125	0.029	**0.159**	0.005	-0.010	-0.004	0.075	-0.010
	G	-0.397	0.499	0.347	0.784	0.110	**0.671**	-0.015	-0.291	0.118	0.612	-0.273
Pod Length (cm)	**P**	-0.001	-0.004	0.003	0.005	-0.006	0.001	**0.032**	-0.006	0.007	0.004	-0.001
	G	-0.156	-0.044	0.059	-0.018	-0.115	-0.004	**0.166**	0.029	0.060	0.073	-0.074
Seeds/Pod	**P**	-0.012	0.013	0.001	-0.013	-0.003	-0.006	-0.018	**0.096**	-0.022	-0.005	-0.003
	G	0.021	0.040	0.009	0.002	-0.067	-0.026	0.010	**0.059**	-0.076	-0.004	0.019

1000 Seed Weight (gm)	**P**	-0.043	-0.054	-0.007	-0.005	0.035	-0.006	0.056	-0.054	**0.237**	-0.026	0.052
	G	-0.328	-0.133	0.275	-0.082	0.341	0.110	0.227	-0.811	**0.629**	-0.203	0.267
Biological Yield (gm)	**P**	0.002	0.324	0.165	0.314	0.004	0.261	0.078	-0.028	-0.061	**0.552**	-0.402
	G	0.007	0.483	0.381	0.659	0.176	0.562	0.271	-0.045	-0.199	**0.616**	-0.443
Harvest Index	**P**	-0.050	-0.236	-0.110	-0.090	-0.007	-0.035	-0.014	-0.014	0.116	-0.386	**0.531**
	G	-0.232	-0.351	-0.321	-0.377	-0.121	-0.218	-0.238	0.172	0.228	-0.386	**0.537**
Seed Yield/ Plant In (gm)	**P**	**-0.099**	**0.440**	**0.341**	**0.830**	**0.162**	**0.756**	**0.186**	**-0.056**	**0.244**	**0.531**	**0.042**
	G	**-0.761**	**0.750**	**0.506**	**0.940**	**0.226**	**1.093**	**-0.074**	**0.186**	**-0.070**	**0.822**	**-0.212**

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COMBINING ABILITY & HETEROSIS FOR GRAIN YIELD & QUALITY TRAITS IN MAIZE

Kumari Rashmi[1], Z.A. Haider[2], M. Chakraborty[2] and Sahay Sanjay[3*]

[1]Department of Plant Breeding and Genetics, Bihar Agricultural College, Sabour, Bhagalpur-813210
[2]Department of Plant Breeding and Genetics, Birsa Agricultural University, Ranchi - 834 006
[3]Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural College, Bihar Agricultural University, Sabour Bhagalpur-813210
***Corresponding Author's: Email**- sanjaysahay38@rediffmail.com

Abstract

Eight yellow maize inbreds were utilized in making twenty eight crosses and twenty eight reciprocal crosses in a complete diallel mating system. These fifty six cross combinations and eight parental genotypes alongwith three checks were evaluated in a randomized block design in the year 2010. The crops growth period was from 8th February to 30th May. Observations were recorded for six characters in two replications. The mean observation data were used for analysis of variance, heterosis estimation, diallel analysis and combining ability following Griffing's (1956) method-I and model-I. Six characters were studied including five quality parameters and one yield parameter.Analysis of variance for six characters revealed significant difference among genotypes for all the characters. All the genotypes, F1s and reciprocals were found significant for all the characters.The estimated variance components of combining ability revealed that the magnitude of sca variance was higher than that of gca variance for all the characters. Out of this the cross K1105 × CM151 showed highly significant maximum positive reciprocal effect in analysis. The crosses CM153 × BAUMI-2 and CM153 × K1105 expressed maximum positive heterosis over check Vivek hybrid-9 for grain yield.

Keywords: Combining ability, Heterosis, Hybrids, Maize (*Zea mays* L.), Protein content.

Introduction

Exploitation of hybrid vigour is considered as an outstanding accomplishment of plant breeding. The magnitude of heterosis exhibited by hybrids depends largely on the heterotic pattern and genetic divergence between parental inbred lines. The information about the heterotic patterns and combining ability of parents and crosses both facilitate the breeders in the selection and development of single cross hybrids. The concept of general (GCA) and specific (SCA) combining abilities has a significant impact on inbred line evaluation, development of hybrids and population improvement in maize. The present investigation was undertaken to select better inbred lines based on combining ability and superior crosses on the basis of heterosis through diallel analysis.

Materials and Methods

Eight yellow maize inbred lines were crossed in a diallel fashion. All possible F1s (including reciprocals) and parents were grown in a randomized block design in two replications in two environments (February to May 2010 and July to August 2010). Each entry was in 3m row, 75 cm distance between rows and 25 cm between plants. Combining ability analysis was done following (3) method-I and model-I.

Results and Discussion

The analysis of variance was done with eight parents, twenty eight crosses, twenty eight reciprocals for six characters to test the significance of difference among the parents, crosses and reciprocals (Table1). As revealed from the Table, the difference among the genotypes (including parents, crosses and reciprocals) were significant for all the six characters.

Table 1: Anova (mean sum of squares)with F1's, reciprocals, parents for quality parameters & grain yield

Source	D.F	Mean sum of squares					
		Protein (1%)	Tryptophan (%)	Lysine (%)	Starch (%)	Oil (%)	Grain yield (q/ha)
Replicates	1.	0.01	0.00013	0.00009	0.62	0.02	0.18
Treatments	63.	1.08**	0.01**	0.16**	11.51**	0.09**	0.77**
Parents	7.	0.85**	0.00244**	0.08**	14.16**	0.02	1.60**
Hybrids	55.	1.13**	0.01**	0.152**	10.28**	0.10**	0.67**
Parent Vs.Hybrids	1.	0.04	0.05**	0.95**	60.82**	0.32**	0.19*
F1's	27.	0.98**	0.01**	0.143**	5.93**	0.11**	0.58**
Reciprocals	27.	1.32**	0.01**	0.17**	14.50**	0.09**	0.79**
F1 Vs Reciprocals	1.	0.04	0.001**	0.008*	13.78**	0.07	0.0004
Error	63.	0.01	0.0001	0.001	0.23	0.02	0.03
CV %		1.28	2.08	1.91	0.72	3.95	1.84
CD at 5%		0.171	0.013	0.046	0.674	0.193	0.263
CD at 1 %		0.227	0.017	0.062	0.897	0.257	0.350

*, ** = Significant at P = 0.05 and P = 0.01 respectively

Analysis of variance for combining ability for quality, the mean sum of squares due to gca, sca and reciprocals were found significant for all the quality characters. The magnitude of mean sum of squares due to gca were higher than that due to sca in all the characters studied except tryptophan content where mean sum of square due to sca and gca was equal in magnitude. The magnitude of mean sum of squares due to sca was higher than the reciprocals for all the characters except for kernel protein content.The estimated variance components of combining ability revealed that the magnitude of sca variance was higher than that of the gca variance for all the characters. Again, the magnitude of sca variance was higher than that of the reciprocal variance for all the characters (Table 2).

Table 2: Anova for combining ability for quality parametres and grain yield

		Mean Sum of squares					
Source	**D.F**	**Protein (%)**	**Tryptophan (%)**	**Lysine (%)**	**Starch (%)**	**Oil (%)**	**Grain yield (q/ha)**
GCA	7	0.844**	0.005**	0.110**	6.988**	0.075**	341.30**
SCA	28	0.413**	0.005**	0.1095**	6.456**	0.050**	262.27**
REC	28	0.592**	0.002**	0.038**	4.749**	0.032**	59.08**
Error	63	0.007	0.00004	0.0005	0.114	0.009	4.93
		Estimate of variance component					
^{2}gca		0.052	0.0003	0.007	0.430	0.004	20.834
^{2}sca		0.406	0.005	0.109	6.342	0.041	254.327
^{2}r		0.292	0.001	0.019	2.317	0.012	25.567
^{2}e		0.007	0.00004	0.00005	0.114	0.009	4.938
^{2}gca/ ^{2}sca		0.129	0.067	0.063	0.068	0.100	0.082

*, ** = Significant at P = 0.05 and P = 0.01 respectively

General Combining Ability (GCA) Effects

The estimates of general combining ability effects for eight parental genotypes for all the characters have been presented in Table 3. Three parents K1105 (5.32) ,BAUMI-2 (3.99) and HKI323 (2.07) showed highly significant but positive gca effect and BAUMI-1 (0.39) gave significant positive gca effect for grain yield while the rest parents showed highly significant but negative gca effect.The parent CM153 (0.312), CM151 (0.286), CM152 (0.194) and K1105 (0.150) recorded highly significant positive gca effect while the parent BAUMI-2 (-0.259), BAUMI-1(-0.191) and CM212 (-0.160) showed highly significant negative gca effect. The parent HKI323 (-0.031) was found to be non significant. Positive and highly significant gca effect for tryptophan content was found for CM212 (0.027), BAUMI-2 (0.015), BAUMI-1 (0.012) and K1105 (0.011). The rest parental lines showed highly significant negative gca effect for tryptophan content. Highly significant positive gca effect for lysine content was observed for CM212 (0.143), K1105 (0.081), BAUMI-1 (0.037) and BAUMI-2 (0.013). The rest parents gave highly significant negative effect for lysine content. The parent BAUMI-1 (0.793), BAUMI-2 (0.559), CM151 (0.483) and HKI323 (0.244) and recorded highly significant positive gca effect for starch content. K1105 (-0.671), CM152 (-0.502) and CM212 (-1.049) were found to give negative gca effect which were highly significant. CM153 (0.143) gave positive but non significant gca effect for starch content.The parent CM151 (0.081) showed highly significant positive gca effect for oil content and CM153 gave significant positive gca effect.

Table 3: General Combining Ability(GCA) effects of parents for quality parameters and grain yield

Parents	Protein (%)	Tryptophan (%)	Lysine (%)	Starch (%)	Oil (%)	Grain yield (q/ha)
BAUMI-1	-0.191**	0.012**	0.037**	0.793**	-0.030	0.39*
CM151	0.286**	-0.022**	-0.081**	0.483**	0.081**	-1.83**
CM152	0.194**	-0.014**	-0.053**	-0.502**	0.034	-3.57**
CM153	0.312**	-0.018**	-0.053**	0.143	0.057*	-4.26**
CM212	-0.160**	0.027**	0.143**	-1.049**	0.020	-1.34**
HKI323	-0.031	-0.011**	-0.086**	0.244**	-0.052*	2.07**
K1105	0.150**	0.011**	0.081**	-0.671**	-0.131**	5.32**
BAUMI-2	-0.259**	0.015**	0.013*	0.559**	0.020	3.99**
S.E (gi)±	0.020	0.002	0.005	0.079	0.023	0.17
S.E (gi-gj)±	0.030	0.0023	0.008	0.120	0.034	0.26
CD at 5%	0.047	0.003	0.013	0.187	0.053	0.34
CD at 1%	0.071	0.005	0.020	0.282	0.080	0.45

*, ** = Significant at P = 0.05 and P = 0.01 respectively

Specific Combining Ability (SCA) Effects

Specific combining ability effects of twenty eight crosses for six characters have been presented in Table 4. Eighteen crosses exhibited significant to highly significant positive sca effect for grain yield. The cross HKI323×BAUMI-2 exhibited highly significant maximum positive sca effect for grain yield. Ten crosses exhibited significant to highly significant positive sca effect for kernel protein content. Among these crosses BAUMI-1×CM151 (1.454) showed highest positive value for sca effect. Seventeen crosses exhibited highly significant positive sca effect for tryptophan content. The cross CM151×HKI323 (0.086) showed maximum positive value for sca effect. Seventeen crosses recorded significant to highly significant positive sca effect for lysine content. Among these crosses, CM151×HKI323 (0.416) showed maximum positive sca effect for lysine content. Twelve crosses were found to record highly

significant positive sca effect for starch content. Highly significant and maximum positive sca effect was observed in cross BAUMI-1×CM212 (2.875). Seven crosses namely CM153×BAUMI-2 (0.355), CM212× HKI323 (0.261), BAUMI-1×CM153 (0.245), BAUMI-1×CM151 (0.204), CM151×CM152 (0.180), CM212×K1105 (0.173) and CM152×CM212 (0.150) were found to show highly significant positive sca effect for oil content.

Table 4: SCA effects of crosses for quality parameters and grain yield

Crosses	Protein (%)	Tryptophan (%)	Lysine (%)	Starchl (%)	Oil (%)	Grain yield (q/ha)
BAUMI-1xCM151	1.454**	-0.083**	-0.440**	1.960**	0.204**	1.02*
BAUMI-1xCM152	0.570**	-0.049**	-0.181**	0.925**	-0.062	-4.64**
BAUMI-1xCM153	-0.591**	0.033**	0.182**	0.987**	0.245**	7.02**
BAUMI-1xCM212	-0.125*	0.011**	0.031*	2.875**	-0.088	6.17**
BAUMI-1xHKI323	0.030	0.014**	0.085**	0.579**	-0.048	3.99**
BAUMI-1xK1105	-0.419**	0.064**	0.235**	-0.009	-0.049	7.29**
BAUMI-1xBAUMI-2	-0.360**	0.023**	0.118**	-1.291**	-0.110	-1.48**
CM151xCM152	0.197**	0.008*	-0.043**	0.212	0.180**	4.72**
CM151xCM153	-0.143**	0.002	-0.012	0.459*	0.059	-0.33
CM151xCM212	-0.084	0.013**	0.034*	-1.006**	-0.074	0.60
CM151xHKI323	-0.345**	0.086**	0.416**	0.824**	0.080	-0.45
CM151xK1105	0.196**	-0.076**	-0.282**	-0.399	-0.112	6.09**
CM151xBAUMI-2	-0.727**	0.032**	0.184**	-0.899**	-0.006	0.01
CM152xCM153	0.235**	-0.001	0.027	-1.526**	-0.239**	2.51**
CM152xCM212	-0.291**	0.019**	0.176**	-1.611**	0.151*	-1.56**
CM152xHKI323	-0.352**	-0.020**	-0.090**	1.284**	0.040	2.76**
CM152xK1105	0.017	0.055**	0.207**	-0.522**	-0.090	1.55**
CM152xBAUMI-2	-0.227**	0.046**	0.273**	2.548	0.081	1.09*
CM153xCM212	0.110*	0.026**	-0.012	1.372**	-0.085	-0.53
CM153xHKI323	-0.200**	-0.051**	-0.275**	0.164	-0.051	-0.71
CM153xK1105	0.124*	0.039**	0.130**	-0.017	-0.083	-1.43**
CM153xBAUMI-2	-0.035	0.018**	0.093**	-2.844**	0.355**	4.35**
CM212xHKI323	-0.204**	0.059**	0.309**	-0.386	0.261**	4.25**
CM212xK1105	-0.085	-0.020**	-0.166**	1.006**	0.173**	6.33**
CM212xBAUMI-2	-0.066	0.016**	0.120**	-1.284**	-0.075	2.29**
HKI323xK1105	0.317**	0.005	0.103**	0.848**	-0.015	6.83**
HKI323xBAUMI-2	0.523**	-0.076**	-0.349**	2.345**	-0.103	8.72**
K1105xBAUMI-2	0.295**	0.014**	0.041**	0.702**	-0.014	6.89**
SE(Sij) ±	0.053	0.004	0.014	0.210	0.060	0.47
SE(Sij-Sik) ±	0.080	0.006	0.022	0.316	0.090	0.70
SE(Sij-Skl) ±	0.074	0.006	0.020	0.292	0.084	0.64
CD at 5%	0.109	0.008	0.297	0.432	0.124	0.94
CD at 1%	0.163	0.012	0.044	0.646	0.185	1.25

*, ** = Significant at P = 0.05 and P = 0.01 respectively

Reciprocal Effect: Reciprocal effects for fourteen crosses were found to be highly significant and positive for grain yield (Table 5). The cross K1105×CM151 was found to be promising for grain yield i.e. 13.29). Nine crosses namely BAUMI-2×K1105 (1.205), HKI323×CM152 (0.885), HKI323×CM153 (0.855), K1105×CM151 (0.718), K1105×CM212 (0.620), HKI323× BAUMI-1(0.612), BAUMI-2×BAUMI-1(0.360), BAUMI-2×CM151 (0.360), BAUMI-2×CM153 (0.308) were found to show highly significant positive reciprocal effects for kernel protein content. Significant to highly significant positive reciprocal effects were found in eight crosses viz., CM153×CM151 (0.058), CM152×CM151 (0.057), CM153× CM152 (0.047), CM212×CM152 (0.042), BAUMI-2×CM152 (0.027), CM212× BAUMI-1 (0.020), BAUMI-2×CM153 (0.017) and HKI323×CM151 (0.012). Ten crosses were found to record significant to highly significant positive reciprocal effects for lysine content. Fourteen cross combinations exhibited positive and significant to highly significant reciprocal effects for starch content. The cross K1105×CM152 (2.950) showed maximum positive value for reciprocal effects.Two cross combinations namely K1105×CM212 (0.225) and HKI323× CM212 (0.207) recorded positive and highly significant reciprocal effects for oil content.

Table 5: Reciprocal effects of crosses for quality parameters and grain yield

Reciprocal	Protein (%)	Tryptophan (%)	Lysine (%)	Starch (%)	Oil (%)	Grain Yield (q/ha)
CM151xBAU-1	-0.145*	-0.008	-0.005	0.060	-0.072*	2.17**
CM152xBAU-1	-0.148*	-0.030**	-0.047**	1.465**	0.145	0.10
CM152xCM151	-0.342**	0.057**	0.267**	-0.138	-0.063	-1.32*
aspalphaCM153xBAU-1	0.075	-0.047**	-0.275**	0.597*	0.045	-5.40**
CM153xCM151	-0.550**	0.058**	0.148**	-0.960**	-0.155*	-2.11**
CM153xCM152	-0.450**	0.047**	0.210**	1.265**	0.090	2.62**
CM212xBAU-1	-0.390**	0.020**	0.115**	-0.022	-0.130	-0.84
CM212xCM151	-0.023	-0.008	-0.065**	1.442**	0.125	3.54**
CM212xCM152	-0.427**	0.042**	0.150**	-0.943**	-0.072	-1.53**
CM212xCM153	-0.213**	0.000	0.028	-2.535**	-0.240**	0.64
HKI323xBAU-1	0.612**	-0.010*	0.005	-1.035**	-0.092	-4.18**
HKI323xCM151	**-0.990****	0.012*	0.027	-0.515*	-0.003	-0.88
HKI323xCM152	0.885**	-0.045**	-0.235**	0.000	0.065	3.22**
HKI323xCM153	0.855**	-0.010*	-0.030	**-2.815****	0.003	0.68
HKI323xCM212	-0.360**	-0.005	-0.020	-0.232	0.207**	-0.56
K1105xBAU-1	-0.505**	0.002	-0.028	1.088**	-0.067	6.25**
K1105xCM151	0.718**	-0.002	-0.003	2.237**	0.090	13.29**
K1105xCM152	-0.050	**-0.047****	-0.185**	**2.950****	-0.140*	2.84**
K1105xCM153	-0.640**	-0.037**	-0.198**	2.645**	-0.070	9.75**
K1105xCM212	0.620**	0.008	0.052**	2.760**	**0.225****	-2.33**
K1105xHKI323	-0.145*	0.005	0.038*	0.560*	0.125	-1.52**
mBAU-2xBAU-1	0.360**	-0.060**	-0.262**	1.895**	-0.072	5.34**
BAU-2xCM151	0.360**	-0.035**	-0.185**	0.582*	-0.072	3.46**
BAU-2xCM152	-0.257**	0.027**	0.157**	-2.230**	-0.188**	0.25
BAU-2xCM153	0.308**	-0.005	-0.027	0.982**	0.015	8.90**
BAU-2xCM212	-0.430**	0.017**	0.115**	1.620**	-0.007	9.10**
BAU-2xHKI323	-0.767**	-0.002	0.033**	-0.493*	-0.138*	2.65**
BAU-2xK1105	**1.205****	-0.010*	-0.010	-0.410	**-0.263****	1.69**
SE(rij) ±	0.060	0.005	0.016	0.239	0-068	0.53
SE(rij-rkl) ±	0.085	0.007	0.023	0.337	0.097	0.74
CD at 5%	0.124	0.009	0.034	0.488	0.140	1.06
CD at 1%	0.175	0.013	0.047	0.691	0.198	1.41

*, ** = Significant at P = 0.05 and P = 0.01 respectively

In the present study both additive and non additive gene actions were important for grain yield with predominance of additive gene action. Similar findings were reported by (4, 13, 14). The result was not in conformity with the results of (5, 8, 9, 12) with respect to grain yield.The analysis of variance for combining ability revealed that the mean square of both gca and sca variances were highly significant for kernel protein content, tryptophan content, lysine content, starch content, oil content. Thus both additive and non additive type of gene action were found to be important for the control of these characters with predominance of additive gene action for all the characters except tryptophan content where both the gene actions were equally important. This result was supported by (10) and (15). The result was not in conformity with the findings of (6, 7), (5, 8, 11) who reported importance of non additive gene action in the inheritance of the trait.

Heterosis Estimation

The expression of heterosis over check Vivek Hybrid 9 was studied for six characters (Table 6).

Table 6: Heterosis (%) over check Vivek Hybrid 9 for quality traits and grain yield

		Heterosis (%) over check Vivek Hybrid 9					
Sl.No.	**Crosses**	**Kernel Protein Content (%)**	**Tryptophan Content (%)**	**Lysine Content (%)**	**Starch Content (%)**	**Oil Content (%)**	**Grain yield (q/ha)**
1	BAUMI-1 × CM151	-15.57**	-11.54**	-15.57**	3.25**	3.40	7.31**
2	BAUMI-1 × CM152	1.38	-6.41**	1.38	2.34**	0.71	29.56**
3	BAUMI-1 × CM153	10.73**	8.97**	10.73**	2.10**	7.23	33.74**
4	BAUMI-1 × CM212	40.83**	32.05**	40.83**	2.21**	-8.23*	7.60**
5	BAUMI-1 × HKI323	21.11**	15.38**	21.11**	-0.76	-8.09*	15.32**
6	BAUMI-1 × K1105	40.83**	37.18**	40.83**	0.15	-9.65*	1.85
7	BAUMI-1 × BAUMI-2	11.76**	11.54**	11.76**	1.27	-7.23	6.64**
8	CM151 × CM152	24.57**	21.79**	24.57**	-1.53*	4.82	-2.96
9	CM151 × CM153	18.34**	19.23**	18.34**	-1.43	-0.57	-1.83
10	CM151 × CM212	20.42**	16.67**	20.42**	-1.81*	2.55	10.14**
11	CM151 × HKI323	37.37**	30.77**	37.37**	-0.09	1.28	16.56**
12	CM151 × K1105	-1.38	-8.97**	-1.38	0.82	-3.83	-2.99
13	CM151 × BAUMI-2	13.49**	11.54**	13.49**	-0.55	-1.13	0.52
14	CM152 × CM153	27.34**	17.95**	27.34**	-2.53**	-3.40	-6.16**
15	CM152 × CM212	47.06**	33.33**	47.06**	-7.67**	1.99	21.24**
16	CM152 × HKI323	-13.84**	-8.97**	-13.84**	-0.10	0.71	-1.95
17	CM152 × K1105	21.80**	15.38**	21.80**	0.24	-11.06**	25.12**
18	CM152 × BAUMI-2	45.33**	33.33**	45.33**	-1.06	-3.26	5.72**

19	CM153 × CM212	25.61**	23.08**	25.61**	-4.67**	-8.79*	11.90**
20	CM153 × HKI323	-12.46**	-8.97**	-12.46**	-4.96**	-2.98	9.62**
21	CM153 × K1105	15.57**	12.82**	15.57**	1.48*	-8.23*	45.50**
22	CM153 × BAUMI-2	20.07**	16.67**	20.07**	-3.33**	10.92**	50.93**
23	CM212 × HKI323	42.21**	32.05**	42.21**	-3.72**	10.64**	26.30**
24	CM212 × K1105	25.95**	20.51**	25.95**	1.40	6.38	30.01**
25	CM212 × BAUMI-2	45.33**	33.33**	45.33**	-1.84*	-2.98	43.04**
26	HKI323 × K1105	27.68**	16.67**	27.68**	-0.17	-3.83	25.29**
27	HKI323 × BAUMI-2	-8.65**	-5.13*	-8.65**	2.30**	-9.50*	39.98**
28	K1105 × BAUMI-2	26.99**	21.79**	26.99**	-1.35	-12.77**	38.27**
	CD at 5%	0.07	0.019	0.07	0.98	0.28	2.15
	CD at 1%	0.09	0.024	0.09	1.27	0.36	2.79

Standard heterosis over the check Vivek hybrid-9 ranged from -6.16 per cent (CM152 × CM153) to 50.93 per cent (CM153 × BAUMI-2). Twenty one crosses showed highly significant positive standard heterosis over the check Vivek hybrid-9. It ranged from -22.54 per cent to 2.64 per cent in the same crosses. Standard heterosis for tryptophan content ranged from -11.54 per cent to 37.18 per cent over the check Vivek hybrid-9. Standard heterosis over Vivek hybrid-9 it ranged from -15.57 per cent to 47.06 per cent. Twenty two crosses over Vivek hybrid-9 showed highly significant positive heterosis for lysine content in kernel protein. Standard heterosis ranged from -7.67 per cent to 3.25 per cent over the check Vivek hybrid-9 for starch content. Five crosses showed highly significant positive heterosis over the check Vivek hybrid-9.The magnitude of standard heterosis over Vivek hybrid-9 ranged from -12.77 per cent to 10.92 per cent for oil content. Most of the crosses showed positive standard heterosis for grain yield. Positive heterosis for grain yield has also been reported by many workers in maize, working with various types of parental population, viz., (1), (5) and (13) which supported the present findings. Lata et al.(2008) also reported similar findings over a wide range of environment. For kernel protein content most of the crosses showed negative significant heterosis over better check Vivek hybrid-9. Negative heterosis for kernel protein content was also reported by (5) and (13). For tryptophan content in kernel protein crosses showed highly significant positive heterosis to highly significant negative heterosis over checks. The present findings were supported by (13).

For lysine content in kernel protein heterosis ranged from significantly negative value to significantly positive value over best check Vivek hybrid-9. Similarly (13) reported a range of negative to positive heterosis for lysine content. Heterosis ranged from -7.67 per cent to 3.25 per cent over Vivek hybrid-9 for starch content. Similar findings were also reported by (5), (2, 13, 16). Heterosis ranged from -12.77 per cent to 10.92 per cent over Vivek hybrid-9 for oil content. Similarly (13) and (16) reported a range of negative to positive heterosis for oil content. The parent BAUMI-2 was most desirable parent as it has high gca for grain yield. For quality parameters the estimates of general combining ability showed high gca effect for parent CM153 (for kernel protein content), CM212 (for tryptophan and lysine content in kernel protein content), BAUMI-1 (for starch content) and

CM151 (for oil content). From the estimates of specific combining ability it was observed that hybrid combinations BAUMI-1 × CM151 (for kernel protein content), CM151 × HKI323 (for tryptophan and lysine content), BAUMI-1 × CM212 (for starch content) and CM153 × BAUMI-2 (for oil content) were good.The extent of standard heterosis was determined for six characters. The cross CM153 × BAUMI-2 (47.41 per cent) expressed highest positive and significant heterosis over the check Vivek hybrid-9 for grain yield. The reciprocals cross BAUMI-2 × CM153 (76.74 q/ha) gave the highest grain yield than the commercial check hybrid, Vivek hybrid-9. Among the crosses CM153 × BAUMI-2 (72.92 q/ha) and CM153 × K1105 (71.86 q/ha) gave higher grain yield than the check Vivek hybrid-9. Among the parents, BAUMI-2 (42.60 q/ha) was the best.

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INFLUENCE OF PLANT GROWTH REGULATORS ON GROWTH AND FLOWERING IN TUBEROSE (*POLIANTHES TUBEROSA* L.) CV. "PEARL DOUBLE"

Pushpendra Singh[1]*, Jitendra Kumar[2], Bijendra Singh[3] and Yesh Pal Singh[4]

[1]Horticulture Department, New Okhla Industrial Development Authority, Noida, U.P.
[2]Dept. of Horticulture, University Teaching Departments, CCS Uni., Meerut, U.P. -250004
[3]College of Horticulture, SVPUA&T, Meerut, U.P. – 250110
[4]KVK, Ujhani, Budaun, SVPUA&T, Meerut, U.P. India
***Corresponding Author: Email**-psbbn22@gmail.com

Abstract

Tuberose, the fascinating cut flower is a major representative of bulbous flower group. The soil of the experimental area was sandy loam and neutral in reaction. The total number of treatments were 10 comprising 3 levels of Ethrel i.e. 100,150 and 200 ppm; three levels of Maleic Hydrazide viz. M1 (50 ppm), M2 (100 ppm) and M3 (150 ppm) and three concentrations of Cycocel (3000, 5000 and 7000 ppm) and control.The salient features of the present study are summarized as ethrel at 150 ppm was found to be superior over 100 ppm and 200 ppm in increasing plant height, number of leaves, width of leaves and number of tillers per clump during study. The flowering parameters spike length, diameter of spike, number of spikes and number of florets per spike were also significantly increased with ethrel at 150 ppm. The results of the study showed that tillers per clump, plant height, number of leaves and width of leaves were positively influenced by MH at 100 ppm. It is pertinent from the present findings that minimum days required for emergence of first spike and visibility of first flowering was recorded with the MH at 50 ppm, while all other flowering characters were reported superior with MH at 100 ppm.

Key words: Tuberose flowering, plant growth, ethrel,maleic hydrazide, cycocel, growth regulators.

Introduction

Flowers are an integral part of human living. We have flowers and ornamental plants for every occasion. Growing of flowers has been practiced in India since time immemorial. This is amply evidenced by the references found in Rigveda, Ramayana as well as their depiction in paintings, murals, coins etc. Use of flowers, which was largely limited of offering in temples, has got a pride of place among all types of people, lowers class to higher strata. Today, it is being adopted as a lucrative profession also. Thus, floriculture has emerged as a potential foreign exchange earner in India. The floriculture consisting of cultivation and trade of cut flowers, cut foliage, potted plants, garden-bedding plants, planting material, services etc. has become an important sector, experiencing rapid change the world over. Consumption of flowers in most countries is rising and associated with income development. Rising demand has resulted in development of new production centers in Latin America, Africa and Asia, which were traditionally grow in U.S.A, Japan, Italy, The Netherlands and Colombia. In Asia, India and China besides Thailand are moving in the direction of more intensive horticulture. The chief centers of its production in India are Thane and Pune districts in Maharashtra, Midnapur district in West Bengal, Madurai and Coimbatore

districts in Tamil Nadu and Devanahalli district in Mysore. The tuberose (Polianthes tuberosa L.) is a bulbous ornamental plant popularly known as 'Rajanigandha'. Plant produces elegant fragrant spikes of waxy and white blossom, belongs to the family Amaryllidaceae and is a native of Mexico or South America. The light green leaves in tuberose are 70-80 cm long, narrow and in crowded form. The flowering stalk, which emerges, from the centre of the cluster of leaves is about 80-120 cm. long bearing leaves and the flower buds are tubular. Flowers are 5-6 cm. long, slightly bent near the base. Normally tuberose begins to flower in 90-95 days after planting. The flowers emit a delightful fragrance and are the source of tuberose oil. The natural flower oil of tuberose remains today one of the most expensive of the perfumery's raw materials and also used in soap and cosmetic industries. The most commonconstituents of tuberose concentrate are geranial, nerol, benzyl alcohol, methyl benzoate, methyl salicylate, eugenol, benzyl benzoate and methyl] anthranilate [9]. Tuberose flowers profusely during the summer and rains (April-September) in the plains and from May to July on the hills, while in mild climate tuberose remains in flowering throughout the year. Growth regulators play a vital role for improving growth and flowering in various flowers but sometimes these chemicals also affected the opening buds adversely.There is not much more information about the application of ethrel, maleic hydrazide &cycocel in tuberose. In this condition growers are needed information about optimum dose and using direction for way to increasing quality production and more profit. Keeping the above points into consideration, present study was conducted to find out the optimum dose of ethrel, MH and cycocel for maximize the growth and flowering attributes of tuberose cv. "Pearl Double" under Meerut conditions of western U.P.

Materials and Methods

The existing study was conducted at the Horticultural Research Farm Department of Horticulture, Ch. Charan Singh University, Meerut (U.P.) during two consecutive years. The climate of Meerut region remains hot in summer season and cold in winter season. Geographically, Meerut is situated at 29.01°N latitude and 77.43°E longitude with an altitude of about 222 meter above the mean sea level. Meerut region has a typical climate of semi-arid with extremes of weather conditions. The average annual rainfall is about 700 mm, bulk of which nearly 70% is received between June to September and rest between October to May. It remains hot in summer seasons and cold with frost in winter season. The maximum temperature ranges between 19.4°C to 45°C during the hottest month of May & June with extremes of 46.50°C and minimum during coldest month of December & January ranges between 3.9°C to 27.2°C. The relative humidity shows a reverse trend, the mean wind velocity of 8.9 km/hr in the month of June and 4.5 Km/hr in January. Thesoil characters of the experimental plot were sandy loam and having EC value 0.087 (mS/cm) as physical features and chemically analysis of the soil samples collected from the experimental field were recorded as pH 6.90,organic carbon 0.44%, available N 0.053%, P 0.081% and K 0.0194%.

Mechanical analysis of the soil constituents was done by Bouycos Hydrometer Method [19]. Electrical conductivity (EC) was measured by conductivity bridge [6] and the pH by glass electrode pH meter[5]. Organic carbon was estimated by the method of Walkley and Black[24]. Available N was estimated by Macro-Kjeldahlmethod[3]. Available P was estimated with Olsen's reagent[15] while available K was estimated by Flame photometer[17].

The well-developed, average size bulbs of tuberose were used for conducting the experiment. The experiments were laid out inrandomized block design with ten treatments including control. All treatmentswere replicated thrice.

Preparation of growth regulators solution:

$V_1C_1 = V_2C_2$

Where,

V_1 = Volume of stock solution to be taken.

C_1 = Concentration of stock solution available.

V_2 = Volume of desired solution to be made.

C_2 = Concentration of desired solution.

For example:

To prepare one litre of 100 ppm solution from 1000 ppm stock solution. Above formula was used as follows:

V_1 = ? C_1, = 1000 ppm

V_2 = 100 m_l C_2 = 100 ppm

Vi = V_2 C_2/ C, =1000x100/1000 = 100 ml.

So, 100 ml of stock solution was dissolved in 900 ml of distilled water to prepare one liter of 100 ppm solution from the stock solution 1000 ppm. and 200 ml. of stock solution was dissolved in 800 ml distilled water to prepare one liter of 200 ppm solution from the stock solution of 1000 ppm.

Five plants were selected from each treatment and tagged for recording the growth observations i.e., days taken for sprouting, number of tillers per clump, height of the plant (cm), number of leaves per clump and width of the longest leaf (cm). Same procedure followed for recording the flowering characters that were days required for the visibility of first spike, days taken for the opening of first flower, duration of flowering (days),number of spikes per clump,length of spike (cm),diameter of spike (cm), fresh weight of spike (gm), number of florets per spike, length of rachis (cm),length of internode (cm).

Results and Discussion

Growth Characters

The perusal of the data presented in Table-1 indicates that all the treatments significantly affect the days taken to sprouting and tillers per clump. Number of days required for sprouting was significantly reduced to 11.46 and 11.74 with E1 (100 ppm) treatment during the both consecutive years. The effect was less, as we increase the ethrel quantity. In E3 (200 ppm) treatment the number of days taken for sprouting was 12.28 and 12.80 during respective years. Maximum number of tillers per clump increased to 1.49 and 1.55 under the E2 (150 ppm) treatment during both the years, However minimum number of tillers per clump was 1.37 and 1.42 with E1 (100 ppm) treatment during both the years respectively. The maximum increase in different characters was found with the 150 ppm ethrel (E2 treatment). These findings are in accordance with findings of[12, 18and16]. Maleic hydrazide has also significantly reduced the days taken for sprouting to 11.80 and 11.98 days in M1 (50 ppm) treatment, during both the years. MH has also shown the same effect as ethrel, that the effect was 'less with the increase in MH concentrations. It was 12.03 and 12.17 days under the M3 (150 ppm) treatment during both theyears. Minimum number of days were required for sprouting with C1 (3000 ppm) treatment of cycocel with 11.66 and 11.86 days during both the years. However, cycocel at 7000 ppm has shown significant reduction with 12.08 and 12.28 days during both the years. Number of days taken for sprouting under the control was 13.50 and 14.20 during both the years. It is also clear from the data that M1 (100 ppm) treatment gave maximum number of tillers per clump were 1.47 and 1.52 during respective years of the study. However, the minimum number of tillers per clump were 1.41 and 1.45 with M1 (50 ppm) treatment during both the years. Maximum number of tillers per clump were recorded to 1.55 and 1.59 with the C2 (5000 ppm) treatment during both the years respectively. However, the minimum number of tillers per clump was 1.31 and 1.34 with C1 (3000 ppm) treatment during both the years of study. Number of tillers per clump under control were recorded to 1.26 and 1.28 during the said years, respectively. Plant height affected by different factors during their different developmental stages is presented in Table-2. Data reveals that maximum height of plants was 73.44 and 74.91 cm recorded with E2 (150 ppm ethrel) treatment after 120 days of sowing during respective years of the study. However, significantly low plant height (71.70 and 73.14 cm) was observed with E1 (100 ppm) treatment after 120 days of sowing during both the years of study. The data clearly reveal that the maximum height of plants during MH treatment was 74.55 and 75.90 cm under M2 (100 ppm) treatment during the consecutive years of study. However, the minimum height of the plants was 70.21 and 71.78 cm with M1 (50 ppm) treatment during both the years. The foliar spray of cycocel shows significant effect in improving the plant height after 120 days during both the years of experimentation. The maximum plant height was recorded to 75.15 and 76.58 cm with C1 (3000 ppm) treatment. However, minimum plant height was observed with C3 (7000 ppm) treatment where it was 69.90 and 71.37 cm during both the years of study. The plant height was 66.5 and 71.5 cm in control during the study. Numbers of leaves per clump as influenced by different factors are presented in Table-3. The perusal of data indicates

that the foliar spray of ethrel registered remarkable improvement in the number of leaves at all stages except at 30 days of planting. E2 (150 ppm) treatment produced more number of leaves per plant (60.74 and 63.30) during both the years. However, the minimum number of leaves (57.42 and 59.87) per plant after 120 days was recorded with E1 (100 ppm) treatment during both the years of study. Data with regards to MH clearly shows that the maximum number of leaves per plant was 60.51 and 63.17 with M2 (100 ppm) treatment during the individual trails. Minimum number of leaves (57.99 and 60.32) per plant was recorded with M1 (50 ppm) treatment after 120 days during both the years of experimentation. These results are in accordance with the findings of[20] that states that maleic hydrazide at higher concentrations promoted the number of leaves over control, However, growth retarding effect of MH was reported by[23] in marigold; [14]in chrysanthemum and [13]in marigold. It is also clear from the data that cycocel at minimum concentration showed significant and favorable effect on number of leaves in both the years. Maximum number of leaves (61.48 and 63.92) per plant was observed with C1 (3000 ppm) treatment. However, minimum number of leaves (59.87 and 59.42) was observed with C3(7000 ppm) treatment. The number of leaves per clump was recorded to 53.8 and 56.8 in control during study.

Data related to the width of the leaves as influenced by ethrel, MH and cycocel are set out in table-4. Foliar spray of ethrel registered remarkable effect on width of leaves over control at all the growth stages. Results in table-4 are in accordance to the findings of[2], which states that at higher concentration, ethrel also enhance leaf production. However, foliar application of ethrel failed to show any appreciable difference in the time of emergence Maximum width of the leaves was recorded to 1.68 and 1.68 cm with E2 (150 ppm) treatment after 120 days during both the years. However, minimum width of leaves was recorded to 1.45 and 1.48 cm with E1 treatment after 120 days during study. It is also clear from data that the maximum width (1.56 and 1.59 cm) of leaves was recorded to with M2 (100 ppm) treatment at the time of investigation. However, the minimum width of the leaves (1.52 and 1.55 cm) per plant was recorded with M1 (50 ppm) treatment during both the years. Maximum width of leaves after 120 days was 1.58 and 1.61 cm under C1 (3000 ppm) treatment during both the years of study. However, the minimum width of leaves was recorded 1.50 and 1.53 cm with C3 (7000 ppm) treatment during both the years, respectively. However, the width of the leaves recorded in control was 1.35 and 1.38 cm during the study.

Table-1: Effect of growth regulators on days taken for sprouting and number of tillers per clump.

Treatments	No. of days taken for sprouting		No. of tillers per clump	
	Ist Year	IIndYear	Ist Year	IIndYear
E1 (100 ppm)	11.46	11.74	1.37	1.42
E2 (150 ppm)	12.05	12.19	1.55	1.55
E3 (200 ppm)	12.28	12.80	1.49	1.48
M1 (50 ppm)	11.80	11.98	1.41	1.45
M2 (100 ppm)	11.99	12.17	1.47	1.52
M3 (150 ppm)	12.03	12.17	1.44	1.47
C1 (3000 ppm)	11.66	11.86	1.31	1.34
C2 (5000 ppm)	12.08	12.18	1.55	1.59
C3 (7000 ppm)	12.08	12.28	1.47	1.51
Control	13.50	14.20	1.26	1.28
SEm+	0.091	0.095	0.009	0.007
CD at 5%	0.253	0.262	0.025	0.020

Table-2: Effect of ethrel, maleic hydrazide and cycocel on plant height.

Treatments	Plant Height (cm)							
	30 Days		60 Days		90 Days		120 Days	
	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear
E1 (100 ppm)	14.04	15.68	31.25	32.58	50.93	52.45	71.70	73.14
E2 (150 ppm)	14.63	15.51	33.10	34.30	54.53	55.90	73.44	74.91
E3 (200 ppm)	15.12	15.32	32.65	34.00	53.70	55.22	72.53	73.99
lparM1 (50 ppm)	14.56	15.21	31.30	32.68	51.58	52.98	70.21	71.78
M2 (100 ppm)	17.78	15.67	33.21	34.39	53.93	55.43	74.55	75.90
M3 (150 ppm)	14.47	15.69	32.50	33.83	53.54	54.97	72.91	74.37
C1 (3000 ppm)	14.32	15.34	33.53	34.91	55.03	56.48	75.15	76.58
C2 (5000 ppm)	14.63	15.54	32.33	33.59	53.00	54.41	72.62	74.10
C3 (7000 ppm)	14.84	15.65	31.14	32.38	51.03	52.49	69.90	71.37
Control	15.30	15.40	31.70	32.90	48.90	50.90	66.50	71.50
Sem+	0.122	0.147	0.308	0.277	0.438	0.347	0.654	0.663
CD at 5%	0.388	0.406	0.853	0.768	1.214	0.962	1.814	1.838

Table-3: Effect of ethrel, maleic hydrazide and cycocel on number of leaves per clump.

Treatments	Number of leaves per clump							
	30 Days		60 Days		90 Days		120 Days	
	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear
E1 (100 ppm)	5.91	6.47	11.55	12.34	35.79	37.32	57.42	59.87
E2 (150 ppm)	6.64	7.20	12.89	13.71	40.63	42.24	60.74	63.30
E3 (200 ppm)	6.68	7.25	12.45	13.29	39.71	41.29	59.58	62.02
M1 (50 ppm)	6.10	6.69	11.66	12.51	36.69	38.24	57.99	60.32
M2 (100 ppm)	6.65	7.22	12.54	13.32	40.58	42.10	60.51	63.17
M3 (150 ppm)	6.48	7.02	12.69	13.51	38.87	40.50	59.24	61.68
C1 (3000 ppm)	6.17	6.73	12.24	14.08	40.54	42.23	61.48	63.92
C2 (5000 ppm)	6.51	7.12	12.25	13.03	38.72	40.23	59.40	61.84
C3 (7000 ppm)	6.54	7.08	11.40	12.23	36.87	38.37	59.87	59.42
Control	6.00	6.50	9.70	10.50	37.40	38.80	53.80	56.80
Sem+	0.068	0.063	0.110	0.117	0.306	0.247	0.450	0.545
CD at 5%	0.190	0.175	0.304	0.325	0.848	0.685	1.247	1.511

Table-4: Effect of ethrel, maleic hydrazide and cycocel on width of leaf.

Treatments	width of leaf (cm)							
	30 Days		60 Days		90 Days		120 Days	
	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear	Ist Year	IIndYear
E1 (100 ppm)	0.56	0.57	0.64	0.67	0.95	0.98	1.45	1.48
E2 (150 ppm)	0.56	0.57	0.76	0.78	1.11	1.15	1.68	1.68
E3 (200 ppm)	0.55	0.57	0.75	0.78	1.08	1.11	1.60	1.60
M1 (50 ppm)	0.56	0.57	0.70	0.72	0.98	1.02	1.52	1.55
M2 (100 ppm)	0.56	0.57	0.73	0.76	1.09	1.23	1.56	1.59
M3 (150 ppm)	0.56	0.57	0.72	0.75	1.07	1.10	1.53	1.56
C1 (3000 ppm)	0.56	0.57	0.75	0.77	1.09	1.13	1.58	1.61
C2 (5000 ppm)	0.56	0.57	0.72	0.74	1.05	1.08	1.52	1.56
C3 (7000 ppm)	0.56	0.57	0.69	0.72	1.00	1.07	1.50	1.53
Control	0.55	0.56	0.57	0.60	0.87	0.91	1.35	1.38
Sem+	0.003	0.004	0.004	0.005	0.007	0.008	0.013	0.011
CD at 5%	0.099	0.011	0.012	0.015	0.020	0.023	0.037	0.030

Table-5: Effect of growth regulators on various flowering attributes in tuberose.

Treatments	Days taken for the opening of first flower		Duration of flowering (Days)		Number of spikes per clump		Length of spike (cm)		Diameter of spike (cm)		Fresh weight of spike (gm)		Number of florets per spike		Length of rachis (cm)		Length of internode (cm)	
	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
E_1(100 ppm)	114.51	116.07	34.44	35.12	1.34	1.37	73.80	74.70	0.84	0.86	37.40	38.11	26.21	27.11	35.57	36.01	7.41	7.46
E_2(150 ppm)	111.00	112.55	36.98	37.54	1.63	1.65	75.35	76.70	0.86	0.88	41.18	41.94	31.04	31.09	37.32	39.77	8.23	8.30
E_3(200 ppm)	109.14	110.64	38.82	38.71	1.61	1.64	74.43	75.25	0.85	0.87	40.33	39.88	29.86	30.57	36.42	38.87	8.08	8.21
M_1(50 ppm)	109.72	111.33	34.92	35.71	1.40	1.43	72.74	73.63	0.84	0.86	38.40	39.08	27.12	28.08	35.44	37.89	7.53	7.63
M_2(100 ppm)	112.05	113.61	36.88	37.54	1.61	1.63	75.74	76.51	0.86	0.88	40.79	40.90	30.60	31.07	37.28	39.83	8.36	8.45
M_3(150 ppm)	112.88	114.32	35.44	36.09	1.56	1.60	75.10	75.88	0.85	0.87	39.72	39.96	29.39	29.93	36.59	38.92	7.82	7.89
C_1(3000 ppm)	108.92	110.53	35.09	35.77	1.47	1.49	73.45	74.31	0.85	0.87	37.30	38.56	28.04	28.70	35.53	37.86	7.41	7.48
C_2(5000 ppm)	112.01	113.57	36.61	37.13	1.56	1.59	76.01	76.68	0.87	0.89	41.91	42.22	30.24	30.84	37.34	39.79	8.47	8.55
C_3(7000 ppm)	113.72	115.16	35.45	35.84	1.55	1.57	74.12	75.03	0.84	0.86	39.70	39.16	28.82	29.53	36.43	38.99	7.83	7.94
Control	115.30	117.30	29.50	30.00	1.20	1.22	68.40	70.40	0.81	0.83	32.40	33.50	26.80	27.40	32.40	35.47	5.95	6.12
Sem±	0.615	0.457	0.144	0.269	0.005	0.008	0.319	0.311	0.006	0.003	0.168	0.145	0.124	0.182	0.193	0.202	0.035	0.029
CD at 5%	1.706	1.268	0.400	0.737	0.013	0.023	0.886	0.864	0.017	0.009	0.466	0.403	0.343	0.504	0.536	0.560	0.096	0.082

Flowering Characters

All the flowering parameters significantly influenced with ethrel, maleic hydrazide and cycocel (table-5). Earliest opening (108.92 and 110.53 days) of the first flower on the spike was recorded with C1 (3000 ppm) treatment followed by 109.14 and 110.64 with E2 treatment. M2 treatment also significantly reduced days (109.72 and 111.33) taken for opening the first flower. Maximum days 115.30 and 117.3 were taken to open first flower in control during both the years of study. All the treatments significantly influenced the duration of flowering. Maximum duration of flowering i.e. 38.82 and 38.71 days was recorded with E3 treatment followed by E2and minimum was in control.[20]applied cycocel through foliar sprays on plants. CCC at lower concentration registered maximum duration from planting to spike emergence. The maximum number of spikes per clump (1.63 and 1.65) was observed with the E2 (150 ppm) treatment followed by 1.61 and 1.63 was recorded with M2 (100 ppm) treatment whereas minimum number of spikes per clump was recorded to 1.20 and 1.22 in control during the both years of study. Longest spike (76.01 and 76.68 cm), rachis (37.34 and 39.79) and maximum spike diameter (0.87 and 0.89 cm) were recorded under C2 treatment which was at par with E2 and M2 treatments. Smallest spike (68.4 and 70.4 cm), and rachis (32.4 and 35.47 cm) were recorded to in

control during the both years, respectively. The diameter of spike was recorded to 0.81 and 0.83 cm in control at time of investigation. Data reveals that foliar application of ethrel, maleic hydrazide and cycocel significantly increased the fresh weight of spike. Maximum fresh weight of spike (41.91 and 42.22) was observed with C2 followed by E2 and M2 respectively as per investigation. It is evident from the data depicted in Table 5, that duration of flowering, maximum number of spike per clump, length of spike and diameter of spike were showing the best result with M2 (100 ppm) treatment. [8]inPolianthes tuberosa L. found that the treatment of cycocel extended the flowering period. The results in terms of duration of flowering are in accordance with the earlier work of[21]. It is evident from the data that the maximum number of florets per spike were 31.04 and 31.09 with the E2 (150 ppm) followed by M2 and C2 treatments during both the years. The present findings confirm the results obtained by different workers who noticed significant role of ethrel in increasing the number of florets[10, 11, 1, 4, 12]. The minimum number of florets per spike (26.21 and 27.11) were recorded under E1 (100 ppm) treatment. All the treatments significantly increased the internodal lengths. Maximum length of internodes was 8.47 and 8.55 cm with the C2 (5000 ppm) treatment followed by 8.36 and 8.45 in M2 and 8.23 and 8.30 cm respectively during both the years of investigation. While length of internodes in control were recorded 5.95 and 6.12 cm during the study.

Conclusion

The present investigation reveals that comparatively ethrel and cycocel at 150ppm and 5000 ppm, respectively are best suited for the growth and flower production of tuberose cv. ' Pearl Double'. Maleic hydrazide had less or very little effect on the crop enhancement. These treatments enhance the quality crop production under the agro-climatic conditions of Meerut region of western U.P.

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, YIELD AND QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. ALLAHABAD SAFEDA UNDER HIGH DENSITY PLANTING

Pratima Gupta[1]* and Vidhur Kumar[2]

[1]College of Agriculture IIMT University, Meerut (U.P) 250001

[2]Department of Horticulture, Allahabad School of Agriculture, S.H.U.A.T.S, Allahabad-211007 (U.P), India
***Corresponding Author: Email**-gpratima41@gmail.com

Abstract

The present investigation entitled, "Effect of integrated nutrient managemnt on growth and yield of guava (*Psidium guajava* L.) cv. Allahabad Safeda under high density planting" was conducted at Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during 2016-17 and 2017-18. The experiment laid out in Randomized Block Design (RBD) with three replications. The experiment consisted of ten treatments viz. (T_0) 100% RDF (NPK-180,90,90g), (T_1) 75% RDF+2.5 kg Vermicompost, (T_2) 50% RDF+2.5 kg. Vermicompost, (T_3) 75% RDF+10 kg FYM, (T_4) 50% RDF+10 kg FYM, (T_5) T_3 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%), (T_6) T_4 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%), (T_7) 50% RDF+10 kg FYM+Azotobactor, (T_8) 50% RDF+10 kg FYM+ Azotobactor+ PSB (100g/P), (T_9) 50% RDF+10 kg FYM+ VAM, (T_{10}) 50% RDF+10 kg FYM+ Azotobactor+ VAM. The results revealed that the application of 75% RDF+10 kg FYM + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%), (T_5) significantly influence the growth and yield of guava. Maximum plant height (256.80 cm), more number of branch (20.56), maximum number of leaves (150.16), maximum plant girth (2.58), higher number of flowers (79.33), more number of fruits (38.23), fruit diameter (6.51 cm), fruit length (6.05 cm) at harvest, fruit volume (121.75 ml), average fruit weight (152.84 g) and number of fruits per plant (5829.59 g) were obtained with treatment T_5. The combined application of 75% recommended dose of NPK with FYM (10 kg) and micronutrient gave significantly higher fruit yield per hectare (99.56q/ha).

Keywords: INM, azotobactor, FYM, vericompost, micronutrient

Introduction

Guava (*Psidium guajava* L.), is one of most exquisite, valuable and popular fruits grown in tropical, sub-tropical and some parts of arid regions of India, which belongs to the family Myrtaceae. The total area under guava cultivation and production in India is about 2.51 lakh hectares and 4083,000 MT, respectively. The productivity of guava in India is 16.2 MT/ha. The total area and production of guava in Madhya Pradesh is around 24370 hectares and 9.12 Lakh MT, respectively. Madhya Pradesh ranks first in productivity with 37.4 MT/ha. Guava shares 4.5 percent of area and 3.3 per cent of production among fruit crops in India [1].

Guava is one of the richest natural source of vitamin C containing 2 to 5 times more vitamin C than oranges. Among fruits, it ranks third in vitamin C content after Barbados cherry and Aonla. However, these fruits unlike guava are not used in fresh form. Compared to other fruits, the whole guava is a moderately good source of calcium, a fair source of phosphorus and a good source of iron. Guava is an

excellent source of dietary fiber, pectin and minerals. it is also stewed and used in short cake and pies. However, guava fruits are processed commercially into jellies, jam, cheese, puree, juice, powder and nectar. Due to their astringent properties, mature guava fruits, leaves, roots, bark and immature fruits are used in local medicines to treat gastroenteritis, diarrhea, anddysentery.

Conventional (chemical based) farming is non-sustainable because of many problems such as loss of soil health and productivity from excessive erosion and low farm income from high production costs etc. In view of these, there is an increasing awareness about alternate agriculture system known as integrated nutrient management. The basic concept of integrated nutrient management (INM) is the adjustment of plant nutrient supply with proper combination of chemical fertilizers, organic manure and biofertilizers suitable to the system of land use and ecological, social and economic conditions. Azotobacter is known to add nitrogen to the soil through biological nitrogen fixation. VAM fungi function mnutualistically by transporting slowly mobile ions of P, Zn and Cu from soil profile which lies beyond depletion zone of active roots. It also promotes and increase nitrate reduce enzyme activityand.

It also promotes and increase nitrate reduce enzyme activity and promotion of antifungal substances. Phosphorus solubilising microorganisms helps in transforming inorganic fixed phosphates to available form by microbial action and have greater economical importance in improving plant nutrition. The activity of phosphorus solubilizing microbes (PSM) can be improved by using them in combination with organic manures. Vermicompost, the compost prepared by earthworms has gained popularity in recent years, which is a rich source of growth promoting substance. s viz., growth hormones, enzymes and vitamins (Bhawalkar, 1992). There is an urgent need for an alternative nutritional package to attain long term sustainability for fruit production as well as for maintaining soil health and productivity under INM system. Keeping the above facts in view, an experiment was conducted to find out the INM effects of integrated nutrient management on pre bearing growth and sustainable production ofguava.

Materials and Methods

The present experiment was carried out at Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (UP) during rainy and winter season of the years, 2016-17 and 2017-18. The experiment was conducted in Randomized Block Design (RBD) with three replications. The experiment was consisted of ten treatments viz., Control (T0) 100% RDF (NPK-180,90,90g), (T1) 75%

RDF+2.5 kg Vermicompost, (T2) 50% RDF+2.5 kg Vermicompost, (T3) 75% RDF+10 kg FYM, (T4) 50% RDF+10 kg FYM, (T5) T3 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%), (T6) T4 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%), (T7) 50% RDF+10 kg FYM+Azotobactor,(T8)

50% RDF+10 kg FYM+ Azotobactor+ PSB (100g/P), (T9) 50% RDF+10 kg FYM+ VAM, (T10) 50% RDF+10 kgFYM+

Azotobactor+ VAM. The whole of the organic manure was applied as a basal dose on the onset of monsoon. Then required doses of fertilizers were applied in the month of August and then bio-fertilizers were applied one week after each application of inorganic fertilizer. For application of manure and fertilizers the top soil around the tree equal to the leaf canopy of the tree was dug up to 30 cm and the fertilizers were uniformly mixed into the soil, which was then leveled. Irrigation was supplied immediately after fertilizer application. Micronutrient were applied before flowering of guava plants. The various growth parameters viz., plant height, number of branches per plant and number of leaves were recorded with the help of measuring device at the time of fertilizer application. Fruit length and diameter were noted using the vernier caliper, volume of fruit was recorded by water displacement method and weight of fruit was recorded using electronic weighbalance.

Results and Discussion

Growth Characters

The applications of integrated nutrient management treatments were significantly effective in improving the growth characters (Table 1). Among treatments, the application of

(T_5) 75% RDF, (NPK 120:60:60 kg/ha) + 10t FYM + (Zn+B+Mn (0.5,0.2,0.1%), was found to be most significantly superior in compression of other treatments and recorded taller plants (256.80 cm) which was significantly at par with 75% RDF, (NPK 120:60:60 kg/ha) + 10t FYM. Treatment receiving 75% RDF, (NPK 120:60:60 kg/ha) + 10t FYM + (Zn+B+Mn (0.5,0.2,0.1%), produced more number of leaves (150.16), higher number of branches (20.93) and plant girth (2.58 m3) as compared all other treatments. However, minimum growth attributes were obtained under control (100% RDF) in present investigations. This might be due to the fact that growth and development of above ground parts of plant are determined primarily by the activity of apical meristem, because the leaf primordial is formed there. The stem elongation depends initially on the new tissue formed at the apex and many of the hormonal signals which determine the later growth and development of all plant parts. It becomes clear that, higher dose of inorganic fertilizers along with manures and micronutrients increased availability of nutrients. Similar findings have been reported by Dutta et al. (2009) [2], Dwivedi et al. (2018) [3] and Jamwal et al. (2018) [5] in guava. Nitrogen positively influenced the vegetative growth of the plant, phosphorus plays an important role in photosynthesis and accumulation of food material and potassium plays an important role in carbohydrate and protein synthesis and in the regulation of water relations. It may also act as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These nutrients also play an important role in metabolic activities of the plant resulting in the synthesis of chlorophyll and cytochromes which are essential for photosynthesis and respiration process in the plants. Application of organic manures with biofertilizers reported to facilitate the wider absorption of micro and micronutrient which help in better growth and development of plant. [11] also confirm the results.

Effect of INM on Yield and Yield Attributes

The application of organic fertilizer with combination of inorganic fertilizer and micronutrient were significantly affected yield and yield attributing characters of guava in present experimentation. The treatment receiving (T5) 75% RDF, (NPK 120:60:60 kg/ha) + 10t FYM + (Zn+B+Mn

(0.5,0.2,0.1%), recorded maximum number of flower per plant (79.33), higher number of fruits per plant (38.23), fruit diameter (6.51 cm), fruit length (6.05 cm), fruit volume (121.75 m3) and average weight of fruit (152.84 g) which was at par with treatment 75% RDF+ 10 T FYM and significantly higher all other treatments, whereas these values were minimum with the treatment of T_0 (100% RDF). Among different treatment combinations, treatment containing 75% RDF, (NPK 120:60:60 kg/ha) + 10t FYM + (Zn+B+Mn

(0.5,0.2,0.1%), had positive influence on yield per plant and per hectare (Table 3). This treatment recorded significantly maximum fruit yield per plant (5829.29 g) and fruit yield per hectare which were at par with treatments 75% RDF+ 10 T FYM. However, minimum fruit yield per plant and per hectare were recorded under the treatment of control (100% RDF). The higher yield with different combinations of organic, inorganic and micronutrients could be attributed to sustained availability of major as well as micro nutrients which is evident from the higher accumulation of nutrients by guava plant from soil. The effect was more pronounced during the second year with combination of organic and inorganic with micronutrients. It is well known that nitrogen is the constituent of proteins, enzymes and chlorophyll and involves in all the processes associated with photosynthesis and growth, hence increase in weight and yield due to nitrogen application is obvious. The increase in weight and yield by addition of adequate quantity of phosphorus was possibly due to its association with various chemical reactions in the cell and is responsible for thesynthesis of protoplasm.

Hence, an increase in the vegetative growth was resulted in more carbohydrates assimilation, which may partly be responsible for higher yields. It is assumed that potassium plays an important part in carbohydrate and protein synthesis and in the regulation of water relations in living cells. It may also act as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. Carbohydrates and co-enzymes are beneficial in increasing size of fruits and ultimately weight of the fruit.

The inclusion of FYM and micronutrients with chemical fertilizer greatly helped in improving the flower and fruit attributes. The application of nitrogen, phosphorus, potash, manures, bio-fertilizer to synthesize of amino acid act as precursor of polyamine and secondary messenger in growth characters and development of flowers. Synthesis of thisamino acid is also influenced by phytohormones which are formed in plant due to the application of chemical and bio- fertilizers were reported by [4], [13] and [3] also reported similar results in guava. The significant increase in number of fruits per plant might be due to active and rapid multiplication of bacteria especially in rhizosphere creating favourable condition for nitrogen fixation and phosphorus solubilization at higher rate through nitrogen supply by nitrogenous fertilizers and supply of other nutrients, bacterial secretion, hormone production and supply of antibacterial and antifungal compounds, which were favourable for growth and ultimately increased yield. These findings corroborate with that of [12], [10], [8] and [6].

Table 1: Effect of integrated nutrient management on growth attributes of guava (mean of two years)

Treatment	Plant height (cm)	No of branches/ plant	No of leaves/ plant	Plant girth (cm)	No of flowers/ plant	No of fruit per plant	
T_0	100% RDF (NPK-180,90,90g)	147.73	14.48	93.05	1.84	48.93	18.33
T_1	75% RDF+2.5 kg Vermicompost	213.93	17.05	119.20	2.23	70.00	28.55
T_2	50% RDF+2.5 kg Vermicompost	199.33	16.18	108.09	2.09	66.45	26.80
T_3	75% RDF+10 kg FYM	249.83	19.38	137.83	2.51	76.15	35.68
T_4	50% RDF+10 kg FYM	203.50	16.75	112.92	2.15	66.93	27.25
T_5	T_3 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%)	256.80	20.93	150.16	2.58	79.33	38.23
T_6	T_4 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%)	231.45	18.45	131.57	2.41	74.50	34.00
T_7	50% RDF+10 kg FYM+Azotobactor	190.58	15.40	100.52	1.97	62.73	25.08
T_8	50% RDF+10 kg FYM+ Azotobactor+ PSB (100g/P)	216.18	17.35	124.57	2.34	72.65	32.03
T_9	50% RDF+10 kg FYM+ VAM	187.35	15.18	97.49	1.92	60.53	23.63
T_{10}	50% RDF+10 kg FYM+ Azotobactor+ VAM	194.35	15.50	104.32	2.02	64.80	26.25
	F- test	S	S	S	S		
	SEm ±	3.08	0.27	1.83	0.03	1.03	0.48
	CD at 5%	9.16	0.79	5.43	0.10	3.07	1.43

Table 2: Effect of integrated nutrient management on yield and yield attributes of guava (mean of two years)

Treatment	Fruit diameter (cm)	Fruit length (cm)	Fruit volume (m3)	Fruit weight (g)	Fruit yield/plant (g)	Fruit yield q/ha	
T_0	100% RDF (NPK-180,90,90g)	5.63	4.59	102.09	96.28	1765.74	27.50
T_1	75% RDF+2.5 kg Vermicompost	6.19	5.70	114.61	133.48	3801.73	62.43
T_2	50% RDF+2.5 kg Vermicompost	6.03	5.54	110.55	127.20	3398.57	51.33
T_3	75% RDF+10 kg FYM	6.38	5.93	119.86	148.31	5277.71	90.12
T_4	50% RDF+10 kg FYM	6.10	5.61	112.92	129.33	3517.00	57.01
T_5	T3 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%)	6.51	6.05	121.75	152.84	5829.59	99.56
T_6	T4 + Micronutrients (Zn+B+Mn (0.5,0.2,0.1%)	6.29	5.86	118.61	143.33	4864.76	79.46
T_7	50% RDF+10 kg FYM+Azotobactor	5.91	5.28	108.63	111.25	2790.57	45.62
T_8	50% RDF+10 kg FYM+ Azotobactor+ PSB (100g/P)	6.25	5.77	116.73	137.38	4395.41	70.75
T_9	50% RDF+10 kg FYM+ VAM	5.84	5.12	106.31	106.10	2503.71	40.97
T_{10}	50% RDF+10 kg FYM+ Azotobactor+ VAM	5.99	5.45	108.57	116.88	3069.14	48.76
	F- test	S	S	S	S		
	SEm ±	0.10	0.09	1.64	2.15	44.19	1.05
	CD at 5%	0.29	0.26	4.86	6.38	131.28	3.13

Table3: Effect of integrated nutrient management on chemical characters of guava (mean of two years)

Treatment		Acidity (%)		Total sugar(%)		TSS (Brix)		Ascorbic acid		pH		Pectin content(%)	
		Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
T_0	100%RDF(NPK-180,90,90g)	0.545	0.557	5.19	5.28	9.13	9.47	174.30	145.70	3.97	3.96	0.84	0.88
T_1	75%RDF+2.5kg Vermicompost	0.490	0.504	6.80	6.06	10.18	10.59	208.45	186.80	4.09	4.02	1.09	1.15
T_2	50%RDF+2.5kg Vermicompost	0.531	0.541	6.30	6.22	9.97	10.28	192.35	168.15	4.03	4.02	1.02	1.08
T_3	75%RDF+10kg FYM	0.433	0.465	7.81	7.64	11.29	11.70	235.55	216.95	4.18	4.09	1.17	1.21
T_4	50%RDF+10kg FYM	0.492	0.511	6.42	6.21	10.09	10.47	201.45	176.80	4.04	4.02	1.06	1.10
T_5	T3 + Micronutrients (Zn+B+Mn(0.5, 0.2,0.1%)	0.398	0.405	7.98	7.80	11.49	11.88	247.55	228.10	4.20	4.12	1.19	1.24
T_6	T4 + Micronutrients (Zn+B+Mn(0.5, 0.2,0.1%)	0.428	0.460	7.72	7.49	10.51	11.10	227.00	205.95	4.17	4.07	1.16	1.22
T_7	50%RDF+10kg FYM+Azotobactor	0.477	0.493	5.83	5.85	9.80	9.91	186.85	164.00	4.00	3.98	0.98	1.01
T_8	50%RDF+10kg FYM+Azotobactor+ PSB(100g/P)	0.523	0.537	7.07	7.22	10.29	10.72	212.10	191.90	4.12	4.04	1.15	1.18
T_9	50%RDF+10kg FYM+VAM	0.539	0.545	6.11	6.32	9.27	9.74	183.00	164.35	4.00	3.96	0.91	0.96
T_{10}	50%RDF+10kg FYM+Azotobactor+ VAM	0.484	0.525	6.40	6.51	9.90	10.08	189.75	165.65	4.01	4.01	1.00	1.05
	SEm±	0.008	0.009	0.11	0.10	0.15	0.16	3.12	2.80	0.06	0.07	0.017	0.017
	CD at5%	0.024	0.026	0.33	0.30	0.45	0.48	9.28	8.31	N/A	N/A	0.049	0.051

Conclusion

Thus, on the basis of results, summarized above it can be concluded that application of 75% RDF+10 kg FYM + Micronutrients (Zn+B+Mn (0.5, 0.2, 0.1%) were proved to be the best for improving the growth, yield and quality of guava (*Psidium guajava* L.) cv. Allahabad safeda under high density planting in eastern part of Uttar Pradesh. It also concluded that guava grow winter season are beneficial and profitable forfarmers

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RESPONSE OF STOMATAL RESISTANCE AGAINST WATER STRESS AT DIFFERENT GROWTH STAGES IN FOUR POTATO CULTIVARS

Subhash Kumar[1]*, Devendra Kumar[2], Yesh Pal Singh[3],
Pushpendra Singh[3] B. Singh[5] and P. S. Pandey[6]
[1]Department of Botany CCR (PG), College, Muzaffarnagar
[2]Plant Physiology, ICAR-CPRI Regional Station, Modipuram, Meerut
[3]KVK, Ujhani, Budaun, SVPUA&T, Meerut (U.P.)
[4]Horticulture Department, New Okhla Industrial Development Authority, Noida.
[5]SVPUA&T, Meerut (U.P.) India
[6]ICAR. New Delhi
***Corresponding Author: Email**-subhashvikal2012@gmail.com

Abstract

Plant response to water-stress is controlled by plant water status. In particular, water potential (w) has been promoted as the determinant of physiological response to water-stress because of its physical basis, its ease of measurement, and its suitability for modeling. Maximum reduction in RWC (28%) was observed when water stress was imposed at tuber enlargement stage (T_3) whereas minimum reduction (12%) in relative water content (RWC) of leaf was observed when water stress was imposed at tuber initiation stage (T_2). 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_3) . Higher stomatal resistance in Desiree indicated its strategy for water conservation under water stress situations.

Introduction

When potato plants are subjected to drought the RWC of their leaves gradually decreases. In field grown potatoes stomata began to close at a RWC between 92 and 96% and complete closure of stomata occurs between 76 and 80% RWC values. At RWC values lower than 55% closure of stomata was complete. It was also suggested that CO_2 exchange could be decreased at a RWC below 92 to 93% (22). (23) reported that transpiration did not start declining before a RWC of 79 to 80% was reached. In contrast, (24) found RWC values of potato leaves from irrigated plants between 80 and 100% against 76 to 87% for water stressed plants. No clear relationship between stomatal resistance and RWC was observed by these workers on specific days during the season. (25) found maximum reduction in RWC under water stress imposed at stolon initiation. They experienced the minimum RWC (ranging from 69% to 74% in different cultivars) at this stage due to water stress. A negative correlation (r = -0.743) was noticed between RWC and percent reduction in tuber yield due to water stress at stolon initiation stage(13,14). No correlation existed between RWC and yield reduction due to drought at other stages of growth. (12) found reduction in RWC under water stress of Kufri Chandramukhi at tuber initiation (11.7%) and tuber development (12.5%). (3) reported that leaf expansion is sensitive to even mild water stress. Leaf expansion was not monitored in the present experiment but the level of RWC in the leaves indicated that leaf area development must have been affected, particularly at stolon initiation which has minimum RWC and the proportion of younger leaves was more than mature leaves. Decrease in RWC of the leaf is often associated with a decline in photosynthesis rate. (26) found a greater effect of drought on

young leaves than on older ones. (27) found that the values for water potential and osmotic potential were lower in Desiree than in Up-to-date in both non-stressed and water-stressed leaves. Plotting changes in osmotic potential against changes in water potential suggested tendency towards osmotic regulation in Desiree. In leaves that showed first signs of wilting, leaf water potentials lower than -8.0 and -9.0 bars were measured in Up-to-date and Desiree respectively.

Photosynthesis and stomatal resistance are good indicators of water stress(4,6,7). One of the first effects of a period of drought in potato is a reduction in the rate of photosynthesis which is mainly caused by an increase in stomatal resistance (26). Water stress of plants leads to closure of stomates (21), which decreases both transpiration and photosynthesis in potato . Moorby et al. (26) 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. (26) 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 (27) differences in drought tolerance between potato genotypes are partially due to difference in water relations and stomatal behaviour. (24) advocated the relationship between stomatal resistance (RS) and water potential (w). He 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}.

In potato, correlation existed between diffusive leaf resistance and yield under stress but varied greatly from one season to the next (1,15,16). (26,17,18,19,20) observed no correlation between stomatal conductance and yield as the cultivars with differing values of stomatal conductance produced similar tuber yields under water stress. (26) found that net rates of photosynthesis saturated by irradiance of > 500 µmol m-2s-1 (PAR) were marked by decreased in 35 to 40 day-old water stressed potato. (32) 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. (12) 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%). (12), (26) 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 I Year and II Year. Forty eight plots were used in a split plot design for accomoding 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:

T_1: Control (well watered plants)

T_2: Water stress at- tuber initiation stage

T_3: Water stress at -tuber enlargement stage

T_4: Water stress at - tuber maturation stage

T_1 control (well watered) plots were irrigated at 6 DAP (days after planting), 27 DAP, 42 DAP, 63 DAP and 80 DAP during the year I Yearand at 8 DAP, 25 DAP, 44 DAP, 67 DAP and 83 DAP during the year II Year. The water stress was imposed by withholding water in T_2, T_3 and T_4 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.

Relative water content was determined in potato leaves during each stress treatment by method of Barr and Weatherley (1962). RWC estimates the current water content of the sampled leaf tissue relative to the maximum water content it can hold at full turgidity.The fully expanded potato leaf (4th leaf from the top of plant) was taken as sample from each treatment at particular growth stage. 5-10 leaf discs of around

1.5 cm in diameter were cut and weigh these sample discs immediately to record the fresh weight of the sample. Hydrate the samples to full turgidity by floating on de-ionized water in a close petri-dish for 4 h under normal room light and room temperature. After 4 hours took the sample out of water and removed any surface moisture quickly and lightly with filter paper and immediately weigh to obtain fully turgid weight. Subsequently, dry the samples in an oven at 60°C for 24h and weigh (after being cooled down in a desiccator) to determine dry weight of the sample. The RWC was calculated by using following formula:

$$RWC(\%) = \frac{\text{Fresh weight - Dry weing}}{\text{Turgid weight - Dry weight}} \times 100$$

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 Findings

The mean values of treatments showed that in well watered control plants, RWC increased up to tuber maturation stage and declined thereafter. The water stress treatments T_2 (water stress at tuber initiation stage), T_3 (water stress at tuber enlargement stage) and T_4 (water stress at tuber maturation stage) caused the significant reduction in RWC in comparison with well watered control (T_1).

Table 1. Effect of water stress on relative water content (%) of leaf at various growth stages of potato cultivars

Treatments*	I Year	II Year				
	Growth stage**				Growth stage	
	TI	TE	TM	TI	TE	TM
Kufri Chipsona-1						
T_1	82.6	90.2	82.6	83. 60	91.4	82.0
T_2	75.4 (-9%)***	76.5	80.4	74.4 (-11%)	75.4	81.4
T_3	80.3	66.4 (-26%)	61.3	81.6	65.8 (-28%)	63.7 (-19%)
T_4	83.0	88.7	64.9 (-21%)	83.0	90.1	66.4
Mean	80.3	80.5	72.3	79.7	80.7	73.4
Kufri Pukhraj						
T_1	85.3	87.4	83.0	86.4	88.4	83.5
T_2	74.1 (-13%)	74.8	79.4	75.9 (-12%)	73.7	81.3
T_3	83.8	63.2 (-28%)	62.3	84.9	64.3 (-27%)	62.4
T_4	84.1	88.3	63.3 (-24%)	85.0	89.4	63.0 (-25%)
Mean	81.8	78.4	72.0	83.1	79.0	72.6
Kufri Lauvkar						
T_1	83.6	92.4	82.0	84.7	93.7	83.1
T_2	70.6 (-16%)	77.4	77.6	71.3 (-16%)	76.3	76.5
T_3	82.6	67.8 (-27%)	63.5	83.6	68.4 (-27%)	63.3
T_4	83.4	91.4	63.4 (-23%)	84.4	92.3	65.3 (-21%)
Mean	80.1	82.3	71.6	81.0	82.7	72.1
Desiree						
T_1	81.9	93.7	85.1	82.3	92.4	86.3
T_2	72.0 (-12%)	74.8	78.2	74.1 (-10%)	76.3	79.4
T_3	82.0	66.3 (-29%)	66.4	82.9	63.4 (-31%)	68.0
T_4	81.4	92.3	67.3 (-21%)	82.3	93.0	68.3 (-21%)
Mean	79.3	81.8	74.3	80.4	82.0	75.5
Mean Values of Treatments						
T_1	83.4	90.9	83.7	84.3	91.5	83.7
T_2	73.0 (-12%)	75.9	79.7	73.9 (-12%)	75.4	79.7
T_3	82.2	65.9 (-28%)	66.4	83.3	66.2 (-28%)	64.4

T_4	83.0	90.2	64.8 (-22%)	83.7	91.2	65.8 (-22%)
CD at 5%						
Cultivar(C)	NS	NS	NS	NS	NS	NS
Treatment (T)	2.1	2.5	2.7	2.1	2.8	2.4
C × T	NS	NS	NS	NS	NS	NS

***Treatments:** T_1 = Control (well watered), T_2 = water stress at tuber initiation, T_3 = water stress at tuber enlargement and T_4 = 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 RWC due to water stress treatment T_2, T_3 and T_4 as compared with respective control

Under water stress maximum RWC (73% and 73.9% during I Year and II Year respectively) was observed when water stress was imposed at tuber initiation stage T_2 whereas minimum (64.8% and 65.8% during I Year and II Year respectively) when water stress was imposed at tuber maturation stage (T_4). As a result of water stress maximum percent reduction (28% in both the years) was observed in T_3 while minimum percent reduction (12% in both the years) in T_2 as compared with respectively control.The difference among cultivars in respect of RWC and interaction between cultivars and treatments was found statistically non significant at all growth stages and in both the years.

Mean values of treatments showed that stomatal resistance increased with age of crop in well watered control (T_1). Water stress treatment T_2, T_3 and T_4 brought about significant increase in stomatal resistance at various growth stages as compared to control (T_1). Highest stomatal resistance (2.54 and 2.59 s cm ^{1} during I Year and II Year respectively) of leaves was recorded when water stress was imposed at tuber maturation stage (T_4) whereas lowest stomatal resistance (0.90 and 0.98 s cm ^{1} during I Year and II Year respectively) was recorded when water stress was imposed at tuber initiation stage (T_2).

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 2 showed that in T2 (water stress at tuber initiation stage) cultivar Desiree recorded highest stomatal resistance (1.06 and 1.20 cm ^{1} during I Year and II Year respectively) whereas cultivar Kufri Lauvkar recorded lowest stomatal resistance (0.76 and 0.80 s cm-1 during I Year and II 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 I Year and II Year respectively) and Kufri Pukhraj recorded lowest stomatal resistance (1.31 and 1.37 s cm ^{1} during I Year and II Year respectively).

Table 2. Effect of water stress on stomatal resistance (s cm-1) of leaves at various growth stages of potato cultivars

Treatment*		I Year	II 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: T_1 = Control (well watered), T_2 = water stress at tuber initiation, T_3 = water stress at tuber enlargement and T_4 = 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 T_2, T_3 and T_4 as compared with respective control

Maximum percent increase in stomatal resistance due to water stress at tuber enlargement stage (T_3) 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 I Year and II Year respectively) and Kufri Pukhraj recorded lowest stomatal resistance (1.68 and 1.72 s cm ^{1} during I Yearand II Year, respectively). Maximum percent increase in stomatal resistance due to water stress at tuber maturation stage (T_4) 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.

Discussion

Plant response to water stress is controlled by plant water status. RWC is the determinant of water status in leaves (8). Water stress at different growth stages in potato crop declined the RWC significantly. Maximum reduction in RWC (28%) was observed when water stress was imposed at tuber enlargement stage (T_3) whereas minimum reduction (12%) in relative water content (RWC) of leaf was observed when water stress was imposed at tuber initiation stage (T_2) (Table 1). (31) argued that relative water content is more important than leaf water potential as a determinant of physiological activity. In present study non significant difference was observed among cultivars and interaction between treatment and cultivars. This is supported by the fact that for a

variety of physiological processes, differences between species in response to water deficits disappear when the response is related to relative water content rather than to water potential (8).

Stomatal resistance is a good indicator of water stress(2). In present study water stress caused significant increase in stomatal resistance at different growth stages (Table 1). (26) 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). Changes in the turgor pressure of guard cells and subsidiary cells bring about changes towards closure in the stomatal aperture (3) which results in increased stomatal resistance. Chemical signals from the root system may affect the stomatal responses to water stress. Abscisic acid (ABA) is known to play central role in the control of stomatal conductance under water stress in field conditions (30). 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(9,10,11). 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 (29,30). 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_3) (Table 1). Higher stomatal resistance in Desiree indicated its strategy for water conservation under water stress situations.

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IMPACT OF REPEATED WATER STRESS ON MARKETABLE YIELD AND TOTAL TUBER YIELD OF POTATO (*SOLANUM TUBEROSUM* L.)

Subhash Kumar[1]*, Devendra Kumar[2], Yesh Pal Singh[3],
Pushpendra Singh[3] B. Singh[5] and P. S. Pandey[6]

[1]Department of Botany CCR (PG), College, Muzaffarnagar
[2]Plant Physiology, ICAR-CPRI Regional Station, Modipuram, Meerut
[3]KVK, Ujhani, Budaun, SVPUA&T, Meerut (U.P.)
[4]Horticulture Department, New Okhla Industrial Development Authority, Noida
[5]SVPUA&T, Meerut (U.P.) India
[6]ICAR. New Delhi
***Corresponding Author Email**-subhashvikal2012@gmail.com

Abstract

Potato needs frequent irrigation for its good growth and yield. The yield is greatly influenced by timing, amount and frequency of irrigation applied . Tuber initiation stage of potato plant growth was observed as most sensitive to water stress because total tuber yield was reduced maximum (16%) at this stage. Though potato yield is considered sensitive to water stress during all over growing season but period of tuber formation is particularly very sensitive for water stress. Tuber enlargement stage of potato plant was also found sensitive to water stress and registered significant reduction in marketable tuber yield (13% and 16%) and total tuber yield (9% and 11%). Stress at this stage caused significant increase in the proportion of small non-marketable tubers. In the present study, cultivar Kufri Pukhraj was found superior in total tuber yield among all cultivars studied under water stress conditions.

Introduction

The potato is known to be very sensitive to the shortage of water (37, 38). Several experiments carried out on water supply and yield under field conditions (33, 9). It has been suggested that for maximal yields soil moisture should not be allowed to drop below approximately 50% of crop available water during the tuber bulking period. But there are also reports mentioning 25 or 75% instead of 50%. As regards the optimal soil water potential for maximum yield reports vary between 0.2 and 0.6 bars in the densely rooted soil layer. Potato yield also depends upon the timing of water stress within the growing period (34) and upon climatic and soil conditions (1,2,3,4,5,12). In a study by (7) the effect of early drought and late drought were compared with a control, the relation between speed of maturation, timing of water shortage and effect on tuber yield was not as marked as expected. However later cultivars were shown to tolerate water shortage occurring in the early part of season. According to (13) an increase in tuber dry matter content has also been found to be an important factor influencing tuber yield variations in response to drought stress.

(22)observed that the reduction by drought of fresh tuber yields were 11% for Desiree, 15% for Nicola, 18% for Monalisa and 44% for Remarka, in comparison with their respective controls. They also showed that final dry weight basis yield of tubers was affected in the same manner as fresh weight basis yield. In the field, drought decreased dry weight of tubers by 11, 13, 15 and 38% in Desiree, Nicola, Monalisa and Remarka respectively. Drought stress increased dry matter concentration in tuber for Remarka the increase was 10% in the field and 8% in green house. Desiree was not affected in field, but its dry matter concentration (DMC) increased by 11% under drought in the green house. Nicola and Monalisa tested in

the field had an average increase of 2.5%.

(36) observed a relationship between harvest index (HI) and cultivar productivity, early maturing cultivars showing the highest values. They concluded that Harvest Index shows highest correlation with tuber yield while total dry matter shows only a weak correlation with total tuber yield. According to (22) yields are frequently constrained by drought stress affecting the development and the growth of shoots, roots and tubers. According to (37) the reduction of yield as a result of water stress can be caused by reduced leaf area and reduced photosynthesis per unit of leaf area.

Water shortage during the tuber bulking period decreases yield to a larger extent than drought during other growth stage (37). (6) found that severe drought at planting time first irrigation at emergence delayed tuber initiation considerably, but shortened the tuber formation period. Dry soil conditions at the beginning of tuberisation result in a limited number of tubers per plant (6). (33) showed that for maximal yield soil moisture should not be allowed to drop below approx. 50% of crop available water during the tuber bulking period. But there are also reports 25 or 75% instead of 50%.

(6) found that if there was drought during the tuberisation stage, followed by irrigation during the tuber bulking stage, yield was considerably reduced, unless high soil moisture stress had been given in the period between planting and emergence. They concluded that as a result of the water stress before emergence the plants were hardened to drought at the critical tuber bulking stage.

(28) found 11-34% reduction in tuber yield due to water stress at the later three stages (tuber initiation, early bulking, and later bulking) whereas 30-65% due to water stress at stolon initiation stage. They suggested that the stolon initiation stage was most critical in its demand for assured water supply. They also observed that small numbers of tubers were significantly more in all stress treatments as compared to the control. However, the water stress imposed at stolon initiation stage caused a tremendous increase in percentage of small tubers on an average 9 to 5% in 1981-82 and 8 to 20% in 1982-83. (20) stated that reduction in tuber yield due to stress was higher (19%) at tuber initiation stage. The cumulative stress both at initiation and development stages showed highly reduced tuber yield (23%). (29) have explained that smaller leaf area at the time of tuber initiation had been attributed to be responsible for lower rate of bulking and lower final yields.

(28) showed that tuber yield under water stress on different growth stages in Kufri Lauvkar was 9.0 kg/plot in T1 (water stress imposed at stolon initiation) 15.7 kg/plot in T2 (water stress imposed at tuber initiation), 16.7 kg/plot in T3 (water stress imposed at early bulking), 15.5 kg/plot in T4 (water stress imposed at late bulking), 21.6 kg/plot in T5 (water control). The difference in varietal response to water stress became apparent if decrease in percentage of large tubers due to water stress at tuber initiation stage alone was considered. According to this criterion Kufri Lauvkar, an early cultivar, was better than Kufri Chandramukhi and Kufri Jyoti. (24) found that dry matter yield in tuber decreased from 56.4 kg/plot in control to 36.2 kg/plot under water stress in Desiree. He also observed that Desiree produced large number of tubers in control than water stress.

(21) found that in well watered (control) plots, tuber yield was maximum in cultivar Kufri Pukhraj (345 q/ha) followed by Kufri Chipsona-1(320 q/ha) and minimum in Desiree (202 q/ha).Significant reduction in total tuber yield was recorded in all the cultivars under repeated water stress. The extent of reduction in tuber yield, however, varied among varieties and maximum reduction was found in Kufri Pukhraj (28 q/ha) and minimum in Desiree (9 q/ha).

(18) observed that tuber production from mid-flowering until plant maturity was similarly affected by soil water stress in microtuber and conventional seed tuber plants. At harvest, plants affected by soil water stress had about 87% of the tuber dry weight of irrigated plants. They concluded that the greater variation on tuber yield of microtuber plants cannot be attributed to soil water stress from 1 month after emergence.

(19) conducted trial to study the effects of 6, 12 and 18 days irrigation periods and three drought stages (planting to emergence of seedlings, from emergence of seedlings to tuber setting and from

tuber setting till maturation) on emergence time, tuber setting and maturation date were determined. In the growth period, the main and lateral stem number, diameter, plant height, tuber number and tuber weight were measured. Combined ANOVA showed that there were significant differences in the irrigation treatments in tuber yield, number, weight and number as well as in tuber > 55 mm. There were significant differences in tuber yield, weight and number (< 35 and 35-55 mm) among the cultivars. Mean comparison of 2 years of irrigation periods showed that water stress led to decrease in tuber yield, weight and number (> 55 mm). In comparison, the control irrigation led to an increase of 4.25 t in tuber yield per hectare with respect to mild condition and 12.18 t in tuber yield per hectare with respect to severe conditions. Water stress at planting time increased the tuber yield, number, weight, number (35-55 mm), number (>55 mm) and decreased the tuber number (<35 mm) more than the tuber setting time. The tuber-setting stage was the most sensitive stage and led to the highest decrease in yield. Cultivars namely Vital, Mondial, Caesar, Draga, Cosmos, Cosima, llona and Granola showed the highest yields of 28.51, 27.83, 26.42, 26.01, 25.58, 24.81, 24.53 and 24.42 t/ha, respectively. These cultivars also had the highest tuber number and weight. Cosima, Vital, Serenade, Draga, Sinja and Idul produced the highest tuber number (35-55 mm).

(8) found that marketable tuber number and yield, and total tuber mass showed declining trend with an increase in maximum allowable moisture depletion (MAD) levels, 25%, 40%, 55%, and 70% of the plant available soil moisture.

Materials and Method

The field experiments were conducted at Research Farm of CPRI Campus, Modipuram, Meerut (U.P.) during rabi season of I Year and II Year. Forty eight plots were used in a split plot design for accomoding 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:

T_1 : Control (well watered plants)

T_2 : Water stress at- tuber initiation stage

T_3 : Water stress at -tuber enlargement stage

T_4 : 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 I Year and at 8 DAP, 25 DAP, 44 DAP, 67 DAP and 83 DAP during the year II 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.

The harvesting of potato was done 15 days after dehaulming, by dismantling the ridges through tractor drawn digger blade and tubers covered with soil were removed manually by using a hoe (khurphi).

The sorting of potatoes was done on the basis of defects in their shape (Pointed, Dumbell shaped, Cracks) and size (i.e. Marketable tubers >30 g and Non marketable tubers <30 g). The potato grading was done manually and yields were weighed on 30 kg electronic, portable balance (Avery, A 611W digital scale).

Results and Findings

Mean values of treatments showed that maximum yield of non-marketable tubers (49 and 50 q/ha during I Year and II Year respectively) was recorded in T3 followed by T4 (44 and 47 q/ha during I Year and II Year respectively) whereas minimum yield of non marketable tubers was recorded by T2 (38 and 39 q/ha during I Year and II Year respectively).

Water stress caused significant increase (20% and 16% in respective years) in non-marketable yield at tuber enlargement stage (T3) in comparison with respective well watered control (T1). Similarly water stress at tuber maturation stage (T4) also caused significant increase (7% and 9% in respective years) in non marketable tuber yield in comparison with respective well watered control (T1). In contrast to T3, and T4, water stress treatment T2 (water stress at tuber initiation stage) caused significant reduction (7% and 9% in respective years) in non-marketable yield.

Data in table 1 clearly showed that non-marketable yield was reduced due to water stress treatment T2 (water stress at tuber initiation stage) in all cultivars except the cultivar Kufri Pukhraj where non-marketable tuber yield was increased (59 and 62 q/ha during I Year and II Year respectively) in comparison with well watered control (T1). When water stress was imposed at tuber enlargement stage (T3), the non marketable yield was increased significantly in cultivar Kufri Chipsona-1(51 and 55 q/ha during I Year and II Year respectively) and Kufri Pukhraj (66 and 68 q/ha during I Year and II Year respectively) whereas non marketable yield was reduced significantly in cultivar Kufri Lauvkar (38 and 39 q/ha during I Year and II Year respectively) and Desiree (41 and 36 q/ha during I Year and II Year respectively) during both the years Similar trend was also found when water stress was imposed at tuber maturation stage (T4).

Marketable Yield

Data pertaining to marketable yield as influenced by water stress treatments showed that well watered control (T1) plots produced highest marketable yield and water stress at all growth stages caused significant reduction in marketable tuber yield than control in both the years. Minimum marketable yield (206 and 219 q/ha during I Year and II Year respectively) was recorded when water stress was imposed at tuber initiation stage (T2) whereas maximum marketable yield (239 and 236 q/ha during I Year and II Year respectively) was recorded when water stress was imposed at tuber maturation stage (T4). Highest reduction in marketable yield (17% in both the years) was observed in T2, while lowest reduction (3% and 11% in respective years) in T4 under water stress conditions.

Data in table 1 clearly showed that marketable yield was reduced due to water stress treatment T2 (water stress at tuber initiation stage) and T3 (water stress at tuber enlargement stage) and T4 (water stress at tuber maturation stage) in all cultivars during both the years. In T2 maximum marketable yield (244 and 264 q/ha during I Year and II Year respectively) was recorded by cultivar Kufri Pukhraj whereas minimum marketable yield (171 q/ha during both the years) was recorded by cultivar Desiree. At this stage maximum percent reduction in marketable yield (19% and 23% in respective years) was observed in cultivar Kufri Lauvkar while minimum percent reduction (7% and 8% in respective years) in Kufri Chipsona-1.

Similar trend in marketable yield in respect of cultivars was observed in T3 and T4 also.

Total Yield

Mean values of treatments presented in Table 1 showed that well watered control plots produced highest total tuber yield (290 and 306 q/ha during I Year and II Year respectively) whereas total tuber yield was found to be reduced in the plots with treatments T2 (water stress at tuber initiation stage), T3 (water stress at tuber enlargement stage) and T4 (water stress at tuber maturation stage). Minimum total tuber yield as influenced by water stress was recorded by T2 (243 and 258 q/ha during I Year and II Year respectively) followed by T3 (265 and 271 q/ha during I Year and II Year respectively) and maximum in T4 (283 and 285 q/ha during I Year and II Year respectively).

Maximum percent reduction in total tuber yield (16% in both the years) due to water stress was recorded when water stress was imposed at tuber initiation stage (T2) whereas minimum percent reduction (2% and 7% in respective years) was recorded when water stress was imposed at tuber maturation stage (T4).

Data in table 15 clearly showed that total tuber yield was reduced due to water stress treatments T2 (water stress at tuber initiation stage), T3 (water stress at tuber enlargement stage) and T4 (water stress at tuber maturation stage) in all cultivars during both the years. Kufri Pukhraj recorded maximum yield (303 and 326 q/ha during I Year and II Year respectively) whereas Desiree recorded minimum total tuber yield (198 q/ha during both the years). Under water stress treatment T3 (water stress at tuber enlargement stage) Kufri Pukhraj recorded maximum yield (321 and 348 q/ha during I Year and II Year respectively) while the cultivar Desiree recorded minimum (218 and 221 q/ha during I Year and II Year respectively) total tuber yield.When water stress was imposed at tuber maturation stage (T4) Kufri Pukhraj recorded maximum yield (350 and

365 q/ha during I Year and II Year respectively) while Desiree recorded minimum (220 and 224 q/ha during I Year and II Year respectively) total tuber yield.

Maximum percent reduction (21% and 26% in respective years) in total tuber yield was observed in cultivar Kufri Lauvkar while minimum percent reduction (7% and 9% in respective years) in Kufri Chipsona-1.

The interaction between cultivar and treatment was also found significant.

Table 1. Effect of water stress on non-marketable, marketable and total yield (q/ha) of potato cultivars

Treatment*	I Year	II Year				
	Non-marketable yield	Marketable yield	Total yield	Non-marketable yield	Marketable yield	Total yield
Kufri Chipsona-1						
T1	32	194	226	41	247	287
T2	30 (-6%)**	180 (-7%)	212 (-7%)	35 (-15%)	227 (-8%)	262 (-9%)
T3	51 (+59%)	161 (-17%)	231 (-6%)	55 (+34%)	213 (-14%)	268 (-9%)
T4	36 (+13%)	202 (-4%)	238 (-5%)	40 (-2%)	231 (-6%)	271 (-6%)
Mean	37	190	227	43	229	272
Kufri Pukhraj						
T1	39	315	354	38	330	368
T2	59 (+51%)	244 (-23%)	303 (-14%)	62 (+63%)	264 (-20%)	326 (-11%)
T3	66 (+69%)	255 (-19%)	321 (-9%)	68 (+79%)	280 (-15%)	348 (-5%)
T4	67 (+72%)	283 (-10%)	350 (-1%)	70 (+84%)	295 (-11%)	365 (-1%)
Mean	58	274	332	60	292	352
Kufri Lauvkar						
T1	50	279	329	54	282	336
T2	33 (-34%)	226 (-19%)	259 (-21%)	31 (-42%)	216 (-23%)	247 (-26%)
T3	38 (-24%)	251 (-10%)	290 (-12%)	39 (-28%)	211 (-25%)	250 (-25%)
T4	43 (-14%)	281 (+0.7%)	324 (-2%)	44 (-19%)	231 (-18%)	275 (-18%)
Mean	41	259	300	42	235	277
Desiree						
T1	45	204	249	38	197	235
T2	28 (-38%)	171 (-16%)	198 (-20%)	28 (-26%)	171 (-13%)	198 (-15%)
T3	41 (-9%)	177 (-13%)	218 (-12%)	36 (-5%)	185 (-6%)	221 (-6%)
T4	31 (-31%)	189 (-8%)	220 (-11%)	35 (-8%)	189 (-4%)	224 (-4%)
Mean	36	185	221	34	185	219
Mean Values of Treatments						
T1	41	248	290	43	264	306
T2	38 (-7%)	206 (-17%)	243 (-16%)	39 (-9%)	219 (-17%)	258 (-16%)
T3	49 (+20%)	216 (-13%)	265 (-9%)	50 (+16%)	222 (-16%)	271 (-11%)
T4	44 (+7%)	239 (-3%)	283 (-2%)	47 (-9%)	236 (-11%)	285 (-7%)
CD at 5%						
Cultivar(C)	3	10	12	2	10	14
Treatment (T)	2	8	9	1	8	10
C × T	3	16	19	3	15	21

*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

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

Discussion

Potato needs frequent irrigation for its good growth and yield. The yield is greatly influenced by timing, amount and frequency of irrigation applied (16, 17, 31). Soil moisture is probably the most important factor determining potato yield and quality (30,25,26,27). The total tuber yield decreased significantly under water stress conditions in all the potato cultivars included in present study (Table 1).

Tuber initiation stage of potato plant growth was observed as most sensitive to water stress because total tuber yield was reduced maximum (16%) at this stage. Though potato yield is considered sensitive to water stress during all over growing season but period of tuber formation is particularly very sensitive for water stress (11, 32, 35). Hassan et al. (2002) also reported that potato was more sensitive to water stress at the stolonization and tuberisation stages than bulking and tuber enlargement stages. It could be ascribed to the significant reduction in relative water content (RWC), leaf area and photosynthetic rate at this stage in all potato cultivars studied. Van Loon, 1981 also found that the reduction in tuber yield under water stress was caused by reduced leaf area and reduced photosynthesis per unit of leaf area.Highly significant increase in stomatal resistance of leaf was also observed due to water stress. (28) reported reduction in tuber yield at tuber initiation stage due to water stress. (6) also found that drought during the tuberization stage followed by irrigation during the tuber bulking stage caused considerable reduction in tuber yield.

Tuber enlargement stage of potato plant was also found sensitive to water stress (Table 1) and registered significant reduction in marketable tuber yield (13% and 16%) and total tuber yield (9% and 11%). Stress at this stage caused significant increase in the proportion of small non-marketable tubers. (10) also found similar results. When water stress was imposed at tuber maturity stage, it also caused reduction in tuber yield but the reduction was very less in comparison with water stress at tuber initiation and tuber enlargement stages.

In the present study, cultivar Kufri Pukhraj was found superior in total tuber yield among all cultivars studied under water stress conditions. Potato varieties are known to differ in their response to water stress (14, 15). Highest root length was observed in Kufri Pukhraj at tuber enlargement stage. A large root system is thought to be one of the plants drought adaptation mechanisms (23,48). Highest leaf area during water stress at tuber initiation stage, comparatively higher RWC, highest chlorophyll content and highest photosynthetic efficiency than Kufri Chipsona-1 and Kufri Lauvkar help the cultivar Kufri Pukhraj to cope up with the negative effects of water stress at tuber initiation stage. This stage has been the most sensitive stage under water stress in our study. On the other hand Kufri Chipsona-1 had lower photosynthetic efficiency, lowest leaf area and lowest total chlorophyll content at tuber initiation stage. The highest leaf area at tuber enlargement in Kufri Chipsona-1 leads to increase in only haulm yield and could not perform better in producing tuber yield. Similarly Desiree observed good photosynthetic efficiency but due to lower leaf area it appears that this cultivar did not meet the demand of developing tubers and could not become superior cultivar under water stress.

Cultivar Kufri Pukhraj observed minimum stomatal resistance at tuber enlargement stage along with lowest proline content, highest chlorophyll 'a' chlorophyll 'b' and total chlorophyll content and moderate leaf area which rescue the Kufri Pukhraj from adverse effects of water stress at this second most critical growth stage sensitive to water stress. Though, cultivar Desiree attained highest photosynthetic rate, and better chlorophyll 'a', chlorophyll 'b' and total chlorophyll content at tuber enlargement stage but due to lowest leaf area and highest stomatal resistance, failed to cope with water stress. Proline is a osmoprotective solute which is capable of osmotic adjustment and maintaining turgor at lower water potential of leaves. Cultivar Kufri Lauvkar observed highest accumulation of the amino acid proline content in leaves when water stress was imposed on both tuber initiation stage and tuber enlargement stage which help Kufri Lauvkar in mitigating the negative effect of water stress.

Water stress treatments at all growth stages reduced the marketable yield though the impact was more at tuber initiation stage and tuber enlargement stage than at tuber maturity stage. (19) and (8) also found similar results and reported the reduction of marketable yield due to water stress. Among the cultivars in our study, Kufri Pukhraj produced highest marketable yield and lead to highest total tuber yield. Yield of non-marketable tubers (smaller than 30 g) was increased at the cost of marketable tubers under water stress at tuber enlargement stage and at tuber maturation stage. On the other hand non-marketable tuber yield was reduced when water stress was imposed at tuber initiation stage. At this growth stage the above ground canopy as well as the developing stolons and tubers (below ground tubers) compete for food material therefore stress caused highest loss in non marketable yield (39,40,41,42,43,44,45,46,47).

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STUDIES ON PREPARATION OF GUAVA ICE CREAM FROM (CV.) ALLAHABAD SAFEDA AND L-49 GUAVA (*PSIDIUM GUAJAVA* L.)

Vidhur Kumar[1] and Pratima Gupta[2*]

[1]Department of Horticulture, Allahabad School of Agriculture, S.H.U.A.T.S, Allahabad-211007 (U.P), India

[2]College of Agriculture IIMT University, Meerut (U.P) 250001
***Corresponding Author: Email**-gpratima41@gmail.com

Abstract

The experimental work was conducted in the P.G. Laboratory, Deportment of Horticulture, Sam Higginbottom Institute of Agriculture Technology & Sciences (Deemed-to-be-University), Allahabad, during the year 2011-2012 for preparation of Guava ice cream from (Cv.) Allahabad Safeda and L-49 guava (*Psidium guajava* L.) for TSS, ascorbic acid and Overall Acceptability revealed that there was increase in the level of TSS and Ascorbic acid during the storage period (eight months). The design was used RBD. Under experiment 4 treatment was taken T_0 (control), T_1 (Allahabad Surkha), T_2 (Apple colour) T_3 (Allahabad Safeda) and 5 replications in Chemical and organoleptic of Guava pulp ice cream. Fully developed sound guava fruits were selected. All the treatments were found better in respect of Moisture %, TSS %, pH, Acidity %, Fat % and Protein % content with organoleptic parameters Colour and appearance. Flavour and Taste, Body and texture, Melting Resistance and Overall Acceptability over Control. Highest mean TSS (47.90%), Acidity % (0.45%), Fat % (11.42%), and Protein content (4.62%) were observed in T_1 (Allahabad Surkha), All the sensory parameters were as based on the overall acceptability which was depended on Color, Texture, Fla-vor and Taste was recorded highest (8.14 score) in Ti (Allahabad Surkha), Precisely on the basis of results obtained it may be concluded that treatment T_1 (Allahabad Surkha) was found as superior colour and ap- pearance (8.20) body and texture (8.05) and flaovour and taste (8.20) and melting resistance (8.10). T_1 (Allahabad Surkha) can be used in commercialization of ice cream preparation. This recipe may also be advocated for safe storage at 3-4°C temperature.

Key Words : Guava (*Psidium guajava* L.), fat, pH, acidity, protein, total solids, melting resistance, milk.

The growing dairy industry is opening new facets for the growth of various dairy products. As a result, a number of many traditional and modern dishes are evolving on the dining table sets of people around the world. India is a major producer of milk around the world, which is giving room to traditional Indian dairy products to grow. One such product is Ice cream which is a renowned indigenous dairy product and it's de- mand is increasing day-by-day, from a traditional to a contemporary dairy product. It is also a good carrier of value added ingredients including nutrients and nutraceuticals. Ice cream can be prepared by using guava pulp, which gives Ice cream a better body and texture which makes it appealing for the dessert freaks. Ice cream is frozen dairy product made by suitable blending and processing of cream and other milk prod- ucts, together with sugar and flavor, with or without stabilizer or colour and with the incorporation of air during the freezing process (1). The complex physical structure of ice cream presents a challenge for food technologists. Simply, stated, overall goal of designing the ice cream is to

incorporate sev- eral different insolubles (air bubbles, ice crystals and fat globules) into an aqueous phase in the smallest sizes and in the greatest number possible (2).

Ice cream is a nutritious, healthy and relatively in- expensive food, supplies approximately 200 calories, 3.99 g protein. 0.31 g calcium, 0.10 g phosphorus, 0.14 mg iron, 548 IU vitamin A, 0.038 mg thiamine and 0.23 mg riboflavin (3). The quality of ice cream depends upon the ingredients used; suitable stabi- lizer is the most important. Hydrophilic plant gums in ice cream mix reduce the amount of free water and give stability to the finished product. Now a day's various types of stabilizers e.g. carboxy methyl cellulose, gelatin, guar gum and sodium alginate are being used in food in- dustry (4).

Guava (*Psidium guajava* L.) is the fourth most important fruit mango, banana and citrus in India. Guava is normally consumed as fresh as desert fruit. It is also stewed and used in sauce, ice-cream, butter, marmalade, chutney, etc., but it's diversified utilization gives poten- tial to combat malnutrition by developing innovative and novel products which could be prepared from guava pulp as such and in combination with other fruit pulp by blending.

Guava face cream is a wondrous power is relatively simple to make. In the view of the facts stated above and previous research emphasize that it is important to con- duct studies to produce good quality ice cream using fresh guava. Prepare ice cream with guava flavour and to increase its acceptability using fresh guava. Prepare ice cream with guava flavor and to increase its accept- ability using different variety of guava pulp in milk blend. The quality of ice cream was evaluated by sen- sory evaluation and physico-chemical analysis. It was aimed at exploiting the exotic flavor and taste and en- riching the product with guava to cope with the mineral and vitamin requirements of the body.

Materials and Methods

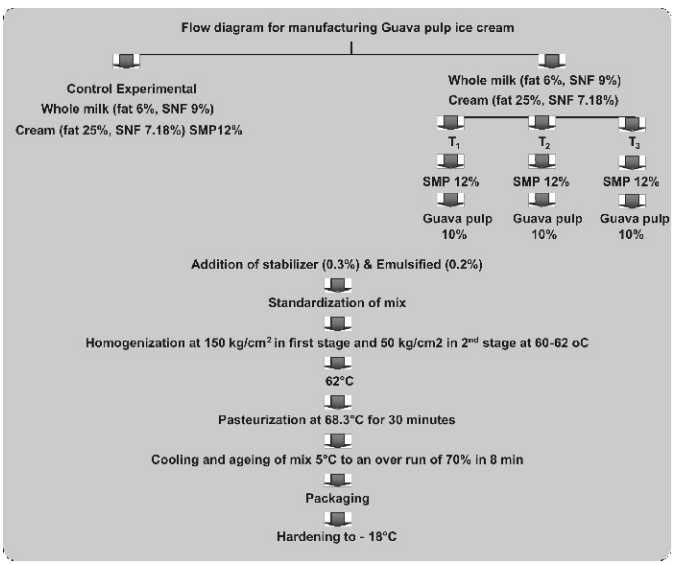
The present investigation entitled 'Preparation of Guava ice cream from(Cv.) Allahabad Safeda and L-49 guava (*Psidium guajava* L.)" was carried out in Fruit Production and Post Harvest Technology Laboratory of the Department of Horticulture, Sam Higginbottom In- Procurement and collection of ingredients. Skimmed milk powder Brand Anik spray, cream, sugar and guava were obtained from local market or Allahabad. Stabilizer (Carrageenan) and emulsifier (Monogylcerides) were obtained from Scientific Coop- eration, Allahabad.

Table. Treatment combinations and ingredients used in guava pulp ice-cream

Treatments	**Ingredients Quantity**				
T_0	Milk fat (%)	Milk SNF (%)	Cane Sugar(%)	Guava (%)	Satb
T_1	10	12	15	Nil	0.5
T_2	10	12	10	10	0.5
T_3	10	12	10	10	0.5
T_4	10	12	10	10	0.5

Detailed procedure for manufacturing control and experimental Ice-cream

For control: Mixing of liquid ingredients - A calculated amount of milk and cream will be placed in a stainless steel container and mixed with the help of wooden ladle and heated by placing the pan in a con- tainer containing water over direct fire (double jacketed vat arrangement) to 50°C.



Mixing of solid ingredients: Calculated amount of dry ingredient like skimmed milk powder, sugar and stabilizer will be mixed and will be added to liquid in- gredients and thoroughly stirred with the help of wooden ladle.

For experimental: Calculated amount of Guava from different varieties will be first peeling from Guava pulping into pulper machine, pulp will be added into calculated amount of milk & cream then heated to 50°C. .

Mixing of solid ingredients: calculated amount of dry ingredients like skim milk powder of stabilizer and emulsifier will be mixed and added to liquid ingredient and thoroughly stirred with the help of wooden ladle.

Homogenization: The ice cream mix for control and treatment will be homogenized at 150 kg/cm^2 in first stage and 50kg/cm^2 in the first stage and 50kg/cm^2 in 2nd stage at 60-62°C using a NontonGaulin two stage homogenization.

Pasteurization: The control and experimental frozen dessert mixes will be pasteurized at 68.3°C for 30 minutes by Batch method. Pasteurization was done after homogenization to avoid any contamination that could be caused by the homogenizer and to avoid lipolysis of fat during ageing period.

Cooling and Ageing: the mix will be immediately cooled to 5°C and held at that temperature for 4-6 hrs.

Freezing of ice-cream mixes: The mixes were fro- zen in a mechanically operated batch freezer without air injection system. Whipping & incorporation of air would be done naturally till the desired over run is achieved (70%). The ice-cream will be packaged in a suitable container & hardened in deep-freezer at 18°C.

Physio-chemical Analysis

The total soluble solids in the samples were directly recorded by hand refractrometer and the results were expressed as per cent soluble solids (°Brix) and the val- ues were corrected at 20 C. Product pH was measured using an electronic pH meter. The pH meter was stan- dardized by using buffers of pH 7.00 and 4.00 prior to recording pH of the samples. The ascorbic acid and acidity was determined by using as described by (5).

Sensory Evaluation

Standard sensory evaluation procedures were fol- lowed to perform descriptive analysis panelists were trained using repeated round table and individual evalu- ations of trial formulations of the control and value added samples. Hedonic scale method as described by (6) was used for the organoleptic evalua- tion products for color, flavor and taste by a panel of six judges.

Statistical Analysis

Statistical analyses of data were done by using ANOVA on all experimental groups with three repli- cates each. The experimental groups were then sepa- rated statistically by using Duncan's new multiple range tests, as described by (7).

Results and Discussion

Moisture: From the perusal of data on moisture percentage in guava ice-cream of different varieties and control, the highest mean moisture percentage was recorded in the ice-cream sample of T_0 (58.39) control T_1 (56.00) Allahabad Surkha, T_2 (55.36) Apple colour and T_3 (52.10) Allahabad Safeda.

TSS %: From perusal of data on total solids per- centage in guava ice-cream of different varieties and control, the highest mean total solids percentage was recorded in the ice-cream sample of T_1 (47.90) Allahabad Surkha followed by T_2 (44.64) Apple colour, T_3 (44.0) Allahabad Safeda followed and T_0 (41.61) control.

pH: From the perusal of data on pH percentage in guava ice-cream of different varieties and control, the highest mean pH was recorded in the ice-cream sample of T_0 (4.92) control followed by T_3 (4.82) Allahabad Safeda, T_2 (4.78) Apple colour and T_1 (4.77) Allahabad Surkha.

Acidity %: From the perusal of data on acidity percentage in guava ice-cream of different varieties and control, the highest mean acidity percentage was re- corded in the ice cream sample of T_1 (0.45) Allahabad Surkha, T_2 (0.44) Apple colour, T_3 (0.42) Allahabad Safeda and T_0 (0.40) control.

Fat %: From the fat percentage in Guava Ice-cream control and Experimental highest mean fat per- centage was recorded in the Ice-cream T_1 (11.42) Allahabad Surkha T_3 (11.22) Allahabad Safeda, fol- lowed by T_2 (11.14) Apple colour and T0(10.48) control.

Table-1. Effect of treatments on physiochemical properties of guava ice-cream. Treatment

Treatment Different parameters of Chemical analysis mean in						
	Moisture %	TSS %	pH	Acidity %	Fat %	Protein
T_0	58.39	41.61	4.92	0.40	10.48	4.24
T_1	56.00	47.90	4.77	0.45	11.42	4.62
T_2	55.36	44.64	4.78	0.44	11.14	4.34
T_3	52.10	44.00	4.82	0.42	11.22	4.46
S.Ed. (±)	0.917	0.917	0.094	0.017	0.229	0.104
C.D. (P=0.05)	1.981	1.981	0.204	0.036	0.494	0.226

Table-2. Effect of treatments on organoleptic properties of guava ice-cream.

Treatment	Different parameters of Organoleptic analysis				
	Colour and appearance	Body and texture	Flavour and Taste	Melting Resistance	Overall Asepctability
T_0	7.75	7.20	7.80	7.30	7.61
T_1	8.20	8.05	8.20	8.10	8.14
T_2	7.95	8.00	8.00	8.00	7.99
T_3	8.10	7.95	8.15	7.51	7.84
S. Ed. (±)	0.198	0.384	0.156	0.278	0.178
C.D. (P=0.05)	0.427	0.829	0.337	0.600	0.412

Protein %: From the perusal of data on protein percentage in guava ice-cream of different varieties and control, the highest mean protein percentage was re- corded in the ice-cream sample of T_1 (4.62) Allahabad Surkha followed by T_3 (4.46) Allahabad Safeda, T_2 (4.34) Apple colour and T_0 (4.24) control.

Colour and Appearance

From the perusal of data on Colour and appearance in guava ice-cream of different varieties and control, the highest mean colour and appearance score was recorded in the ice-cream sample of T_1 (8.20) Allahabad Surkha followed by T_3 (8.10) Allahabad Safeda, T_2 (7.95) Apple colour and T_0 (7.75) control.

Body and Texture

From the perusal of data on body & texture in guava ice-cream of different varieties and control, the highest mean Body and texture score was recorded in the ice-cream sample of T_1 (8.05) Allahabad Surkha, T_2 (8.00) Apple colour, T_3 (7.95) Allahabad Safeda fol- lowed by T_0 (7.20) control.

Flavour and Taste

From the perusal of data on flavor and taste in guava ice-cream of different varieties and control the highest mean Jiavour and Taste score was recorded in the ice-cream sample of T_1 (8.20) Allahabad Surkha, T_3 (8.15) Allahabad Safeda, T_2 (8.00) Apple colour followed by T_0 (7.80) control.

Melting Resistance

From the perusal of data on melting resistance in guava ice-cream of different varieties and control the highest mean melting resistance score was recorded in the ice-cream sample of T_1 (8.10) Allahabad Surkha, T_2 (8.00) Apple colour, T_3 (7.51) Allahabad Safeda followed by T_0 (7.30) control.

Overall Acceptability

From the perusal of data on overall acceptability in guava ice-cream of different varieties and control, the highest mean overall acceptability score was recorded in the ice-cream sample of T_1 (8.14) Allahabad Surkha, T_2 (7.99) Apple colour, T_3 (7.84) Allahabad Safeda and T_0 (7.61) control.

On the basis of results obtained during the present experiment (Allahabad Surkha pulp ice-cream) was found as superior in physic-chemical and organoleptic characters for preparation of guava ice-cream.

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STRATEGIES FOR REDUCING THE IMPACT OF CLIMATE CHANGE IN AGRICULTURE

Varsha Rani* and R.S. Sengar

Department of Agricultural Biotechnology, College of Agriculture
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110
***Corresponding Author Email-Id:** raniv096@gmail.com

Introduction

Global climate change is one of the foremost problems of the 21st century [7]. Climate change is defined as climate change over time, whether due to natural variability or as a result of action or not. Global climate change and agriculture are processes that are closely related, and climate change responses in developed and developing countries differ widely. In recent times, exaggerated levels of greenhouse gases such as carbonic acid gas, methane, ozone, general anesthetic inhalation and chlorofluorocarbons are the primary required environmental change It is estimated that warming (i.e., exaggerated greenhouse gases) would have critical impacts on agricultural conditions, as well as exaggerated global average surface temperature, glacial run-off, precipitation and the interaction of these components. The balance of these effects will depend on the overall impact of global climate change on agriculture. The frequency of droughts in many tropical countries has been underestimated thanks to warming, while flooding in many countries has severely non-continuous food production and also the region's carrying capacity. Therefore, there is considerable concern about potential climate change and its direct or indirect effects on agriculture [17]. Varied crops, shifts in international supply and demand for global climate change growth, present new challenges to farmers around the world. There are no exhausting facts on what would inevitably be the consequences of growth in the atmospheric concentration of greenhouse gases and no firm time scales are understood. In terms of global climate change, agriculture is a very critical area to think about. This paper aims to provide an analysis of the effects of global climate change on farming systems. It also stresses that agricultural growth and property have to be accomplished when combating the development of global climate change [18].

Climatic Changes Due to Global Warming

The temperature rise due to the release of greenhouse gases into the atmosphere has a profound influence on the overall climate system of the Earth and has important implications for the geosphere and the biosphere. The Periodic Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the fourth Assessment Report (AR4), published in 2008, remains the official source of information on these impacts. The Fifth Assessment Report is currently under planning and due in 2012. According to AR4, the most significant climate changes that could occur as a result of global warming are:

1. With changes in both maximum and minimum temperatures, daily and seasonal temperature trends will change. The largest land in the northern latitudes, with a limited number of cold days and nights and a growing number of warm days and nights, will be a temperature rise.
2. There will be major shifts in rainfall patterns, with subtropical areas of the world expected to receive slightly less rainfall and increased rainfall at northern latitudes. The distribution of rainfall within a year or season is not only the overall annual or seasonal rainfall that can change, but also. As a consequence, on days with less rain, the same overall rainfall can be transmitted during the rainy season.
3. The frequency of severe weather events such as heat waves, unusually heavy rainfall, and violent storms and cyclones will be increased by increasing temperatures. Seasonal climate trends may also undergo alterations, such as seasonality.
4. Following the increase in global temperature, the melting of the polar ice cap would lead to the rise in sea level, although the magnitude of the rise is unknown. Coastal cities and several island countries would be affected by rising sea levels.
5. Due to global warming, the oceans will change. Because of elevated CO_2 concentrations, the oceans would become acidic, resulting in detrimental effects for marine flora and fauna. Ocean temperatures can also be affected, and disturbances in the current flow pattern of ocean currents are likely. An integral part of the process by which the Earth's heat balance is retained is the flow pattern of ocean currents. Although disruptions in this pattern may be small in the present century, in later periods they have less effect on the ocean's circulation.

Indian Scenario

India, like other nations, has also begun to witness severe weather events that are causing climate change. As stated earlier, one of the key driving parameters for changing the environment is global warming. In India, the annual average temperature has been reported to have risen at a rate of 0.42°C. [3]. The southwest and north-east monsoons are the origin of the Indian agricultural system. Around 80 percent of the overall rainfall is from India's southwest monsoon. Any variations and uncertainties in the pattern of long-term rainfall can affect the agricultural sector and can increase the frequency of droughts and floods at the regional level [12]. There has been a major growing trend in rainfall along the west coast, north Andhra Pradesh and northwest India [11], while the trend has been observed by significant decreases in parts of Gujarat, Madhya Pradesh. Kerala and Northeast India, bordering regions [16]. Western disturbances on a small scale affect the northwestern area of India, as such disturbances only affect rabies production [6], not for more than 20-30 days only. The influence on agriculture has not only been demonstrated by the monsoon, but also by the weather. In the southern region, extreme maximum and minimum temperatures showed a growing trend, while in the northern part of India, the trend decreased [12]. Research studies indicate that crop productivity is likely to decline in the future with a rise in temperature [13]. Therefore, the dependence of temperature on crop production, stability, yield and efficiency needs to be studied in order to uplift the economy.

Global Scenario

One of the parameters impacting the environment could be climate change. The IPCC has estimated that many of the changes observed are unprecedented due to climate change [9]. It is estimated that the global sea level rise in 2050 will be between 0.17-0.41 m. [4]. The rate of rising sea levels was found to be higher than the average rate over the last two centuries until the mid-19th century [14]. The IPCC stated that changes in precipitation would be non-uniform in most mid-latitudes and wet tropics and that its peak incidence would become more extreme and persistent [15]. Recent results of rising trends in recent rainfall have contributed to a higher risk of regional flooding [17]. The last three decades have been steadily warmer since 1850 than every other decade on the surface of the Planet. In large parts of Asia, heat wave frequencies have risen since the mid-20th century [10]. CO_2 emissions and other greenhouse gases also boost temperature levels. The IPCC report states that for the 21st century, the quantity and rate of warming depends on the cumulative volume of greenhouse gases released by mankind (National Academy of Sciences Report, 2014). These observed variations in

various areas of the World are responsible for different climates and may also result from extreme weather events. Hurricane Katrina struck the U.S. in 2005. Attacked, which in the last 100 years has been considered one of the strongest storms. The Gulf Coast area was under attack and the report stated that the disaster caused the greatest losses in agricultural production. In the same year, long-term droughts witnessed major crop losses in the mid-western areas prior to Katrina [19]. Climate change can increase or decrease crop yields depending on the region and application of irrigation. Weather events of this type impact ecosystems worldwide. In the future, increasing temperatures and changing rainfall will reduce crop productivity [13]. Temperature can be an important parameter that influences crop yield around the world. Studies relating to the impact of temperatures on crop yields will also help the agricultural sector prepare and boost the economy in the future.

CC and Impact on Agriculture

Agriculture is an economic activity that relies primarily on the weather and environment in order to produce food, fiber and other vital items to sustain human life. Agriculture, the backbone of any economy, is expected to be vulnerable to climate fluctuations and changes in economic activity. Natural processes that also include a certain proportion of nutrients, temperature, precipitation and other factors are involved [22].

Agriculture is influenced by CC in many respects, such as variations in rainfall, average temperatures and extremes of climate, a major impact on soil erosion (i.e. floods and droughts): changes in diseases and pests, carbon dioxide, food quality and nutrition [23]. Crop yields display a good association with fluctuations in temperature and hot or cold wave cycles and differ depending on the plant maturation phases during severe weather events[8]. Changes in the pattern of rainfall would increase the problem of water shortage and drought for crops and alter irrigation plans. They also reduce the prediction of rainfall and its related preparation for farmers. Indirectly, changes in the levels of humidity and temperature will cause changes in the absorption rate of fertilizers and minerals that decide the production of yields. In short, if both are below the limits, a drop in precipitation as well as a rise in temperature decreases agricultural productivity (suitable for crop production; [21]).

CCs have been a natural threat to all sectors worldwide, such as commerce, industry and particularly the agricultural sector [24]. For the economy and rural livelihoods of any country, the agricultural sector ranks high, as CCs are very significant from the point of view of the agricultural sector.

Agricultural practices and changes in climate behavior are influenced by direct dependency on climatic factors; higher temperatures due to CC can allow longer growing seasons in low temperatures along high latitude regions. Many forms of pollutants, primarily GHGs such as carbon dioxide, methane and nitrite oxides, emanate from the agricultural sector, mainly affecting the atmosphere [27]. A number of studies have shown, on the other hand, that current agricultural practices are a significant source of GHGs that cause worse climate disruption. Most developing countries have developed agricultural GHGs and a large number of farm animals, as well as insufficient management of fertilizers, excessive use of agriculture and soil mismanagement. As they are mostly dependent on the agricultural sector, the effect of CC in developing countries is becoming more serious. The great ability to reduce and optimize CCs is significant in the agricultural sector. According to the IPCC report, participation is a collaboration in reducing or rising the emission sources of GHGs that go below the surface, whereas adaptation is a way of minimizing or reducing real or predicted climate change or harm to natural or human systems. Amendments are the key. Profitable Chance. Agricultural activity can generally be a good source of GHG, especially through the storage of carbon in organic soil materials and biomass sinks affected by climate change.

CCs are largely responsible for the continued rise in GHGs in floods, including carbon dioxide, fluoride-rich gases, methane, nitrous oxide, and many other gases that change precipitation patterns, temperature, and water and land supplies. On the other hand, its impacts are more generally felt in developed countries due to their vulnerabilities and the marginal capacity of CCs to mitigate the effects. India, Pakistan, Africa and other low-income countries, as developing nations, mostly have economies. Recent study has

increasingly considered the impact of CC on agricultural development in developing continents (e.g., Asia and Africa). Agriculture is a staple for millions of people's livelihoods in various low-income or developing countries such as Africa and Asia. The main platform provides livelihoods and jobs in developing countries [20]. The effect of the CC on the agricultural sector has a significant impact on food production, livelihoods and the overall economy of countries, especially developing countries' economies. Agriculture accounts for 29% of GDP in developed countries, and 65% of agricultural production accounts for 29% of GDP in developing countries [5].

Strategies for Reducing the Impact of Climate Change in Agriculture

Renewable Energy

Maximizing energy capacity and shifting away from the square of fossil fuels calculate crucial measures that farmers want to scale back their climate footprint. This may include the generation of agro-renewable energy such as star panels and wind turbines, decreased use of fertilizers and pesticides dependent on petroleum, and reduced reliance on fuel inputs for storage and crop transportation.

Practices of Organic

Agricultural industrialization has led to widespread reliance on petroleum-based pesticides, herbicides, and fertilizers in conventional agriculture since the mid-twentieth century. Most synthetic inputs are forbidden by organic farming, which means a reduction in GHG pollution, as well as soil, water and food. In addition, biological and sustainable techniques provide farmers with additional advantages, such as increasing soil quality and fertility, resulting in additional climate-friendly benefits.

Keeping Agriculture Green

Land management practices such as the reintroduction of ranelands, the restoration of bank zones, and the planting of hedgersaws and various perennial plants provide several benefits, such as providing shelter for life, beautifying fields, impregnation and the management of natural gadfly to draw helpful insects. Additionally, on the climate front, trees, shrubs and various woody vegetation store carbon in their biomass, protect the soil from erosion and conserve water.

Improving Livestock Feeding

Improving the feeding of livestock Using specialized agents or dietary additives, improving the quality and quantity of high-productivity and deep-rooted fodder, fodder grass or legumes, reducing the fuel load by vegetative management, will boost the efficiency of the digestion process, thereby reducing the emissions from enteric fermentation.

Efficient Irrigation Management

In any area, especially in times of drought, it is necessary to use water. However, given that most of the energy consumption on farms is groundwater pumping (in California, 1.5 billion households are expected to consume ample electricity from agricultural irrigation), irrigation efficiency also reduces the consumption of fossil fuels and it is necessary to do so with greenhouse gases (GHG). Emission Water- and climate-wise farmers can use an arsenal of water-saving and energy-saving technologies, such as drip irrigation, crop cover planting, dry farming, and more.

Increasing Soil Health

A significant collection of sustainable activities that demonstrate great potential to offset the impacts of climate change and also add to the production of carbon. Plants serve as carbon sinks through photosynthesis to expel CO_2 from the atmosphere. It then deposits about 40 percent of the carbon in the soil, where it feeds on microorganisms such as bacteria, fungi, protozoa, and nematodes. In exchange, those species give plants mineral nutrients, providing a natural fertilizer. By growing the case and application of manure, planting cover crops, and building plants and soil fertility by reduced or no-till farming, farm plants will help this farm carbon sequestration process.

Conclusion

Agriculture is a very critical subsistence and employment sector significantly in developing countries, it is crucial remorse for CC disturbance to improve the situation during this sector attention should provide a lot of attention, but during this scenario it is extremely slow at present attention. In this field, it's important to build a lot of knowledge and analysis.

It is extremely clear that CC plays a crucial negative role, particularly for farmers in specific or underdeveloped countries. Therefore, correct implementation of live mitigation and adaptation should be used extensively in this area.

Square assess various convections and international agreement on climate variation or change and agriculture responsible for extensively unfolding data around the globe would also like a lot of concern about this nexus as they are extremely vital to distress about CO_2 emissions and assistants that should start from indigenous farmers.

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MYCORRHIZAL RELATIONSHIP: BOON TOWARDS HORTICULTURAL PRODUCTION

R.S. Sengar[1*], Surya Pratap Singh[2] and Varsha Rani[1]

[1]Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110

[2]J.S University Ssikhohabad, 283135

***Corresponding Author Email**-sengarbiotech7@gmail.com

The symbiotic relationship between crop or perennial plants and microorganisms improves soil fertilisation, development, mineral nutrients, and resistance to abiotic and biotic stresses. Bacteria and fungi are the microorganisms involved in the majority of symbiotic relationships. The fungi are involved in the uptake of low-mobility nutrients (7). Arbuscular mycorihizal fungi are soil residents belonging to Glomeromycota, a recently conferred phylum with a presumed origin of at least 460 million years. Gloireroinycota fungi live in close proximity to the roots of most plants, especially angiosperms, Pteridophytes and gymnosperms.

These vesicular arbuscular mycorrhizae are developed by phycomycetous septate fungi belonging to four major genera, namely Gloinus, Crigaspora, Acaulospora and Sclerocystis. This symbiotic relation was found in several plant families, in arctic, temperate and tropical regions, in aquatic and desert environments (20). The mutualictic symbiosis (non-pathogenic association) between soil-borne fungi and the roots of higher plants is known as mycotrhiza (26). In general, there are two types of mycorrhizae: ecto- and endo-mycorrhizae. Extracellular fungal development in the root cortex distinguishes the ectoinycotrhizae. They are more popular in temperate climates, with over 5,000 species mostly belonging to the Basidiomycetes genus (26). Ectomycorrhizal interactions have also been discovered in tropical trees like pine and eucalyptus. Endomycorrhizae are differentiated by inter- and intracellular mycelial growth in the root cortex, which results in the development of complex fungal structures known as vesicles and arbuscles. Since all mycorrhizae do not form vesicles, the endomycorrhizae have an alternative name: vesicular arbuscular mycorrhiza (VAM), which is now known as arbuscular mycorrhizal fungi (AMF). This form of symbiosis is present in about 80% of all terrestrial plant species(27).

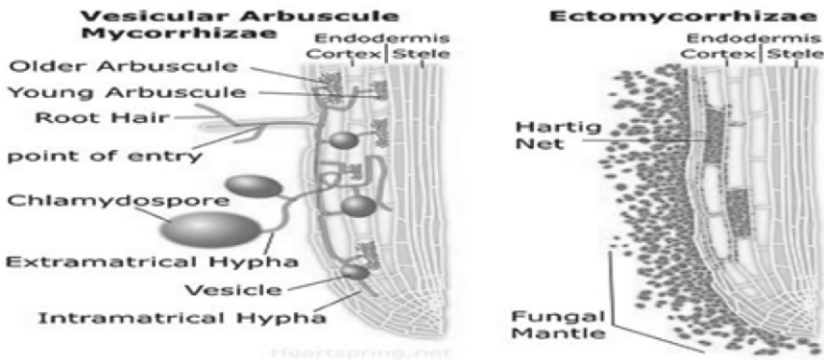


Fig. The arbuscular mycorrhizal fungi(AMF)belong to taxonoinic order called Glomales,which coinprises of six genera(Figure1).

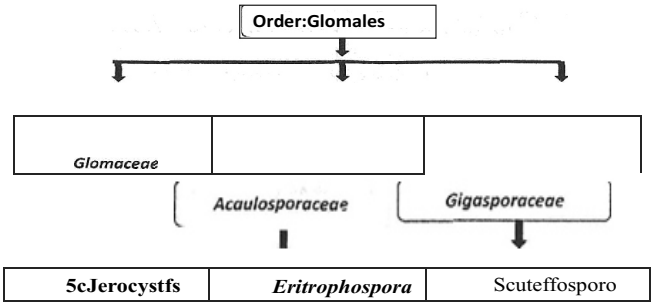


Figure 1. The current taxonomy of AMF with examples of different genera in soil (adapted from Dodd,2000).

AMFhabitat

Arbuscular mycorrhizal fungi can be present in a number of settings, including angiosperm roots, gymnosperms, and pteridophytes, as well as gainetophytes of certain mosses, lycopods, and psilotales, which are all rootless (19). Plants such as Proteaceae, Cruciferae, and Zygophyllaceae, on the other hand, are mycorrhiza-free. Dipterocaceae, Betulaceae, Myrtaceae, and Fagaceae are four families of plants (17). Moreover, despite the fact that the Cactaceae, Chenopodiaceae, Cyperaceae, Ainarantaceae, and Juncaceae families are considered to be mycorrhiza-free, most of the species were found to be infected in natural conditions (16). When litchi roots were introduced to the United States, Coville (1921) documented the first intracellular infection of litchi roots with mycorrhizal fungi. The explanation for certain plants' failure to form mycorrhizae is unclear. However, the presence of fungitoxic compounds in root cortical tissue or root exudates may be a factor. Salicylic acid in high concentrations has been found to reduce mycorrhization.

AMFinfectionprocess

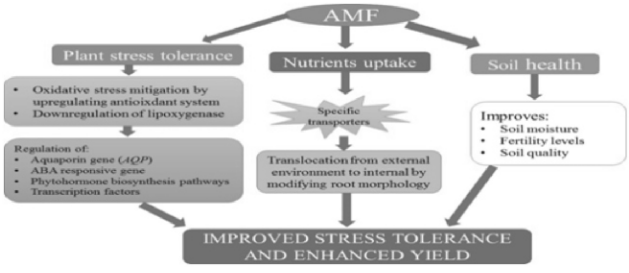
In ecto-mycorrhizae and hyphae of Pisolithus tinctorius, two fungal transcripts encoding a novel class of proteins known as hydrophobins have been isolated (15). Hydrophobins can play a role in hyphal aggregation and binding in plant roots, resulting in the formation of ecto-mycorrhizal mantle (29). In mycorrhizal symbiosis, intercellular infection is also seen (23). H- or Y-connections form between the hyphae, allowing intercellular spaces to expand.The aspersorium's infecting hyphal branches expand through the intercellular spaces and colonise the outer root cortical cells. Some hyphae spread out in all directions at the same time, carrying auxiliary cells or intercalary spores. Auxiliary cells are one of the most distinguishing features of the Gigasporirae family of arbuscular mycorrhizal fungi. Most arbuscular mycorrhizal fungi begin sporulation 3 days after contact, and spores can be produced well ahead of the rooting region (7). The synergistic interaction between volatile compounds and exudates formed by roots stimulates hyphal growth in Arbuscular mycorrhizal fungi (4). Flavonoids, on the other hand, can serve as signals for the initiation and development of arbuscular mycorrhizal symbioses and are important components of the regulatory system that regulates fungal growth. Phosphatases are produced by arbusctilar mycorrhizal fungi for the utilisation of organic phosphorus. Arbuscular mycorhizal fungi provide protection against such soil-borne pathogens in addition to enhancing the mineral nutrition of their hosts. By secreting mucilaginous compounds, arbuscular mycorhizal fungi affect microbial communities and enhance soil structure. Vesicles are mostly lipid-filled and act as a fungus storage reserve.These vesicles are formed prior to the formation of arbuscules, but they survive better after the arbuscles have died.

Arbuscular Mycorrhizal Fungi and Environmental Stresses in Plants

Plant stress tolerance is a complicated process involving physiological, biochemical, and molecular shifts. Plants' most important physiological responses to unfavourable environmental conditions are certainly decreases in growth and yield. By - water and nutrient absorption from the soil, AMF may help to mitigate the negative effects of various environmental stresses (water and salinity). It's essential to fully comprehend the mechanisms that enable a plant to adapt to and develop in a changing/unfavorable climate. Many stress management techniques currently in use seek to reduce crop losses by causing changes. Traditional breeding for developing stress-tolerant crop varieties and genetic engineering for developing tolerant cultivars through the use of a

particular set of markers are two examples of such strategies (24). However, putting the preceding techniques into effect necessitates comprehensive expertise and substantial financial investments. As a result, we must find less costly and environmentally sustainable solutions to overcome crop production losses caused by environmental stresses. As a result, researchers are interested in using/exploiting biological approaches to reduce the harmful effects of stress. Plants' physiology and metabolism have been reported to be altered by AM symbiosis. Early flowering and a greater number of flowers are caused by AMF colonisation (18). Plant growth and resistance to different environmental stresses can be enhanced by symbiotic relationships formed with arbuscular mycorrhizal fungi. Drought, salinity, heavy metals, and pest resistance have all been related to the AMF symbiosis. Furthermore, they have been reported to play an important role in improving nutrient uptake as well as the soil-water relationship. Plants could have increased stress tolerance as a result of AMF association, which could be due to the following attributes:

1. Rhizospheric soil properties improvement
2. Improved water absorption due to enhanced/prolific root growth, resulting in increased root area and root plasticity
3. Improved nutritional status of the host plant due to increased absorption of nutritional elements, especially phosphorus (2)
4. Activation of a defence mechanism in a timely manner
5. Antioxidant enzyme activity enhancement to minimise oxidative harm (11)
6. Impact on gene expression (28).



Arbuscular Mycorrhizal Fungi and Water Stress

Water stress-induced negative changes can be mitigated by arbuscular mycorrhizal fungi. The beneficial influence of AMF interaction has been studied under water-stress conditions, mainly at physiological levels such as control of water absorption, transpiration, and photosynthesis. Under water-stress conditions, the AMF association aids plants in retaining leaf water potential, preventing turgor loss. Furthermore, compared to non-AMF plants, AMF-infected plants easily recover to normal conditions after stress release. The ability to recover from stress is similar to the ability to withstand stress. When compared to non-AMF plants, AMF-associated plants have different transpiration rates and stomatal conductance. AMF has been related to improvements in stomatal conductance and transpiration in blue gramme, cowpea, lettuce, soybean, and wheat. AMF encourages stomatal opening in plan. However, it should be noted that the beneficial effects of AMF colonisation on stomatal characteristics differ by genus-for example, AMF colonisation has no effect on stomatal conductance in Citrus taxa or sorghum. Increased expression levels of some genes are caused by AMF interaction, resulting in increased drought tolerance (22). P5CS and genes encoding late embryogenesis abundant (LEA) proteins are among these genes. P5CS enzyme is included in proline biosynthesis and osmoregulation, while LEA proteins are participating in ion interaction, the antioxidative mechanism, membrane integrity, protein stabilisation, and folding. Furthermore, differential expression of genes coding for NCED has been observed in AM-infected plants . The interaction of AMF with ABA has been suggested as the cause of changes in expression levels (22), and all mentioned previously genes are regulated by ABA . Furthermore, the abscisic acid (ABA) level of plants has been observed to be controlled by the related AMF under drought conditions. However, the effects of exogenous ABA on the expression levels of these genes as well as the physiology of AMF has yet to be investigated. Furthermore, although it is generally recognised that AMF colonisation alters both the physiology and metabolism of above ground plant parts, observations pertaining to the differential expression of these genes by AMF have only been carried out at the root stage (31).

Arbuscular Mycorrhizal Fungi and Salinity Stress

One of the most common agricultural and biological issues is salinity. The majority of studies have found that AM colonisation enhances plant salinity tolerance by altering hormonal profiles. Green basil was found to be more salt resistant after being inoculated with Glomus mosseae and Glomus intraradices (*Ocimum basilicum* L.). In aerial organs and roots, mycorrhizal inoculation decreased lipid peroxidation and sodium content while increasing reduced sugars, free proline, protein, and potassium content. Salinity inhibits plant development, as well as associated AMF and AMF colonising capacity; it also inhibits spore germination and fungal hyphal growth. In *Jatropha curcas* L. (13), tomato (1), and *Ocimum basilicum* L., salinity-induced reductions in viability and AM-colonization capability have been identified (25). In terms of stomatal conductance and photosystem II quality, lettuce plants treated with AMF had better growth output under salinity stress. AMF colonisation of plants has a number of beneficial effects on their development under different stress conditions. Because of the immense potential and qualities of AMF, any alleviation of negative effects on crop plants caused by NaCl stress is of great interest. Most studies on the interactions of higher salt concentrations and arbuscular mycorrhizal fungi colonisation of plants are somewhat controversial, according to the current literature. Higher salt concentrations have been found to inhibit spore/fungal propagule germination, plant root colonisation, and, as a result, AMF sporulation .Plants (such as *Aster tripolium*) that thrive in salt marshes, on the other hand, have been reported to have a high level of AMF colonisation. It is well known that AMF increases salinity-induced reductions in plant growth and yield, thus imparting improved salt tolerance in saline soils. However, the exact mechanisms underlying AMF's enhanced salt tolerance are still unclear at the molecular level. Plants use a number of tolerance mechanisms that contribute directly or indirectly to salinity tolerance. These mechanisms involve the synthesis and accumulation of osmoprotectants (e.g., proline, glycine betaine, free sugars, and polyols), meeting the increasing energy demands of ATPases for the rapid export of Na_1 and Cl_2 ions from the cytoplasm, unique transport proteins that efficiently move exported ions into the vacuole or apoplastic spaces, and highly efficient aquaporins to preserve the osmobal balance(10). The majority of the few fully sequenced Na_1/H_1 antiporters were found to be homologs in the plasma membrane intrinsic protein (PIP) subgroup. Inoculation of arbuscular mycorrhizal fungi (*Glomus mosseae and Paraglomus occultum*) raised plant height, stem diameter, shoot, base, and maximum plant biomass, photosynthetic rate, transpiration rate, stomatal conductance, and preserved ionic balance in Citrus tangerine under salinity stress, according to (33). The effect was greater in plants inoculated with Paraglomus occultum.Under normal circumstances, AM reduced leaf Na_1 content while simultaneously increasing K_1 and Mg_{21} content and the K_1/Na_1 ratio. Inoculation of AMF (Glomus mosseae) to tomato plants decreased cell membrane osmosis and malonaldehyde concentration with a substantial increase in antioxidant enzyme activities, resulting in better growth through efficient scavenging of reactive oxygen species (ROS) produced, according to (21) under both normal and salt-stress conditions. AMF inoculation enhanced general morphological attributes, antioxidant enzyme activity, K uptake, Ca, and proline accumulation in pigeon pea while decreasing Na uptake and accumulation, leading to higher K/Na and Ca/Na ratios. Excessive phosphate and reduced Na uptake can lead to increased plant growth.However, the precise processes involved have yet to be completely elucidated. Mycorrhizal fungi, also known as arbuscular mycorrhizal fungi, are an integral part of the natural environment. As previously reported, AMF have the ability to grow in saline environments, improving plant tolerance to salinity. AMF increases plant water absorption potential under saline environmental conditions by raising root hydraulic conductivity and preserving osmolarity (3), thereby helping to mitigate the negative effects of excess salt accumulation in roots.

Arbuscular Mycorrhizal Fungi and Pathogen Attack

Plants are continually threatened by a variety of pathogens that cause a variety of diseases that cause plant growth retardation and, in the worst-case scenario, plant death. Infection by pathogens decreases crop production, which has a clear and obvious connection to increasing the risk to the world's food supply. Shriveling of leaf and fruit, root and stem rot, chlorosis, and necrosis, all of which have a direct effect on the rate of photosynthesis , leading in yield loss; in extreme cases, this can lead to plant extinction (6). Several plant pathogen interactions that are native to the host plant are triggered during pathogen attack. The creation of physical barriers, improvements to the cell wall, and de novo synthesis of metabolites are all common changes induce. Biotrophic fungi are useful in preventing fungal penetration because they can stop the parasitic fungal intracellular hypha (haustorium) from growing and functioning, preventing it from extracting nutrients from plant cells (32). Plant pathogen control using biological methods to increase plant yield by suppressing or killing them, thereby improving plant resistance, is an important technique that has piqued the interest of scientists all over the world. Microorganisms that are antagonistic to plant pathogens may be native to the region or introduced from elsewhere; however, there are risks associated with using microorganisms from other locations. Biological control, on the other hand, is generally acknowledged to have numerous advantages, including being a component of the environment, the production of pesticide resistance being relatively healthy, having a low risk of causing damage, and possibly playing a role in enhancing sustainable agriculture. Arbuscular mycorrhizal fungi are one type of organism that can function as plant bioprotectors. Incompatible AMF association can result in poor plant development and yield decrease, while compatible association improves plant productivityprevents pathogen growth, and up-regulates plant hormone production .AMF are credited with improving plant growth and yield, causing local and systemic resistance to pathogens through a variety of mechanisms, involving improved mineral nutrition, and increasing the expression of plant genes, both of which result in increased resistance due to their antifungal effects. AMF helps plants in their defence against pathogens by improving genetic, biochemical, and signalling factors involved in their defence .The precision of AMF can never be underestimated when it comes to disease prevention. Many studies have been published on this topic, including those on eggplant, cucumber (14), and banana (12). The capacity of AMF to defend against a variety of pathogenic fungi has been well established. However, some researchers say that AMF has no effect on pathogen resistance (34). To draw a strong conclusion, AMF must be used widely, practically, and on a daily basis against plant pathogenic fungi. To prevent pathogen infection/growth, different AMF species or combinations of microorganisms are frequently used. For example, inoculating groundnut with *Gigaspora margarita, Acaulospora laevis*, and *Sclerocystis dussii* prevented *Sclerotium rolfsii* from causing damping-off and black shank disease, and inoculating tobacco with a mixture of *Glomus fasciculatum* and *Trichoderma harzianum* prevented damping-off and black shank disease caused by *Pythium aphanidermatum*. Often microbial mixtures function in combination with pesticides to effectively control plant diseases-for example, *carbendazim* and *Glomus fasciculatum* protected safflower from the root rot pathogen *Macrophomina phaseolina*. Furthermore, there have been many studies of AMF-induced root rot disease reduction in cereal crops. *Phytophthora* spp. and their interactions with crop plants have been used as a model system by many researchers to better understand AMF-mediated disease control (9) Inoculation with AMF lessens the severity of the disease. AMF's ability to monitor diseases in the field has not been extensively investigated. *Glomus* sp. inoculation of grass (*Vulpia ciliate* var. ambigua) reduced *Fusarium oxysporum* growth, and *Glomus* sp. pretreatment of onions improved yield by controlling white rot disease. In fact, according to studies, AMF appears to have enormous potential for controlling and protecting plants from any pathogenic attack, and careful planning and execution are needed to properly address the issues of inconsistency.

AMF and Herbicides and Pesticides

Agriculturalists rely heavily on the use of fungicides, insecticides, and other chemical substances that are harmful to plant invaders, causative agents, or carrier agents for disease control. The adverse effects of these chemicals, or their degradation products, on the environment and public health, however, clearly necessitate the search for new, non-toxic disease control options. As a consequence, a natural/biological phenomenon/means to enhance inherent as well as acquired resistance to disease defence is needed. Several biosynthetic pathways are activated depending on the chemical used to control pests and herbs.Chemical defences in plants are triggered by elicitors, which are compounds that activate chemical defences in plants. Salicylic acid, methyl salicylate, benzoic acid, chitosan, and other chemical elicitors are frequently tested and affect the activation of enzymes involved in secondary metabolite synthetic pathways, especially in the development of phenolic compounds. Introduction of biological approaches to pest and herb control into agricultural practises could reduce the need for chemical control, leading to the development of sustainable agriculture. A wide range of biotic stresses (for example, fungal, bacterial, or pest infections) can result in significant yield loss. Farmers have a lot of choices when it comes to disease defence for their crops. The most important and open up options for an agriculturalist are the production of resistant cultivars, biological control, crop rotation, tillage, and chemical pesticides. Almost all chemical pesticides and fungicides have a direct antibiotic principle; nevertheless, their industrial usage is not cost-effective, and their widespread use has a direct impact on the food chain-some are also carcinogenic. Environmentally sustainable methods are being developed to tackle plant diseases and protect humans from health risks. As previously mentioned, when addressing the use of AMF against pathogen attack, AMF can be extremely useful in this regard. However, it is important to remember that there are few scientific studies on the use of AMF as a biological controller of pests and herbs; this is a field of great concern that needs to be addressed.

AMF Management and Perspectives

The key areas where the advantages of incorporating inoculant AMF into a plant growth system can manifest themselves are that where native AMF inoculum is missing. Sterilized soils or post-in vitro plant micro-propagation, buried, highly fertilised, degraded areas, or pepper cutting rooting are examples (30). Plants with a highly branched root system (Poaceae) are thought to be less amyotrophic (less reliant on fungi for normal growth) than those with coarser roots (e.g., cassava, onion). The plant's dependency on the symbiosis is determined by root branching. Low-input management soils have more AMF fungus spore populations than conventionally managed soils (8). The early sand dunes species that colonise are non-mycorrhizal1, while the later grasses are colonised with AMF (17). The presence or absence of crops, as well as the crop grown, can affect AMF soil survival. Plants benefited from AMF inoculation and the addition of composted grape pomace. This has been explained as a result of the mycorrhizal fungus increasing P uptake through extra-radical hyphae. This form of absorption improves nutrient utilisation.

In certain cases, the addition of composted urban waste and mycorrhizal inoculation were useful tools in shrub revegetation programmes in semi-arid areas. Native mycorrhizal was regarded a preferential method for ensuring the effective re-establishment of natural shrub species in semi-arid degraded soil.The vulnerability of Acacia seedlings to AMF colonisation seemed to be seasonal, according to (5). Despite the positive effects of AMF, soil fumigation, non-responsive plant varieties, or rotations mainly based on non-mycorrhizal crops or crops with low AM F dependence can severely limit their activity. Increased salicylic acid levels in plants delayed AMF root colonisation, meaning that increased salicylic acid levels in plants delay AMF root colonisation. While salicylic acid inhibits AMF root colonisation, it has no effect on the isotential for AMP colonisation of plants.

Conclusion

Despite a concerted effort on various facets of the AMF organisation, the problems that most directly impact modern agriculture, such as drought and disease resistance, as well as increased crop growth and yield, must be fully understood. It is important to collect the AMF diversity that exists in the world. The management of indigenous AMF requires a focus on their less known aspects in order to be established, defined, and conserved for the future. The basic characteristics of the AMF, such as host-fungus specificity interaction and competition between AMF, as well as its effectiveness under potential environmental stresses, like well-watered, drought stress, salinity, and N and P deficiency conditions, must be determined. Furthermore, the rapid implementation of this technology would be aided by the low cost and realistic mass production of AMF inoculum.

Mycorrhizae (AMF) are symbiotic associations among plant roots and certain soil fungi of the order Glomales that play an important role in nutrient management and defend host plants from environmental and biotic stresses in a variety of ecosystems. Since mycorrhizae colonise about 80% of plants, their proper use can improve productivity in difficult soils while also helping to mitigate the negative effects of abiotic and biotic stress. For crops with a transplant point, such as horticultural/forestry systems, AMF biotechnology is feasible. Several functions of mycorrhizal symbiosis have been established, and they are known to influence plant growth and health as bio-fertilizers and bio-protectors. It is generally agreed that an effective management of various stresses can be achieved. Inoculation with an effective AM fungal strain and thus careful selection of compatible most/fungus/substrate combinations will produce the best results. By ensuring a suitable mycorrhizal arrangement at transplanting, the efficiency of micropropagated plants or plug plants can be improved significantly. When inoculated with AM fungi, woody horticultural plants that are difficult to root in vitro have been shown to root and, as a result, increase their survival rate and quality.

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TO STUDY THE EFFECT OF VARYING DOSES OF NITROGEN AND SULPHUR ON GROWTH, YIELD AND OIL CONTENTS OF VARUNA VARIETY OF MUSTARD

Sandeep Sherawat[1]*, Arvind Kumar[2], Vibhu Pandey[2], Vyankatesh Bagul[3], Bijendra Singh[2]

Department of Agronomy[1], Department of Horticulture[2], Department of Ag. Biotech.[3]

J.V. (P.G.) College, Baraut[1], Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut[2, 3]. Uttar Pradesh.

***Corresponding Author Email**-ssherawat81@gmail.com

Abstract

The present investigation was conducted mainly to find out the effect of various levels of nitrogen and sulphur on mustard variety Varuna. Cultivation was carried to obtain maximum yield in west region of Uttar Pradesh. For this purpose, the experiment was conducted using c.v. Varuna with four levels of nitrogen viz. 0, 40, 80 and 120 Kg N/ha and four levels of sulphur viz. 0, 10, 20 and 30 Kg S/ha. The experiment suggests that Varuna variety of mustard crop showed significantly superior distinguishable growth characters, yield attributes and oil contents when supplied with 120Kg/ha of nitrogen and 30Kg/ha of sulphur.

Keyword: Nitrogen, Sulphur, Mustard, c.v. Varuna.

Introduction

Indian mustard (*Brassica juncea* L.), locally known as "khardal", belongs to Cruciferae family and genus **Brassica** (11). It is introduced as an oily herb (38 to 40% oil content), which is appropriate for zones with short seasons and less rainfall (3). Rapeseed-mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeis guineensis* Jacq.) oil. Rapeseed-Mustard is a principal oilseed crop, which plays a significant role in the India economy. Among the seven edible oilseeds cultivated in India, Rapeseed-mustard (*Brassica* spp.) contributes 28.6% in the total production of oilseeds. The global production of rapeseed-mustard and its oil is around 38-42 and 12-14 Mt, respectively.

In western Uttar Pradesh oil seed crops are more responsive to nitrogen than any other plant food nutrient. Its deficiency limits production. In view of this it is essential to determine to the optimum dose of nitrogen in relation to basic soil fertility. Further, it is quite imperative that the use of sulphur along with other necessary inputs would be needed for increasing productivity of both, the mustard yield as well as the oil yield has been reported by Singh & Singh (1978) Tiwari et al. (1984) and Chatterjee et al. (1985) Modern high analysis fertilizer levels as DAP and triple super contain phosphate contain very little sulphur. Their continuous use has resulted in sulphur deficiency which is becoming more pronounced and wide spread in Gangetic plain of Uttar Pradesh. Keeping all above aspects in view the present investigations will be carried out with objective of effect of varying doses of Nitrogen and Sulphur on growth, yield and oil contents of Varuna variety of mustard.

Material and Methods

The experiment was carried out at Department of Agronomy, A.S Post Graduate College, Lakhaoti Bulandshahr, (U.P.) during rabi season 2000-01. Its lies in the alluvial belt of Gangetic plains and is located in the western Uttar Pradesh. The experimental trial was laid out in two factors with Factorial Randomized Block Design with treatments consisted of four levels of nitrogen (0, 40, 80 and 120Kg/ha) through urea and four levels of sulphur (0, 10, 20 and 30Kg/ha) through elemental sulphur was laid out.

Table 1. Possible treatment combinations in kg/ha.

Symbol	Treatment		Symbol	Treatment	
	N	S		N	S
N_0S_0	Nil	Nil	N_2S_0	80	Nil
N_0S_1	Nil	10	N_2S_1	80	10
N_0S_2	Nil	20	N_2S_2	80	20
N_0S_3	Nil	30	N_2S_3	80	30
N_1S_0	40	Nil	N_3S_0	120	Nil
N_1S_1	40	10	N_3S_1	120	10
N_1S_2	40	20	N_3S_2	120	20
N_1S_3	40	30	N_3S_3	120	30

Observations

During the course of present investigation following studies were made on different plants trials.

Plant stands: It was recorded in each plot before harvesting time the crop

Plant height: Three plants per plot were randomly selected and tagged for the study of individual plant height. The height of selected tagged plant was measured in cm from base to tip of the main shoot at maturity stage.

Fresh weight per plant: Fresh and dry weights per plant were recorded at harvesting stage of the crop.

Dry weight per plant: The cut pieces of each plant were dried under sunlight for about 4-5 days and then transferred to oven for complete drying till constant weight, and weight was measured.

Primary and Secondary Branches

These were measured manually just before maturity of the crop.

Number of siliquae per plant

These were counted manually.

Weight of siliquae per plant: Siliquae were weighed on electronic balance.

Number of grains per siliquae: Twenty siliqua were threshed from branches from each plot and total seeds were counted. The average number of seeds per siliqua was computed.

Seed weight per plant: The seeds obtained from plants were weighed.

Test weight: A total of 1000 seeds were taken from each plot and weighed with the help of electronic balance to ascertain the test weight.

Seed yield: Before threshing, the total sundried produce from each plot was weighed with the help of spring balance in kilogram and threshing was done. The yield was noted in kg/plot and then it was converted into kg/ha plot wise.

Stick yield per plot: Before threshing the total sundried produce from each plot wise weight with the help of spring balance.

Oil content: The oil analysis was done by NMR machine. For the analysis of oil content, seeds were kept in envelopes. These envelopes were kept in oven at 70°C for 24 hours for the purpose of removal of moisture. Readings were recorded.

Result and Discussion

The present investigation was made mainly to find out the effect of various levels of nitrogen and various levels of sulphur on mustard variety Varuna to as contain the best levels of nitrogen and best level of sulphur in mustard.

Pre-harvest Studies

Plant Height The result presented in Table 2 shows that there was significant increase in height of plant with increased doses of nitrogen up to 120 kg N/ha which had shown the maximum height of the plant. The nitrogen levels increase plant height at maturity increases 9.0%, 16.5% and 21.7% over control plot respectively. It is due to availability of more nitrogen to plant which increased cell multiplication and elongation of cells which ultimately resulted increase in height of the plant. The above results also supported by (4, 6, 7, 9, 11, 15, 16, 20, 21, 22). The application of sulphur has also influenced the height of the plant significantly and it was measured that 30kg sulphur has increased significantly height of mustard plant by

6.67% over control plot. The said findings are supported by Singh (1983a) and Singh and Saran (1987) also observed beneficial effect of sulphur in promotion of height of the mustard plant. The interaction effect of N×S failed to touch the significant level, but the N120 and S30 Kg/ha produced numerically higher plant height over rest combinations of N×S levels.

Fresh Weight: The increasing levels of nitrogen significantly increase the fresh weight was noted at N120 kg/ha with 59.3% increase over control which was significantly higher than all other levels of nitrogen. The increase in fresh weight may be mainly attributed to increased height and a greater number of branches. There was progressive increase in fresh weight plant with in increasing levels of sulphur. The highest dose of sulphur 30 kg/ha significantly increase 10.9% more than control plot and can be attributed to more vegetative growth as reflected in height of plant and number of branches that resulted in increased fresh weight in fresh weight per plant over lower doses of sulphur. The interaction effect of N×S was found non-significant, but the combination of N120 and S30 kg/ha produced numerically higher over other combinations.

Dry Weight: The data pertaining in the mean table 2 shows that in the higher dose of nitrogen 120 kg N/ha produced significantly higher and 50.44% increase over control dry weight per plant followed by 80, 40 kg N/ha and over control. The significant increase in dry weight may be on account of more vegetative growth, a greater number of branches and fresh weight of plant under 120kg N/ha level. The same result also reported by (1), (25), (2), (8) (17), (19), (15). (11), Saran and Giri (1988), (18), Singh and Dixit (1989), Manohar (1989 a), Panu et al. (1991), (4), (22), (7). There was positively progressive Increase in dry weight per plant with increasing levels of sulphur. The higher dose of sulphur 30 kg/ha caused significantly increase of 11.4% over control plot in dry weight per plant over lower doses of sulphur. The same results also supported by (10). (5), (24) (20), (14), (13) (4) and (7). The interaction effect of nitrogen and sulphur were found non-significant but the combination, but the combination of N 120 kg and S 30 kg/ha produced numerically higher dry weight over other combinations. The same finding also reported by (14).

Primary Branch: It is clear from the table 2 that is the nitrogen levels significantly relucted the number N120 kg/ha produced significantly highest number of primary branches/plant over 80, 40 and 0 kg N/ha linear increasement observed to increase levels of nitrogen. The results is in conformity with the results already reported by (23), (25), (16), (20), (9), (8), (17), (15), (11), Parihar and Tripathi (1989), Pana. et al. (1991), (4), (22), (7). The higher levels of sulphur increased significant number of primary branches per plant by 28.0%. The interaction effect of N×S was found non-significant but the combination N120 and S 30 kg/ha produced numerically higher number of branches/plant. It may be due to sufficient availability of nitrogen and sulphur than the reflected the height of the plant and consequently the number of branches/plant. The same finding also reported by (14).

Secondary Branch: It is clear from the results table 2 that the nitrogen levels significantly relucted the number of secondary branches/plant. The higher levels of nitrogen produced significantly higher number of secondary branches/plant over rest levels of nitrogen. The same has been discussed in primary branches. The sulphur application also significantly reflected the secondary branches/plant. The higher level of sulphur 30Kg/ha was produced significantly 21.54% higher number of secondary branches over 20, 10 kg/ha sulphur. The interaction affect also significantly reflected the secondary branches. The combination N 120 S 30 kg/ha was produced significantly higher number of secondary branches/plant over N0 x S0 combination. It may be due to sufficient availability of nitrogen and sulphur than the reflected the height of the plant and consequently the number of branches/plant. The same finding also reported by (14).

Post Harvest Studies

No. of Siliqua Per Plant

It is clear from the result table 2 that the number of siliquae per plant were reflected significantly by nitrogen levels. The higher level of nitrogen (120kg N/ha) produced significantly more number of siliquae over N-80 kg/ha, N 40 kg/ha and over control. The various levels of sulphur also reflected significantly higher number of siliquae over S20 and S10kg/ha and 9.31% over control.

The same finding also reported by Singh (1983 a), Chatterjee et al (1985). (20), (14), Pana et al (1991) (4) and (7). The interaction effect of N×S were failed to touch the significant level.

Weight of Siliquae Per Plant

It is clear from the results table that the weight of siliquae was reflected significantly by nitrogen levels. The higher dose of nitrogen 120 kg N per ha was recorded significantly higher weight of siliquae over N 80, N 40 kg/ha and over control plot. The percentage increment over the control was 65.85. (1) also noted similar results of nitrogen. The different levels of sulphur also reflected significantly the weight of siliquae. The higher level of sulphur (S-30kg/ha) produced significant higher weight of siliquae over S 20, S 10 and over control. It may be attributed to more vegetative and reproductive growth of the plant under effect of sulphur application. The interaction of N×S was also reflected significantly the weight siliquae. The N 120 kg and S30 kg/ha were produced significantly higher siliquae weight over other combination.

Seed yield per plant: It is clear from the results that increasing levels of nitrogen increased significantly the seeds yield per plant and the highest yield has been recorded under the include of N120 kg/ha. The seed yield per plant generally universally proportion at to number of Siliquae/plant, number of seeds/siliquae and number of branches/plant. The same results also reported by Mehrotra et al. (1978), (25), (21), (19), (15), (11), (13), (4), (22). It is also clear that the seed yield per plant of mustard increased significantly with progressive increase in doses of sulphur up to higher level. It had percentage higher grain yield per plant 6.95% over no application of sulphur. The same results also reported by Singh (1983 a), Chatterjee et al. (1985). The interaction effect of N×S was found non-significant and it was observed that the N120 x S 30 kg/ha produced numerically higher seed yield over other combinations. The numerically increase in seed yield per plant may be attributed to more number of siliquae/plant, higher weight of siliquae and higher test weight that helped increase in the seed yield per plant.

Test weight: It is clear from the result that the test weight increased significantly up to nitrogen test weight over rest levels of nitrogen. The test weight is generally universally proportional to number of seeds per siliqua. The results showed that the test weight increased significantly up to 120kg N/ha (cf. Table-4.10) with percentage increase of 17.35. The same finding also reported by Mehrotra et al. (1979), Chariara and Damor (1982), (9), Singh et al. (1985), (17), (11). Pana, et al. (1991). (4) and (7). The application of S30 kg/ha significantly higher test weight followed by S20 kg/ha over S10 kg/ha and over control. The same results also reported by Singh (1983 a), Chatterjee et al. (1985), (20), (14), (13) (7). The interaction effect of N×S revealed that the maximum test weight was observed at N120 x S30 kg/ha which was higher than other combinations. may be due to more availability of photosynthates under the effect of N3XS3 may due to numerically increases in number of seeds/siliqua under this combination.

Table 2. The effect of various levels of N and S on mustard variety Varuna.

Treatment	PH	FWP/P	DWP/P	PB	SB	NS/P	WS/P	TW	SY	OC	NG/S	SW/P
Nitrogen kg/ha												
N0	147.00	215.67	89.25	9.58	13.25	283.50	20.09	4.38	10.58	36.32	11.07	291.00
N40	160.25	250.58	113.00	10.50	16.42	330.08	24.90	4.79	12.85	37.40	13.08	313.92
N80	171.25	294.17	125.83	13.17	19.33	367.42	28.95	4.98	14.96	37.73	13.53	334.83
N120	178.92	343.67	144.42	16.75	23.75	397.25	33.32	5.14	17.33	38.39	14.80	368.75
SE(m)±	1.09	4.28	1.97	0.63	0.55	3.67	0.36	0.06	0.25	0.32	0.12	2.58
CD(0.05)	2.22	8.57	4.02	1.29	1.13	7.51	0.74	0.12	0.52	0.65	0.24	5.27
Sulphur kg/ha												
S0	158.83	262.08	111.75	11.00	16.25	329.58	25.37	4.71	12.51	36.89	12.59	315.25
S10	162.42	273.25	116.58	12.25	10.08	339.58	25.62	4.79	13.56	37.11	13.04	325.17
S20	166.75	278.08	119.67	12.67	18.67	348.83	27.59	4.88	14.51	37.89	13.13	330.92
S30	169.42	290.67	124.50	14.08	19.25	360.35	28.67	4.93	15.14	37.95	13.72	337.17
SE(m)±	1.08	4.28	1.97	0.63	0.55	3.67	0.36	0.06	0.25	0.32	0.12	2.58
CD(0.05)	2.22	8.57	4.02	1.29	1.13	7.51	0.74	0.12	0.52	0.65	0.24	5.27

Treatment	PH	FWP/P	DWP/P	PB	SB	NS/P	WS/P	TW	SYQ/ha	OC	NG/S	SW/P
N_0S_0	142.33	200.00	81.00	8.33	12.00	266.67	17.33	4.20	9.00	35.27	10.73	280.00
N_0S_1	143.70	216.00	90.00	8.33	13.33	279.00	19.23	4.30	10.11	35.87	10.70	290.00
N_0S_2	148.33	220.00	90.00	10.67	13.67	287.33	20.80	4.50	11.11	37.07	10.73	295.33
N_0S_3	153.67	226.67	96.00	11.00	14.00	301.00	23.00	4.53	12.11	37.07	12.13	298.67
N_1S_0	157.00	240.00	110.00	7.67	13.00	313.33	24.93	4.70	11.67	37.23	12.23	308.33
N_1S_1	159.33	246.67	112.00	10.00	16.67	325.00	24.57	4.80	12.78	37.02	13.20	312.33
N_1S_2	162.33	249.00	112.00	10.67	17.00	335.33	24.80	4.85	13.33	37.53	13.13	315.00
N_1S_3	162.33	266.67	118.00	13.67	19.00	347.67	25.30	4.83	13.61	37.80	13.77	320.00
N_2S_0	163.33	268.33	120.00	12.67	19.00	356.67	28.80	4.90	13.89	37.33	13.00	317.67
N_2S_1	171.00	288.33	112.67	14.00	20.00	364.33	27.97	4.95	14.72	37.50	13.57	333.33
N_2S_2	175.00	303.33	129.00	12.33	19.00	371.00	28.97	4.99	15.28	38.07	13.77	340.00
N_2S_3	175.67	316.67	131.67	13.67	19.33	377.67	30.07	5.10	15.94	38.03	13.80	348.33
N_3S_0	172.61	340.00	136.00	15.33	21.00	381.67	30.43	5.03	15.50	37.73	14.40	355.00
N_3S_1	175.67	342.00	141.67	16.67	22.33	390.00	30.70	5.10	16.61	38.05	14.70	365.00
N_3S_2	181.33	340.00	147.67	17.00	25.00	401.67	35.80	5.20	18.33	38.90	14.90	373.33
N_3S_3	186.00	352.67	152.33	18.00	26,67	415.67	36.33	5.23	18.89	38.90	15.20	381.67
SE(m)±	2.17	8.75	3.94	1.27	1.11	7.35	0.72	0.12	0.51	0.64	0.24	5.16
CD(0.05)	NS	NS	NS	NS	2.26	NS	1.48	NS	NS	NS	0.49	NS

Seed yield (q/ha): It is clear from the results table that the seed yield increased considerable with the progressive increase in nitrogen doses. The highest seed yield was produced with 120kg N/ha level of nitrogen which was significantly higher that over levels of nitrogen. The increased seed yield/ha may be attributed to more hight of plant, higher number of branches, more number of siliquae per plant, more number of the seed/siliquae and increased the test weight obtained under. As regards the effect of sulphur that the seed yield per q/ha increased significantly with the progressive increase in sulphur doses. The highest seed yield q/ha was obtained with 30kg S/ha level of sulphur which was significantly higher that over other levels of sulphur. It had percentage higher yield 21.02% more over control plot with sulphur. Since the application of sulphur resulted in more vegetative growth and development of plant, more number of primary and secondary branches, more number of siliquae/plant, higher seed yield/plant and also higher 1000-grain weight. The same finding were reported by Rollier and Ferric (1969), Singh et al. (1970), Joshi et al. (1973), Randhawa (1973), Singh and Singh (1978), (10), Singh and Singh (1979). Singh Bairathi (1980), Singh (1983 a), Chatterjee et al. (1985), Chaudharyand Sharma (1986), Sawarkar et al. (1987), (4, 13, 14). The interaction effect of N×S was found nonsignificant on seed yield g/ha.

The application of N120 kg/ha at S30kg/ha level of sulphur produced numerically higher seed yield q/ha over other combination of N×S. Major et al (1977), Aulakh et al. (1977 b), (10) also reported similar results.

The result should that the highest level of nitrogen 120 kg N per ha significantly increased the oil content by 5.69% followed by 80 kg N/ha over 40kg N/ha and control plot. The same results also reported by Sinha et al. (1962), Arora and Bhatia (1970), (1), (2), (16), Singh and Singh (1988), Parihar and Tripathi (1989), (10), (4, 7, 8, 13, 14, 22) and Mishra & B.K. and Rana N.S. (1992). The percentage increament over the control was 26,72. Mehrotra et al. (1978), (23, 25), (2), Chaniara and Dumor (1982), (20), (9), Singh et al. (1985), (17), (19), (15), (11), Kumar et al. (1988), Pana et al. (1991). (4), (22) (7).

The application of 30 kg sulphur/ha increased significantly oil content of mustard over no sulphur. The interaction of N×S showed non-significant effect, but N120 x S30 kg/ha was produced numerically higher oil content.

No. of grain per siliquae: The results mean was significant increase in number of grains pe siliquae with increased dose of nitrogen up to 120 kgN/ha which had shown maximum number of seed per siliquae. This has already been discussed under the heading seed yield (q/ha). The application of sulphur has also influenced the number of seeds per siliquae and it was counted that S30kg/ha has increased significantly over 20 and S10kg/ha respectively. The interaction effect of N×S also was found significantly and that the 120N x 30S kg/ha were recorded significantly higher over other combination.

Summary and Conclusion

The experiment suggests that Varuna variety of mustard crop showed significantly superior distinguishable growth characters, yield attributes and oil contents when supplied with 120Kg/ha of nitrogen and 30Kg/ha of sulphur.

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TO FIND THE OPTIMUM DOSES OF NITROGEN FOR COMPONENT CROPS IN SOLE AND INTER-CROPPING SYSTEM OF FRENCH BEAN AND POTATO

Sandeep Sherawat[1]*, Arvind Kumar[2], Vibhu Pandey[2], Vyankatesh Bagul[2] and Bijendra Singh[2]

[1]Department of Agronomy, J.V.(PG) College, Baraut, India,
[2]SVPUA&T, Meerut (U.P), India
***Corresponding Author Email**-ssherawat81@gmail.com

Abstract

The present investigation was carried out to find the optimum dose of nitrogen for component crops in sole and inter-cropping system of French bean and potato. The experiment was conducted in two successive Rabi season in split plot design with three cropping system and four nitrogen levels in three replications. The results of present investigation could be concluded that, the optimum dose of nitrogen for French bean was found 155.30 kg N/ha for sole crop and 158.61 kg N/ha for intercropping. The optimum dose of nitrogen for potato was computed as 166.62 kg N/ha for sole cropping and 176.20 kg N/ha for intercropping. No remarkable effect of component crops was observed on each other in intercropping system.

Keyword: Nitrogen, French bean, Potato, Intercropping.

Introduction

French bean commonly known as Rajmah/Rajmash/Dry bean/field bean is one of precious and highly relished pulse of northern India and its demand is increasing day by day throughout the country and throughout the year in small to big location of urban and rural areas. The present yield level of pulses is definitely very low which should be improved in order to increase the total production as well as to increase the per capita availability of pulses under Indian conditions. French bean has also opened the possibilities of intercropping with high input crops. At Kanpur, intercropping of French bean cv. Udai (D.P.R.-14) with early potato variety Kufri Chandramukhi under 2:2 row ratio has given 1.59 L.E.R. (2).

Potato (*Solanum tuberosum*) has become so popular in India during short period that it has brought the country on the world map at fourth rank in area and fifth in production among the important potato growing countries. Intercropping of potato with other Rabi crops has been advocated that as a companion crop, potato is ideally remunerative under different situations.

Nitrogen is of great importance in crops production. Nitrogen is an essential constituent of proteins and chlorophyll and is present in many other compounds of great physiological importance in plant metabolism such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins etc. It is thus the very basic constituent of life. It improves quality of produce by increasing protein content of food and fodder crops (35). Potato requires heavy dose of N for its optimum yield. French bean also required heavy dose of N in plain area due to lack of nodulation in its roots. Therefore, it can be successfully grown in association of potato.

Keeping all above points in consideration, the present investigation entitled "Response of nitrogen and potassium in french bean + potato intercropping system" was carried out with the following objectives:

To find out the optimum dose of N for component crops in the sole and inter-cropping system

Material and Methods

Experimental Site

The present experiment was conducted at J.V.P.G. College Baraut, Baghpat in Western Uttar Pradesh in field of College Farm during Rabi 2003-04 and 2004-05.

Experimental Soil

Soil of the experimental field was Indo-Gangetic alluvial in origin. To determine the mechanical class and basic fertility status of the soil, the samples were taken randomly from 10 places up to a depth of 0- 25 cm in zig-zag fashion from both the fields in every year separately. The mechanical analysis was done by international pipette method (Piper, 1950). The organic carbon, available phosphorus and available potassium were determined by modified Kjeldahl method; Olsen's method and flame photometer (8), respectively. The obtained results are summarized in Table 1

Table-1. The results of the mechanical and chemical analysis of experimental fields

Particulars	2003-04	2004-05
Mechanical Analysis		
Sand (%)	22.40	21.10
Silt (%)	55.20	56.70
Clay (%)	22.40	22.20
Chemical analysis		
Organic carbon (%)	0.30	0.36
Available P (kg/ha)	14.50	15.00
Available K (kg/ha)	275.00	263.00
Soil pH	7.50	7.40
Soluble salts (%)	0.30	0.30

Treatments Details and Plan of Layout

The experiment in each year was laid out in split plot design with three replications. The details of treatments and symbols used are given here below:

Main Plot treatments

(A) Cropping systems - 3 - C

(1) Rajmash solo - C1(2) Potato sole - C2(3) Frenchbean+potato in 3:2 row ratio- C3

Sub-plot treatments

Nitrogen level - 4 - N

(1) No Nitrogen - N0(2) 60 kg/ha - N1(3) 120 kg/ha - N2(4) 180 kg/ha - N4

All possible combination of treatments is given here:

1. C1K0N02. C1K0N13. C1K0N24. C1K0N35. C2K0N06. C2K0N1

7. C2K0N28. C2K0N39. C3K0N010. C3K0N1 11. C3K0N212. C3K0N3

Field Operations

Varieties Used

The crop varieties used in test was Amber of french bean and Kufri Chandramukhi of potato. The main characters of variety are described here.

Seed and Sowing

The seed rate of 125 kg/ha of french bean and 25 q/ha seed tubers of potato was used in sowing was done on row basis.

Observations Recorded

To find out the effect of different treatments, the following growth and yield contributing characters and yields were recorded at appropriate stages of crop during both the years of experimentation. The methodology for recording such observations is given as under

Observation on French Bean

1. **Plant height:** For recording the growth and yield characters, five plants per plot were randomly selected and tagged. The height of each sample plant was measured in centimeter from ground level to the base of last pair of leaves at successive stages of crop growth viz. 35, 70 and 105 days after sowing and at harvest. Mean was taken as final reading.
2. **Number of branches per plant:** Number of branches on tagged plants were counted at different stages of growth and development of the plant. The sum the branches including main and sub-branches of the plant was taken as total branches. Mean was taken as final reading.

3. **Leaf area per plant:** Three leaves randomly from top, bottom and middle of each plant were selected for the measurement of leaf area maximum length and maximum width of three leaves/ plant were measured with help of scale. The average area per leaf was calculated. Besides, the actual area of the same leaves was also recorded with the help of automatic leaf area meter or graph paper. The actual area of each leaf measured by leaf arca meter was divided by the false area of the same leaf measured with scale. The fooled factor based over the factor of one level was worked out as 300. The false area per leaf for each plot was converted into actual area by multiplying with factor at all the four stages.
4. **Leaf area index:** This is a ratio between the area of the surface of green leaves and ground area covered. The leaf area indices were calculated treatment wise. The following formula was used for the calculation of leaf area index.
5. **Number of pods per plant:** This was measured manually.
6. **Number of grains per pod:** Five pods from each sample plant were randomly selected. The obtained grains were counted and mean number was calculated.
7. **Length of pod:** Five pods from plant according to length selected and measured the pods by scale and average length was calculated.
8. **Harvest index:** Harvest index was calculated with following formula-

$$\text{H.I.} = \frac{\text{Grain yield}}{\text{Total biological yield}}$$

Observations on Potato

1. **Height of plant:** This was measured manually in centimeter and average was taken.
2. **Dry weight of shoot per plant:** The sample plants after recording fresh weight were sun dried for 7-8 days in paper bags and then dried at constant temperature in electric oven at 85°C temperature. After oven drying the average dry weight of shoots per plant was calculated.
3. **Number of tubers per plant:** This was calculated manually and average was taken.
4. Diameter of tubers: It was measured by dipping the sample tubers in a water jar.
5. **Weight of tubers per plant:** The fresh weight of tuber was also taken from sample plants after washing them by water. The average tuber weight per plant Wits used for statistical analysis.
6. **Yield of tubers (q/ha):** The produce of tubers from different net plots were weighted. The tuber weight was recorded in kilograms per net plot which was later on converted into q/ha by multiplying with factor based on net plot area
7. **Foliage yield (q/ha):** Green upper portion of the plant from the ground is called foliage yield. It was weighed in kg per net plot and converted into q/ha on the basis of net plot area.
8. **Harvest index:** It was calculated by the formula:

$$\text{H.I.} = \frac{\text{Tuber yield}}{\text{Tuber yield} \quad \text{foliage yield}}$$

Results and Discussion

The main effects of treatments are presented in all cases while interaction effects between treatments are described only in cases of statistical significance. If interactions were found statistically significant in pooling, those are presented only for pooled results.

Studies on Frenchbean

The comparative performance of French bean in sole and intercropping systems and crop response to increasing levels of nitrogen are presented here for important crop characters studied in this investigation.

Plant Height the data furnished in Table-2 indicate that plant height was not influenced significantly by cropping system. It is clear from Table-2 that each increasing level of N had significant increase in plant height over lower dose and thus, highest dose of N180 maintained significantly tallest plants in almost all cases of observation. The pooled data of final stage show that N180 dose produced tallest plants of 48.61 cm height which was 14.08, 8.89 and 3.43 % more than plant height at N0, N60 and N120 doses, respectively. Number of branches per plant it is evident from Table-2 that branches per plant were not influenced significantly by cropping systems. The application of N at increased rates caused significant increase in branches/plant at all stages up to the level of N120 beyond which increase was not significant. The pooled data of harvest stage show that the dose of N180 produced maximum of 5.59 branches/plant which was 28.80, 6.51 and 0.18 % more than N0, N80 and N120, respectively. More utilization of N by plants caused more cell

elongation and carbohydrate production which improved observed higher N uptake in french bean due to increased N application up to 120 kg N/ha. Leaf area per plant sole crop of French bean produced significantly higher leaf area than intercropping (Table-2) in all cases of study. Leaf area increased with each successive stage of crop growth and thus, the maximum was measured at final stage of harvest. At harvest stage, sole crop gave 3026.86 cm^2 area/plant which was 31.24% higher than the leaf area in intercropping system on pooled basis. It could be attributed to adverse effect of potato on french bean which restricted the formation of leaves and their size. These results are in close conformity to those of (1) in case of French bean + potato intercropping.

Leaf area showed significant increase with each increasing dose of N up to highest of N180, however in some cases differences between N120 and N180 levels were not significant. It may be seen from pooled data of harvest stage that N180 dose produced significantly maximum of 2985,39 cm^2/plant leaf area which was calculated to be 35.67, 17.73 and 1.38% higher over leaf area at N0, N80 and N120 doses, respectively. The data furnished in Table-2 revealed that in sole cropping, N application increased leaf area of french bean significantly up to the dose of N120 while in intercropping such increase was significant up to highest tested dose of N180. Similar results were found at all the stages of crop growth. The combination of sole cropping and N120 produced larger leaf area which was at par with N180 but significantly higher than all other combinations. Leaf area index sole cropping of French bean has shown significantly higher values of LAI than intercropping at all the stages of observation during both years and pooled results. The pooled data of harvest stage show that sole french bean gave 9.925 LAI which was 1.860 unit or 23.06% higher than intercropped french bean. Increasing levels of N had positive significant effect on LAI of french bean at all stages during both years up to highest tested dose of N180 where LAI values maximized in all cases. On the basis of pooled results at final harvest stage, N180 gave maximum of 10.146 LAI which was found 2.799 units or 38.10%, 1.625 units or 19.07% and 0.182 unit or 1.83% higher than N0, N60 and N120 levels, respectively. Number of pods per plant French bean in intercropping produced significantly a greater number of pods than sole crop in first year and pooling. In pooled results, pods in intercropping were counted 11.25/plant which was 0.69/plant or 6.53% more than pods in sole crop. The translocation of more nutrients from vegetative parts to reproductive organs of plants due to better growth might have improved the yield attributes in intercropping system. The number of pods/plant increased with increasing levels of N significantly up to N180 in first year and pooling while during second year increase over N120 dose was not significant. Pooled data show that N180 produced maximum of 13.47 pods/plant which were computed to be 7.2, 36.6 and 73.8% higher than the pods at N120, N60 and N0 levels, respectively.

Number of grains per pod it is evident from Table-2 that number of grains per pod were not influenced significantly by cropping systems. Increasing levels of N enhanced grains/pod significantly up to N120 in first year and pooling while during second year up to N180 level. The maximum of 6.00 grains/pod were recorded under N180 which were 5.3, 18.1 and 44.2% more than N120, N60 and N0 levels, respectively on the basis of pooled results. (1) also reported significantly higher yield of french bean in sole cropping than intercropping system. Similar results have been reported by (31), (29), (21) in case of potato + mustard intercropping system and (9) in case of maize + potato intercropping. Length of pod French bean in intercropping produced significantly lengthy pods than in sole crop during pooling. In pooled data, intercrop produced 8.51 cm lengthy pods being 3.78% margin over sole crop. Effect of N was significant on pod length in all cases where, each increasing N dose caused significant increase in pod length up to the last dose of N180. At this dose, pod length was measured maximum of 9.82 cm which was 0.64, 1.72 and 3.50 cm or 7.0, 21.2 and 55.4% higher than the pod length at N120, N60 and N0, respectively on the basis of pooled results. Harvest index it is evident from Table-2 that harvest index was not influenced significantly by cropping systems. Increasing N doses caused significant improvement in harvest index up to the level of N120 during pooled results. The pooled data show that N120 dose resulted in 47.29% harvest index which was found 1.10 and 4.31 units more than N60 and N0 levels respectively.

Studies On Potato

Plant height potato in intercropping system attained significantly more plant height than in sole cropping, which might be due to competition with french bean and margin of difference in pooled results remained 3.34 cm or 8.11%. Increase in each N dose resulted in significantly taller plants and thus, plant height maximized significantly at N180 dose. Pooled data show that N180 produced 46.39 cm plant height which was 1.97 cm or 4.43%, 4.11 cm or 9.72% and 8.11 cm or 21.18% higher than plant height at N120, N60 and N0 levels, respectively. Nitrogen use by plants promotes vegetative growth as it is an essential constituent of protein and chlorophyll. (28) has also stated that nitrogen is mainly responsible for promoting the growth of crops. Increase in plant height of potato with increased levels of N application has also been reported by Singh (1974), (12), (25), Gupta 1992) and Dhangal et al. (2001). Dry matter per plant it could affect dry matter significantly only during second year of study when intercropped potato accumulated more dry matter/plant than sole potato by the margin of 0.83 g/plant or 1.14 %. It is, thus proved that potato in intercropping could take some advantage of space for growth and development of plants. Dry matter showed significant increase with increasing N doses up to N120 beyond which increase was not significant in each case of study. On pooled basis, N120 accumulated 76.90 g/plant dry weight which was 2.66 g or 3.58% and 12.38 g/plant or 19.19% higher than dry weight at N60 and N0 levels, respectively. Increase in dry matter per plant due to N application at increased rates has been reported by (16), (32). The response indifferent studies varied form 50 kg to 200 kg N/ha.

Number of tubers per plant among yield contributing characters, number of tubers per plant was not influenced significantly by cropping systems while tuber size reduced in intercropping significantly (Table-3). It indicates that tuber formation was not affected by intercropping while the development of tubers was adversely affected in intercropping system. The adverse effect of french bean on tuber development of potato might be due to teletoxic effect of french bean roots on potato. Similar results have also been reported by (29) in case of potato + mustard intercropping. In earlier stage of tuberization in potato, growth of french bean roots may be limited, thus could not harm the formation of tubers. Application of N increased number of tubers significantly up to N180 during first year and up to N120 during second year and pooling. In pooled results, N120 produced 11.48 tubers/plant which were 1.23 and 2.49 in number or 12.0 and 27.7% more than N60 and N0 levels, respectively. Effect of cropping systems was not found significant on number of tubers per plant. Tuber size tuber size was influenced significantly by cropping systems during first year and in pooling where sole crop produced higher size tuber than intercropping. As number of tubers per plant was not affected by cropping systems, the tuber size might have mainly responsible for more tuber yield per plant. In pooled d.ata, tuber size in sole crop was 235.00 cc which was 6.55 cc or 2.87 % higher than tuber size in intercropping. Increased N doses enhanced tuber size significantly up to N120, dose beyond which a significant reduction in tuber size was observed during first year and in pooling. Thus, pooled data show that N120 dose produced highest size of tubers (248.94 cc) which was 6.30, 21.69 and 40.86 cm. The increase in number of tubers per plant and tuber size with increased N application might be attributed to more absorption of N by plants. The supply of N is related to carbohydrate utilization through proteins formation and simultaneously there is a movement of N in plants from the older parts to the parts where few tissues are being formed. This process of N in plant might be helpful in increasing the number of tubers per plant and mean tuber size at increased rates of N availability. These results are in agreement to those of (15), (10). (34), (4) and (21) who observed significant increase in number of tubers per plant and or tuber size at increased application of N even up to 200 kg N/ha.

Tuber yield per plant potato in sole cropping produced significantly more tuber yield per plant during second year and in pooling while in first year difference was not significant. In sole cropping, 298.94 gm/plant tuber yield was obtained which was 19.47g or 7.00% higher than intercropping. This could be attributed firstly to reduced plant density per unit area of potato in intercropping and secondly to the competition effect with french bean. The roots of french bean

might have released some allelo chemicals having adverse effect on potato as also proved from reduced tuber size in intercropping. These results are in close conformity to those of (1) was observed reduced potato yield in French bean+potato intercropping system than sole potato. (27) and (20) also reported similar results in potato+French bean and sugarcane+French bean intercropping systems, respectively. Increasing N doses caused significant increase in tuber yield/plant up to the application of N120 dose in all cases. It may be seen from pooled data that N120 produced 319.58 g/plant tubers which was 38.55 and 85.03 g/plant or 13.7 and 36.3% higher than N60 and N0 doses, respectively. Though N content in tubers was higher in intercropping but it could not compensate the loss in tuber yields thus, uptake was higher in sole potato. More nutrients uptake in potato due to higher production has also been reported by (26), (32), (33) and (11). Tuber yield per plant is the resultant of number of tubers per plant and mean tuber site. As both these increased at higher N rates, tuber yield per plant was automatically higher at increased rates of N availability. These results are in close conformity to those of Dhangal et al. (2001) who reported significant increase in tuber yield per plant with increasing doses of N application upto 120 kg N/ha in Western Uttar Pradesh condition Yield of potato tubers per hectare it is proved from observations that sole crop of potato yielded significantly much higher tubers than in intercropping. Sole crop produced 241.89 q/ha tubers which was 105.80 q/ha or 77.4% more than tuber yield in intercropping system in pooled data. Nitrogen application with each increasing dose had significant increase in tuber yield up to N120 dose beyond which, though increase was there but, it was not to the level of significance. On pooled basis, N120 produced 209.25 q/ha tubers and it was 25.87 and 60.06 g/ha or 14.11 and 40.26% higher than tuber yields at N60 and N0 doses, respectively. Among different interaction, the effect of only CxN was found significant ton tuber yield of potato during (iv) both individual years and in poling. Hence, the pooled results are presented in Table-3. It is an additive effect where yield trends are similar at increasing rates of N in both cropping systems but rate of yield increase varied. In sole cropping, rate of yield increase due to N application was much higher (26.1%) than intercropping (17.7%) at N60 dose over N0 but at highest dose of N180 over N120, intercropping showed higher rate of increase (2.6%) than sole cropping (1.8%), However, in both systems yield increased significantly only up to N120 dose.

Foliage yield of potato the yield of potato foliage was significantly higher in sole crop than intercropping system and the margin of difference was found 39.41 g/ha or 80.1% on pooled basis over years. The same reasons stand for reduced foliage yield in intercropping systems as to the tuber yield per plant. Increasing N doses caused significant increase in foliage yield up to N120 dose in each case. Pooled data show that N120 produced 71.93 q/ha foliage which was 4.35 and 11.46 q/ha or 6.44 and 18.95% higher than N60 and N0, respectively. Harvest index the result indicated that the effect of only nitrogen application had significant effect on harvest index. Harvest index increased with increasing N levels significantly up to N120 dose during both years and also in pooling. Pooled results show that N120 dose gave harvest index of 74.50% which was found to be 1.14 and 3.00 units per cent more than harvest index recorded at N60 and N0 doses, respectively. It may be explained that rate of increase in tuber yield was higher than rate of increase in foliage yield at increased in foliage yield at increased doses of N application which might be due to the reason that a major part of nutrients was translocated from foliage to tuber at later stage of crop development. It might have caused later stage of crop development. It might have caused more increase in tuber yield at increased supply of nitrogen.

Table-2: Pooled data of characters observed of French bean under main effect of treatment at harvest stage

Character	Sole cropping	Inter-cropping	SEd.+	CD (p=0.05)	N0	N60	N120	N180	SEd.	CD (p=0.05)
PH	45.65	45.78	0.20	NS	42.61	44.64	47.00	48.61	0.32	0.63
NB/P	5.19	5.19	0.09	NS	4.34	5.22	5.58	5.59	0.06	0.12
LA/P	3026.86	2306.37	18.46	38.51	2200.42	2535.83	2944.84	2985.39	19.22	38.06
LAI	9.925	8.065	0.096	0.6435	7.347	8.521	9.964	10.146	0.059	0.116
NP/P	10.56	11.25	0.19	0.39	7.75	9.86	12.56	13.47	0.25	0.49
NG/P	5.20	5.27	0.10	NS	4.16	5.08	5.70	6.00	0.18	0.35
LP	8.20	8.51	0.08	0.16	6.32	6.32	9.18	9.82	0.12	0.24
HI	48.18	45.074	0.30	NS	42.98	46.19	47.29	46.89	0.23	0.46

Table-3: Pooled data of characters observed of French bean under main effect of treatment at harvest stage

Character	Sole cropping	Inter-cropping	SEd.+	CD (p=0.05)	N0	N_{60}	N_{120}	N_{180}	SEd.	CD (p=0.05)
PH	41.17	44.51	0.17	0.36	38.28	42.28	44.42	46.39	0.36	0.71
DMP/P	73.17	73.25	0.26	NS	64.52	74.24	76.90	77.18	0.51	1.01
NT/P	10.67	10.62	0.10	NS	8.99	10.25	11.48	11.88	0.20	0.40
TS	235.00	228.45	2.45	4.69	208.08	227.25	248.94	242.64	2.04	4.04
TYP(gm)	298.94	279.47	2.53	5.28	234.55	281.03	319.58	321.67	3.14	6.22
YTQ/H	241.89	136.09	1.62	3.39	149.19	183.38	209.25	213.55	2.92	5.76
palphaFY/P	88.04	48.63	0.63	1,.32	60.47	67.58	71.93	73.35	0.84	1.66
HI	73.50	73.53	0.15	NS	71.50	73.44	74.50	74.61	0.24	0.47

Conclusion

The results of present investigation could be concluded that, the optimum dose of nitrogen for french bean was found 155.30 kg N/ha for sole crop and 158.61 kg N/ha for intercropping with estimated grain yields of 28.03 and 17.93 q/ha, respectively. The optimum dose of nitrogen for potato was computed as 166.62 kg N/ha for sole cropping and 176.20 kg N/ha for intercropping with respective yield estimates of 276.01 and 152.38 g/ha tubers. No remarkable effect of component crops was observed on each other in intercropping system

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SOIL TEST BASE FERTILIZER RECOMMENDATION BY SOIL FERTILITY RATING FOR MAJOR FIELD CROPS AND VEGETABLES IN UTTAR PRADESH FOR FOOD SECURITY OF INDIA

Ashok Kumar, B.P. dhyani, Satendra Kumar, Yogesh Kumar, S.P. Singh, U.P. Shahi, Ashok Kumar and Bijendra Singh

Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut-250110

Abstract

Production potential of a soil depends upon inherent capacity of soil to supply the nutrients, addition of nutrients through chemical fertilizers and organic and bio-sources. Continuous growing of crop since long time with imbalance use of fertilizers declined its use efficiency. Fertilizer application on the basis of soil testing rating has been the practices of farmers from the inception of green revolution .These recommendation are suitable for medium soil fertility condition irrespective of wide variation that occurs in soil fertility status. Hence under high or low fertility condition application of fertilizer become a wasteful expenditure or insufficient, respectively. In both the cases optimum fertilizer use efficiency cannot be achieved. Fertilizer recommendation on the basis of each value of soil test can be better approach than earlier approach. Under this study regression equation equating different soil test value and nitrogen, phosphorus and potassium dose to be applied in field are developed for different crops .To facilitates the analyst for the easy recommendation ready reckoner was also developed. With the help of equation and ready recknor , fertilizer recommendation for different crops and vegetables for each soil test value will certainly be economically cost effective.

Introduction

India will require more than 333 mt food grain by the end of 2025 to maintain its food security. Agriculture production depends upon soil fertility, climate, genetic material (varieties) and crop management practices. Out of these soils fertility is most important factor. Liebig's law of minimum states that the growth of plant is limited by the plant nutrient element present in the smallest amount, all others being in adequate quantities. From this it can be concluded that knowledge about the nutrients status in soil is essential. Nutrient uptake and removal by crop is influenced strongly by the variety, season, nature and composition of the soil and the yield level. According to an estimate, to produce 4.6 tonnes grains + 6.9 tonnes straw , wheat crop in sub tropical Indian condition absorbed 128 kg N, 46 kg P_2O_5, 219 kg K_2O, 27 kg Ca, 19 kg Mg, 22 kg S, 1.8 kg Fe, 0.5 kg Zn, 0.5 kg Mn and 0.15 kg Cu. Similarly to produce 1 tonne of paddy (rough rice), the rice crop absorbs an average of 20 kg N, 11 kg P_2O_5, 30 kg K_2O, 3 kg S, 7 kg Ca, 3 kg Mg, 675 g Mn, 150 g Fe, 40 g Zn, 18 g Cu, 15 g B, 2 g Mo and 52 kg Si. A Pulse crop like chick pea producing 1.5 tonnes of grain remove 91 kg N, 14 kg P2O5, 60 kg K2O, 18 kg MgO, 39 kg CaO and 9 kg S /ha and 302g Fe, 57g Zn, 105 g Mn and 17g Cu /ha (2) . In subtropical north India, the nutrient removal per tonne of mustard seed was 32.8 kg N, 16.4 kg P_2O_5, 41.8 kg K_2O, 8.7 kg Mg, 42.0 kg , 17.3kg S per hectare and 123 g Fe, 100 g Zn, 95 g Mn and 17g Cu per hectare (2). In the past 50 years, advances in agricultural technology led to a quantum leap in food production of India. However, in many states this intensive crop production has depleted the soil jeopardizing scope of maintaining production in future. With a huge population that is projected to exceed 130 billion by 2050, compounded by competition for land and water resources and the

impact of climate change, our current and future food security depends farmers efforts to increase yields and food quality using the soils that are already under production today. Continuity of cereals based rotation like rice-wheat in recent days without judicious use of chemical fertilizer put agricultural sustainability and environmental safety under trouble. The response to fertilizers use has decreased from 17 kg grain /kg nutrient in 1951 to 5-6 kg grains/kg nutrients during 2017-18, which ideally should be in the range of 18-25 kg kg-1 nutrient. Data from farmers' fields (1999-2003) showed cereals responding around 8-10 kg grain kg-1 fertilizer (average). Traditional practices of organic manuring and growing of soil fertility restoring crops are no more in practice while nutrient outflows through intensive crop production indicated an apparent negative balance of nearly 10 million tons at the national level. The recovery of fertilizer nutrients is about 20-40, 15-20 and 40-50% for N, P and K, respectively while for secondary and micronutrients, it is substantially low ranging 5-12%. Major factors contributing to the low and declining crop responses to fertilizer nutrients are continuous nutrient mining from the soil due to imbalanced nutrient use (6:2.9:1 NPK) leading to depletion of some of the major, secondary and micro nutrients like N, K, S, Zn, Mn, Fe, B etc. Limited application of organic sources of nutrients such as FYM, compost and integration of green manures in the cropping systems leading to serious soil degradation qualitatively(1). Site specific nutrient management and use of customized fertilizers integrated with organic sources could be the best option to minimize the multi nutrient deficiencies and similar problems arising due to application of imbalance chemical fertilizers and maximize the sustainability and farmers income by reducing the cost of production and finally food security of India (6).

Soil testing has been accepted as an unique tool for rational fertilizer use. It helps to assess the soil fertility status and recommend suitable and economic nutrient dose through chemical fertilizer and organic manure for different crops and cropping system (5). The soil testing and fertility management practices could be best option for sustaining crop production and balanced fertilization in Indian agriculture. Balanced fertilization is a key input for achieving the estimated food grain production goal of the country. A farmer who follows only the soil test based fertilizer recommendations is assured of a good crop. Soil testing is essential and is the first step in obtaining high yields and maximum returns from the money invested in fertilizers. Several workers have documented many fertilizer adjustment equation for different crops under different climatic condition to prescribe the fertilizers .To facilitate the soil test laboratory of the Uttar Pradesh a ready reckoner and an equation for prescription of fertilizers is highly required . Present study is an attempt to develop equations and ready reckoner for different crops to prescribed fertilizers especially nitrogen, Phosphorus and potash on the basis of soil test.

Material and Methods

Fertilizer recommendation by soil fertility rating concept has been used for the development of equations and ready reckoner for different crops and vegetables grown in Uttar Pradesh under this study. Generally fertilizer recommendations are based on multi location trials conducted with different dose of N,P,K fertilizers and their economic evaluation obtained at an optimum dose of a particular crop (Table-1-3).These recommendation are suitable for medium soil fertility condition irrespective of wide variation that occurs in soil fertility status . Hence under high or low fertility condition, the applied nutrients often prove to be wasteful expenditure or insufficient, respectively. In both the cases optimum fertilizer use efficiency cannot be achieved. In this approach , medium soil fertility is equated with general recommended dose (GRD) .Soil test rating based on soil fertility evaluation experiment(Muhr et al., 1965) are present in Table-4. Soil testing provides information regarding nutrients availability in soil which forms the basis for the fertilizer recommendation for maximizing crop yield. On the basis of soil testing results, the recommended fertilizer dose for the crop are modified for making fertilizer recommendations to the farmers. At low nutrients level (Table.4), the recommended fertilizer dose for the crop is increased by 25 % of general recommended dose (GRD), at medium level the GRD is recommended as such and at higher level of nutrient recommended dose is reduced by 25 % (3). However some states like Maharashtra is following 6 classes of the nutrient status (Table 5) Based on these classes the fertilizer dose for

different crops and vegetables grown in Uttar Pradesh have been estimated over general recommended doses and presented in table 6-8.

Table-1. General recommended dose for nitrogen for different crops and vegetables grown in Uttar Pradesh

S.No	Crops and Vegetables	GRD N
1	Sugar Cane , Hybrid tomato	180
2	Wheat, late potato, Hybrid paddy, Mentha	150
3	High yielding paddy, Hybrid maize, Composite maize, Mustard, Rajma, Timely potato, cauliflower	120
4	Basmati paddy, Desi maize, hybrid bajra, toria, tomato (high yield variety), onion, garlic okra, brinjal	100
5	Hybrid Jawar, Late wheat, yellow mustard	80
6	Barley	60
7	Deshi Bajra	50
8	Till	30
9	Ground Nut, soybean, Gram, Lentil, Pea, Arhar, Moong, Urd	20

Table-2. General recommended dose for Phosphorus for different crops and vegetables grown in Uttar Pradesh

S.No	Crops and Vegetables	GRD (Kg/ha)	
		P_2O_5	P
1	Sugar Cane , Hybrid tomato, Soybean	80	35
2	Hybrid paddy	75	32.8
3	Hybrid maize, composite maize, wheat, mustard, Gram, Lentil, Pea rajma, Mentha, potato, tomato (high yield variety), cauliflower, onion, garlic	60	26.2
4	Toria, okra, brinjal	50	21.8
5	Arhar	45	19.7
6	Basmati Paddy, Bajra, hybrid Jawar, Urd, Moong, Late wheat, Yellow mustard	40	17.5
7	Groundnut, Barley,	30	13.1
8	deshi Bajra,	25	10.9
9	Till	15	6.5

Table-3. General recommended dose for Potassium for different crops and vegetables grown in Uttar Pradesh

S.No	Crops and vegetables	GRD (Kg/ha)	
		K2O	K
1	Sugarcane, Late Potato, Hybrid Tomato	100	83.3
2	Timely Potato, high yielding Tomato, cauliflower	80	66.7
3	Hybrid Paddy	75	62.5
4	High yield Paddy, Maize hybrid & Composite, Mustard, Onion, Garlic	60	50.0
5	Toria, Okra, Brinjal	50	41.7
6	Groundnu	45	37.5
7	Maize local, Bajra Hybrid, Soybean, Wheat, Yellow mustard, Pea, Mentha	40	33.4
8	Paddy basmati, Rajma,	30	25.0
9	Deshi Bajra, Till,	25	20.8
10	Hybrid Jawar, Arhar, Moong , Urd, Barley, Gram, Lentil	20	16.7

Table-4. Rating limits for soil test values used in India

Parameters	Rating of soil		
	Low	Medium	High
Organic Carbon (%)	>0.50	0.50-0.75	> 0.75
Available N (Kg/ha)	>280	280-560	>560
Available P (Kg/ha)	>12.5	12.5-25	>25
Available K(Kg/ha)	>135 (Deficient)	135-335 (Sufficient)	>335
Recommendation	125% of GRD	100 % of GRD	75 % of GRD

Table-5. Rating limits for soil test values used in Maharashtra

Parameters		Rating of soil				
	Very low	Low	Medium Low	Medium	High	Very high
Organic Carbon (%)	<0.20	0.21-0.40	0.41-0.6	0.61-0.8	0.81-1.0	>1.0
Available N (Kg/ha)	<140	141-280	281-420	421-560	561-700	>700
Available P (Kg/ha)	<7.0 (<16)	7-14 (16-32)	14-21 (32-48)	21- 28 (48-64)	28-35 (64-80)	>35 (>80)
Available K(Kg/ha)	>100 (>120)	101-150 (121-180)	151-200 (181-240)	200-250 (241-300)	251-300 (301-360)	>301 (>360)
Recommendation	150 -140 % 0f GRD	140-120-% f GRD	120-101 % of GRD	100-80 % of GRD	80-50 % of GRD	< 50 % of GRD

(Methods Manual, 8)

Results and Discussion

Higher dose of fertilizer application at higher level of fertility is wasteful expenditure while inadequate recommendation at low fertility level may lead to yield loss. To improve income by avoiding extra expenditure or yield loss soil has been classified into 6 classes (Table 5) .Fertilizer dose for different crops have been calculated on the basis of 6 classes and presented in Table 6-8. Fifty percent fertilizer is either extra recommended or reduced with the very low or very high soil fertility.

Data presented in Table 6 shows that soil test value of OC (%) is inversely related with fertilizer dose for nitrogen. Additional 50 % nitrogen is recommended over GRD if the OC level is very low while 50 % nitrogen over GRD is reduced at very high level of OC . A regression equation was developed between OC (%) and dose of nitrogen to be applied in a crop. Different equation for estimation of dose for nitrogen and test value of OC (%) are presented in table 9. Through the equation we can calculate the dose of nitrogen required for a crop. Similar equation were developed by several workers (4, 7, 9).

Similarly data presented in Table 7 shows that soil test value of available P_2O_5 kg /ha is inversely related with fertilizer dose for phosphorus. Additional 50 % P_2O_5 is recommended over GRD with low available P_2O_5 while 50 % P_2O_5 is reduced over GRD with very high available P_2O_5. A regression equation was also developed between available P_2O_5 kg/ha and dose of phosphorus to be applied in a crop. Different equation for estimation of dose for phosphorus and available P_2O_5 kg/ha are presented in table 10. Through the equation we can calculate the dose of phosphorus required for a crop. Similar equation were developed by several workers (4, 7, 9).

Similarly data presented in Table 8 shows that soil test value of available K_2O kg /ha is inversely related with fertilizer dose for potassium . Additional 50 % K_2O is recommended over GRD with low available K2O while 50 % is reduced over GRD with high available K_2O. A regression equation was developed between available K kg/ha and dose of potassium to be applied in a crop. Different equation for estimation of dose for potassium and available K kg/ha are presented in table 11. Through the equation we can calculate the dose of potassium required for a crop. Similar equation were developed by several workers (4, 7, 9).

Table 6. Nitrogen Recommendation (Kg/ha) in different crops and Vegetables on the basis of Soil test report of OC (%) grown in Uttar Pradesh

OC %	Recommendation (% of GRD)	S Cane, Tomato Hybrid	wheat, Late Potato, Hybrid paddy , Mantha	Paddy high yield , Hybrid Maize / composite, Mustard, Rajma , Timely Potato, Cauliflower	Basmati Paddy , Maize, Hhybrid Bajra , Toria , Tomato high yield , Onion Garlic , Okra, Brinjal	Hybrid Jawar, late Wheat, Yellow Mustard	Barley	Deshi Bajra	Till	Groundnut , Soybean, Gram, Lentil, Pea, Arhar , Moong, Urd
		180 kg/ha	150 kg/ha	120 kg/ha	100 kg/ha	80 kg/ha	60 kg/ha	50 kg/ha	30 kg/ha	20 kg/ha
0.1	150	270	225	180	150	120	90	75	45	30
0.2	140	252	210	168	140	112	84	70	42	28
0.3	130	234	195	156	130	104	78	65	39	26
0.4	120	216	180	144	120	96	72	60	36	24
0.5	110	198	165	132	110	88	66	55	33	22
0.6	100	180	150	120	100	80	60	50	30	20
0.7	90	162	135	108	90	72	54	45	27	18
0.8	80	144	120	96	80	64	48	40	24	16
0.9	70	126	105	84	70	56	42	35	21	14
1	60	108	90	72	60	48	36	30	18	12
1.1	50	90	75	60	50	40	30	25	15	10
1.2	40	72	60	48	40	32	24	20	12	8
1.3	30	54	45	36	30	24	18	15	9	6
1.4	20	36	30	24	20	16	12	10	6	4
1.5	10	18	15	12	10	8	6	5	3	2

Table 7. Phosphorus Recommendation (Kg/ha) in different crops and vegetables on the basis of Soil test report of P /P_2O_5 kg/ha grown in Uttar Pradesh

P kg/ha	P_2O_5 Kg /ha	Recommendation (% of GRD)	Sugarcane, Soybean, Hybrid Tomato,	Hybrid Paddy,	Hybrid Maize /composite/ simple, Wheat, Mustard, Gram, Lentil, Pea, Rajma, Mentha, Potato, Tomato high yield , Cauliflower, Onion, Garlic,	Toria, Okra , Brinjal	Arhar	Basmati Paddy, Bajra Hybrid Jwar, Urd, Moong, Late wheat, Yellow Mustard,	Groundnu, Barley	Deshi Bajra	Till,
			80kg/ha	75kg/ha	60kg/ha	50kg/ha	45kg/ha	40kg/ha	30kg/ha	25kg/ha	15kg/ha
1	2.29	150	120	112.5	90	75	67.5	60	45	37.5	22.5
2	4.59	147.5	118	110.625	88.5	73.75	66.375	59	44.25	36.875	22.125
3	6.88	145	116	108.75	87	72.5	65.25	58	43.5	36.25	21.75
4	9.18	142.5	114	106.875	85.5	71.25	64.125	57	42.75	35.625	21.375
5	11.47	140	112	105	84	70	63	56	42	35	21
6	13.76	137.5	110	103.125	82.5	68.75	61.875	55	41.25	34.375	20.625
7	16.06	135	108	101.25	81	67.5	60.75	54	40.5	33.75	20.25
8	18.35	132.5	106	99.375	79.5	66.25	59.625	53	39.75	33.125	19.875
9	20.65	130	104	97.5	78	65	58.5	52	39	32.5	19.5
10	22.94	127.5	102	95.625	76.5	63.75	57.375	51	38.25	31.875	19.125
11	25.23	125	100	93.75	75	62.5	56.25	50	37.5	31.25	18.75
12	27.53	122.5	98	91.875	73.5	61.25	55.125	49	36.75	30.625	18.375
13	29.82	120	96	90	72	60	54	48	36	30	18
14	32.12	117.5	94	88.125	70.5	58.75	52.875	47	35.25	29.375	17.625
15	34.41	115	92	86.25	69	57.5	51.75	46	34.5	28.75	17.25
16	36.7	112.5	90	84.375	67.5	56.25	50.625	45	33.75	28.125	16.875
auto17	39	110	88	82.5	66	55	49.5	44	33	27.5	16.5
18	41.29	107.5	86	80.625	64.5	53.75	48.375	43	32.25	26.875	16.125
19	43.5	105	84	78.75	63	52.5	47.25	42	31.5	26.25	15.75
20	45.88	102.5	82	76.875	61.5	51.25	46.125	41	30.75	25.625	15.375
21	48.17	100	80	75	60	50	45	40	30	25	15
22	50.47	97.5	78	73.125	58.5	48.75	43.875	39	29.25	24.375	14.625
23	52.76	95	76	71.25	57	47.5	42.75	38	28.5	23.75	14.25
24	55.06	92.5	74	69.375	55.5	46.25	41.625	37	27.75	23.125	13.875
apdefault25	57.35	90	72	67.5	54	45	40.5	36	27	22.5	13.5
26	59.64	87.5	70	65.625	52.5	43.75	39.375	35	26.25	21.875	13.125
27	61.94	85	68	63.75	51	42.5	38.25	34	25.5	21.25	12.75
28	64.23	82.5	66	61.875	49.5	41.25	37.125	33	24.75	20.625	12.375
29	66.53	80	64	60	48	40	36	32	24	20	12
30	68.82	77.5	62	58.125	46.5	38.75	34.875	31	23.25	19.375	11.625
31	71.11	75	60	56.25	45	37.5	33.75	30	22.5	18.75	11.25
32	73.41	72.5	58	54.375	43.5	36.25	32.625	29	21.75	18.125	10.875
33	75.7	70	56	52.5	42	35	31.5	28	21	17.5	10.5
34	78	67.5	54	50.625	40.5	33.75	30.375	27	20.25	16.875	10.125
35	80.29	65	52	48.75	39	32.5	29.25	26	19.5	16.25	9.75
36	82.58	62.5	50	46.875	37.5	31.25	28.125	25	18.75	15.625	9.375
37	84.88	60	48	45	36	30	27	24	18	15	9

Table 8. Potassium Recommendation (Kg/ha) in different crops and vegetables on the basis of Soil test report of K/ K_2O kg/ha grown in Uttar Pradesh

K Kg/ha	K_2O kg/ha	Recommendation (% of GRD)	Sugarcane , late Potato, Hybrid Tomato	Timely Potato, Tomato high yield , cauliflower	Paddy Hybrid	Paddy high yield, Maize hybrid & Composite , Mustard, Onion, Garlic	Toria , Okra, Brinjal	Ground nut	Maize local, Bajra Hybrid, Soybean, Wheat, Yellow Mustard , Pea, Mentha	Paddy basmati , Rajma,	Deshi,Bajra Till,	Hybrid Jawar, Arhar, Moong , Urd, Barley, Gram, Lentil
			100kg/ha	80kg/ha	75kg/ha	60kg/ha	50kg/ha	45kg/ha	40kg/ha	30kg/ha	25kg/ha	20kg/ha
83	100	150	150	120	112.5	90	75	67.5	60	45	37.5	30
92	110	145.5	145.5	116.4	109.125	87.3	72.75	65.475	58.2	43.65	36.375	29.1
100	120	142	142	113.6	106.5	85.2	71	63.9	56.8	42.6	35.5	28.4
108	130	138.5	138.5	110.8	103.875	83.1	69.25	62.325	55.4	41.55	34.625	27.7
117	140	135	135	108	101.25	81	67.5	60.75	54	40.5	33.75	27
125	150	131.5	131.5	105.2	98.625	78.9	65.75	59.175	52.6	39.45	32.875	26.3
133	160	128	128	102.4	96	76.8	64	57.6	51.2	38.4	32	25.6
142	170	124.5	124.5	99.6	93.375	74.7	62.25	56.025	49.8	37.35	31.125	24.9
right150	180	121	121	96.8	90.75	72.6	60.5	54.45	48.4	36.3	30.25	24.2
158	190	117.5	117.5	94	88.125	70.5	58.75	52.875	47	35.25	29.375	23.5
167	200	114	114	91.2	85.5	68.4	57	51.3	45.6	34.2	28.5	22.8
175	210	110.5	110.5	88.4	82.875	66.3	55.25	49.725	44.2	33.15	27.625	22.1
183	220	107	107	85.6	80.25	64.2	53.5	48.15	42.8	32.1	26.75	21.4
192	230	103.5	103.5	82.8	77.625	62.1	51.75	46.575	41.4	31.05	25.875	20.7
200	240	100	100	80	75	60	50	45	40	30	25	20
208	250	96.7	96.7	77.36	72.525	58.02	48.35	43.515	38.68	29.01	24.175	19.34
217	260	93.4	93.4	74.72	70.05	56.04	46.7	42.03	37.36	28.02	23.35	18.68
225	270	90.1	90.1	72.08	67.575	54.06	45.05	40.545	36.04	27.03	22.525	18.02
233	280	86.8	86.8	69.44	65.1	52.08	43.4	39.06	34.72	26.04	21.7	17.36
242	290	83.5	83.5	66.8	62.625	50.1	41.75	37.575	33.4	25.05	20.875	16.7
250	300	80.2	80.2	64.16	60.15	48.12	40.1	36.09	32.08	24.06	20.05	16.04
258	310	76.9	76.9	61.52	57.675	46.14	38.45	34.605	30.76	23.07	19.225	15.38
267	320	73.6	73.6	58.88	55.2	44.16	36.8	33.12	29.44	22.08	18.4	14.72
275	330	70.2	70.2	56.16	52.65	42.12	35.1	31.59	28.08	21.06	17.55	14.04
283	340	66.9	66.9	53.52	50.175	40.14	33.45	30.105	26.76	20.07	16.725	13.38
292	350	63	63	50.4	47.25	37.8	31.5	28.35	25.2	18.9	15.75	12.6
300	360	60	60	48	45	36	30	27	24	18	15	12

Table 9. Regression equation between soil test value of OC % and dose of N kg/ha for different crops

S.No	Crops and Vegetables	Equation
1	Sugar Cane , Hybrid tomato	Y= -180X+288
2	Wheat, late potato, hybrid paddy, mentha	Y= -150X+240
3	High yielding paddy, hybrid maize, composite maize , mustard , rajma , Timely potato, cauliflower	Y= -120X+192
4	Basmati paddy, desi maize, hybrid bajra , toria , tomato(high yield variety) , onion, garlic okra, brinjal	Y= -100X+160
5	Hybrid Jawar, Late wheat , yellow mustard	Y= -80X+128
6	Barley	Y= -60X+96
7	Deshi Bajra	Y= -50X+80
8	Till	Y= -30X+48
9	Ground Nut, soybean, Gram, Lentil ,Pea, Arhar , Moong , Urd	Y= -20X+32

Table 10. Regression equation between soil test value of available phosphorus kg/ha and dose of P_2O_5 kg/ha for different crop

S.No	Crops and Vegetables	Equation
1	Sugar Cane , Hybrid tomato, Soybean	Y= -0.8718X+122
2	hybrid paddy	Y= -0.8173X+114.37
3	hybrid maize, composite maize, wheat , mustard , Gram , Lentil, Pea rajma, Mentha. potato, tomato(high yield variety),cauliflower, onion, garlic	Y= -0.6539X+91.50
4	toria, , okra, brinjal	Y= -0.5449X+76.25
5	Arhar	Y= -0.4904X+68.62
6	Basmati Paddy, Bajra, hybrid Jawar, Urd, Moong, Late wheat , Yellow mustard	Y= -0.4359X+61.00
7	Groundnut, Barley,,	Y= -0.3269X+45.75
8	deshi Bajra ,	Y= -0.2724X+38.12
9	Till	Y= -0.1635X+22.88

Table 11. Regression equation between soil test value of available potassium kg/ha and dose of K_2O kg/ha for different crop

S.No	Crops and vegetables	Equation
1	Sugarcane, Late Potato, Hybrid Tomato	Y= -0.3428X+182.92
2	Timely Potato, high yielding Tomato, cauliflower	Y= -0.2743X+146.34
3	Hybrid Paddy	Y= -0.2571X+137.19
4	High yield Paddy, Maize hybrid & Composite, Mustard, Onion, Garlic	Y= -0.2057X+109.7
5	Toria, Okra, Brinjal	Y= -0.1714X+91.46
6	Groundnu	Y= -0.154X+82.31
7	Desi Maize, Bajra Hybrid, Soybean, Wheat, Yellow mustard, Pea, Mentha	Y= -0.137X+73.17
8	Paddy basmati, Rajma,	Y= -0.1029X+54.87
9	Deshi Bajra, Till,	Y= -0.0857X+45.73
10	Hybrid Jawar, Arhar, Moong , Urd, Barley, Gram, Lentil	Y= -0.0686X+36.59

Conclusion

To facilitate the soil test laboratory of the Uttar Pradesh a ready reckoner and equation for prescription of fertilizers especially for nitrogen, phosphorus and potassium based on each soil test value may be economically useful . By the use of these equation and ready reckonear fertilizer use efficiency for different crops may be improved.

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MEASUREMENT OF VIABILITY FOR DIFFERENT PADDY SEED VARIETIES WITH HELP OF ELECTRICAL CONDUCTIVITY

Anuj Yadav[1]*, Amarjeet Singh[2], Shusheel Kumar[3], Vishal Kumar[4]

[1, 4]Swami Vivekanand Subharti University, Meerut
[2, 3]Chaudhary Charan Singh University (Meerut)
***Corresponding Author: Email**- anuj.0720@gmail.com

Abstract

Viability of paddy seeds was found to be critically influenced by electrical conductivity for freshly harvested seeds at different level of electrical conductivity. When electrical conductivity of seeds dropped blow 2 milli siemen viability starts to increase and 4.02 milli siemen seeds become virtually nonviable. The present study thereby conform the recalcitrant nature of paddy seeds step in retention of paddy seed viability. As such, if the initial electrical conductivity is high, germination may take place during storage it self, and if too low the final seed electrical conductivity in a particular treatment may fall blow the desirable electrical conductivity range resulting in the higher viability. From the present study it was concluded that improved storability of paddy seeds under ambient temperature is possible by maintaining a proper seed seed moisture content. Result were also found that basmati genotype having highest viability of paddy seeds and moderate value of viability was shown by Ratna and lowest shown by Gainda Paddy seed when higher value of electrical conductivity of Gainda.

Key words: Paddy seeds, Electrical Conductivity test, Seed viability, Time, Temperature.

Introduction

In early year of the twentieth century, as the result of beginning of agricultural research a few improved strains of paddy, wheat, groundnut and sugarcane came in to existence. The state department of agriculture adopted two methods for distribution of seeds of the improved veritiesIn the first method the seeds of improved verities multiplied at one location and distributed a large area so that the area under local varieties could be replaced by improved verities.In second method seeds were distributed in small packets to the maximum number of farmers and it was expected that farmer would multiply their own seeds.However when the second method were tried in Bengal by distributing packet of rice and jute seeds, it was found that this did not increase the spread or coverage under new strain.As a result the practice was discontinued and attention was concentrated only on the first methods. In united provinces the responsibility for replacing old verities was placed on the state department of Agriculture. Several seed multiplication laboratories were set up in the state to achive these goals. The seed multiplied at these laboratories were further multiplied on the farms of landlords. This marked the beginning of the distribution of good quality. Seed viability denote the degree to which a seed is alive, metabolically active, processing germination power and seedling growth. A seed may contain both dead and live portion. In case of conductivity poor germination of seeds in the field is the leakage of metabolites (Nutrient) from deteriorated seeds in water and with the result these are not available for the germination seedswhen such seeds was soaked in distilled water and electricity was passed through , they show higher electrical conductance in comparison to the vigorous seeds due to high concentration ion present in water.

A practical index of salinity is called electrical conductivity, expressed in the milli siemen. An approximate relation because it also depend upon specific ionic composition between electrical conductivity and total salt concentration 1ds = 10mmol. Electrical conductivity values are always expressedat a standard temperature of 25ºC to enable comparison of ready taken varying climatic conditions. Using electrical conductivity as an index of salinity emphasizes the concept, as a good first approximation, seeds respond primarily to total concentration of salt rather then to the concentration or proportion of individual salt concentration. (6, 7, 8, 11) reported that the electrical conductivity test measures the amount of electrolytes which leach from seeds during imbibition. There is a need for the development of rapid seed quality tests that determine viability (defined as the viability to germinate) without the necessity for completion of germination. (12) reported that electrical conductivity (EC) has been evaluated as a possible method for measuring viability and seedling vigour in paddy and other crops.

Role of Electrical Conductivity

The electrical conductivity of most water sources was below 0.7 milli siemen which does not pose a salinity problem however some drain water sources, may contribute to seed salinity problem. Field water and seed electrical conductivity level increase significantly from sample to sample Basmati to Gainda. Paddy yield decreased with increase in electrical conductivity and were significantly lower in samples basins. Seedling density biomass decreased with increase in Electrical conductivity. (2, 3, 4, 5, 9, 10) reported that the increase in conductivity has been found to be correlated with the decrease in germinationand seed vigour in several crop.A direct correlation between electrical conductivity and seed viability has been reported by several researchers. As seed vigorous decline with age, the ability of the seed to retain solutesalso reduces.In some paddy samples the electrical conductivity was high enough in the samples Gainda that seedling establishment and growth were greatly affected. This was observed in several higher electrical conductivity samples.Most of the problems of samples associated with higher electrical conductivitydrain water sources. Rice surplus problem in the past have forced Thiwan's rice growers to focus on improved rice quality through cultivation techniques. Site specific or field specific fertilizer management for rice is a good way to helping farmer to apply fertilizer to their fields rationally. Through the implementations of this technology rice quality can be improved and environment protected.

According to (1) the following data were observed for good health of paddy seeds

Water Classes	Electrical conductivity ds/m	Salt concentration mg/l	Type of water
Non-saline	0.7	500	Drinking and irrigated water
Slightly-saline	0.7 – 2	500-1500	Irrigation water
Moderately-saline	2 – 10	1500 – 7000	Secondary
Highly-saline	10-25	7000-15000	Very Saline ground water
Very Highly-saline	25-45	15000-35000	Vary saline ground water
Brine	>45	>45000	Seawater

Materials and Methods

Freshly harvested seeds of seven genotype of paddy were collected from the Meerut district (U.P.). To determine the relationship between viability of seeds and electrical conductivity of seeds. Seeds were soaked in distilled water at temperature 30±1ºC in 2:1 ratio (distilled water and seeds) in the 250 ml beakers. Seeds were divided in to seven genotype of paddy seeds. Each reading of electrical conductivity was taken at 24, 48 and 72 hours.

Calibration of Electrical Conductivity Meter

Electrical conductivity meter was set at definite Electrical Conductivity in 1407 milli siemen unit. For this process the electrical conductivity of the standard Potassium Chloride solution having 0.02 M, Molarity at the same temperature 25ºC is also set and solution having different paddy genotypes the electrical conductivity was measure of every sample.

Viability in paddy seeds soaked in distilled water is characterized as the total content of dissolved and organic and inorganic solute. It is conventionally determined by measuring the electrical conductivity. The electrical conductivity is a measurement of ability of a salt solution to carry electric current by the migration of ions under the influence of an electric field ions are the carrier of electricity. Increase in the temperature also promotes dissociation of the salt with consequent rise in temperature promotes dissociation of the salts with consequent rise in conductivity at the rate of approximately 2% of each degree Celsius rise in the temperature. At infinite dilution, the ions are theoretically independent to each other and each ion has its contribution to the total conductance.

Thus, *a* ( ) ( )

Where *a* is a total conductance

is conductance of cations

is the conductance of ions at infinite solutions

The test solution is filled in a conductivity cell, which is usually made out for two platinum sheets embedded in glass so that the two surface facing to each other remain exposed. The area and distance between these plates must remain constant.

The cell constant k, of a conductivity cell is determined by measuring the electrical conductance of a standard KCL at the same temperature according to the equation:

k L C

Where L and C are the known specific electrical conductance and measured conductance of a standard solution (usually 0.02M KCL) in the given cell is milli siemen.

Result and Discussion

Viability of paddy seeds was found to be critically influenced by electrical conductivity of fresh harvested seed at different level of electrical conductivity but when the electrical conductivity of seed dropped blow 2milli siemen viability started to increased and at 4.02 milli siemen seeds became virtually nonviable. Electrical conductivity is an important factor of viability of seed, because when electrical conductivity dropped blow a critical level seeds start to deteriorate but when the electrical conductivity exceeds a optimum level, viability decreased. As such if the initial seed electrical conductivity is high, germination, may take place during itself, and if too low the final seed electrical conductivity in a particular treatmentmay fall below the desirable electrical conductivity range in higher viability. The germ inability and subsequent growth of the cracked and sprouted seed was, however as good as non germinated viable seed. From the present study it was concluded that improved storability of paddy seed under ambient condition is possible by maintaining proper seed moisture content and controlling microbial spoilage.

Results also show that Basmati genotype having highest viability of paddy seeds and moderate value of viability was showed by Ratna and lowest shown by Gaind paddy seed.

Electrical conductivity of different varieties of paddy seed at different time interval

S. No	Name of Verities	Electrical conductivity at different time interval in ms/m		
		24 hour	48 hour	72 hour
1.	Basmati	1.89	2.44	2.54
2	Parmal	2.40	2.66	2.70
3	Ratna	2.45	3.24	3.33
4	Basmati Bona	2.48	2.83	2.93
5	Sarvati	2.66	3.84	3.92
6	Tildar	3.16	3.91	3.78
7	Gainda	3.14	4.04	4.10

Decreasing order of Viability

Basmati>Parmal>Ratna>Basmati Bona>Sarvati>Tildar>Gainda

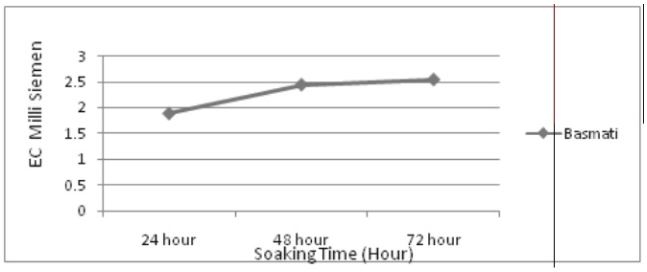
ANOVA for Electrical conductivity of different varieties of paddy seed at different time interval

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	5.582581	6	0.93043	26.31047	3.072115	2.996112
Columns	2.310971	2	1.155486	32.67454	0.0000139	3.885294
Error	0.424362	12	0.035363			
Total	8.317914	20				

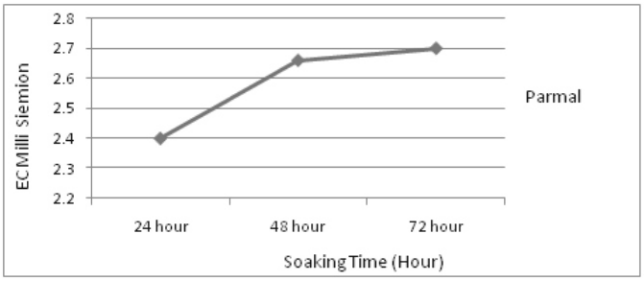
Raw: Verities

Colum: Time in Hour

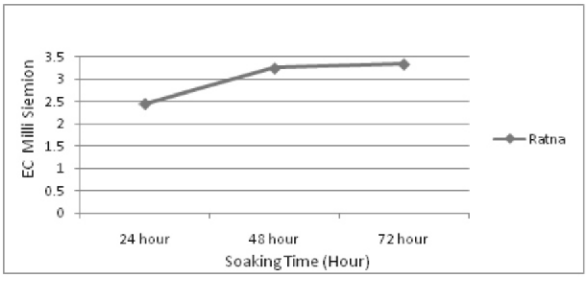
Electrical Conductivity of different paddy varities with different time interval show by graph



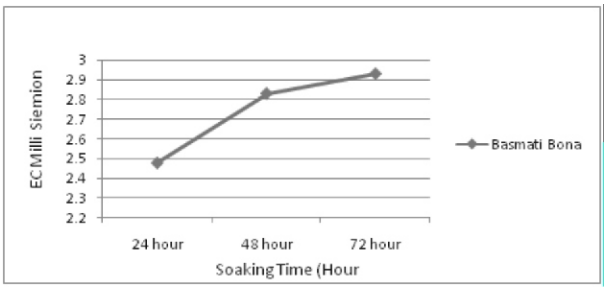
Electrical Conductivity of Basmati Verities in Different Time interval



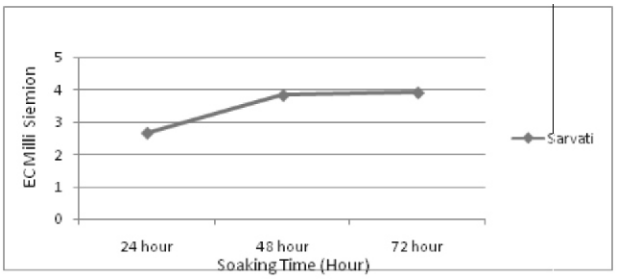
Electrical Conductivity of Parmal Verities in Different Time interval



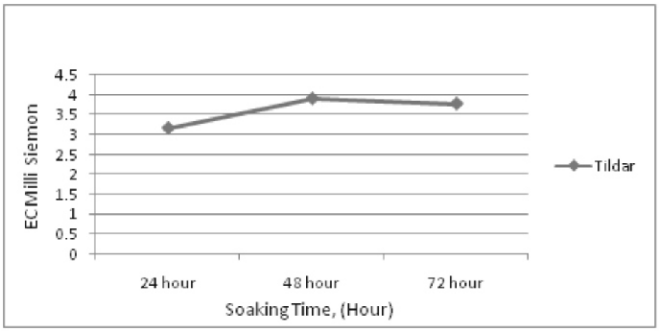
Electrical Conductivity of Ratna Verities in Different Time interval



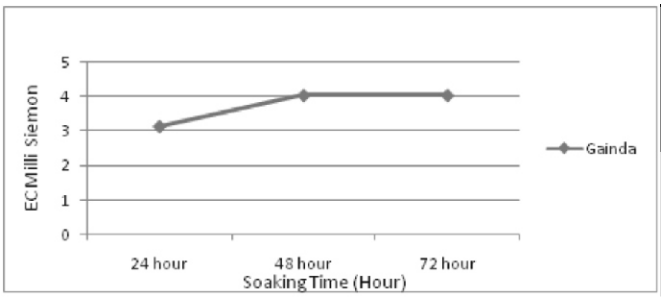
Electrical Conductivity of Basmati Bona Verities in Different Time interval



Electrical Conductivity of Sarvati Verities in Different Time interval



Electrical Conductivity of Tildar Verities in Different Time interval



Electrical Conductivity of Gainda Verities in Different Time interval

Conclusion

In the view of present study different conclusion have been drawn electrical conductivity and viability of paddy seeds inversely proportional to each other.The different genotype (7 varieties) having different electrical conductivity level.Basmati variety is the most viable among all genotype.Gainda having higher electrical conductivity level and lower viability.Basmati is most viable having strong bond in the paddy constituents.Lower viability show by Tildar and Gainda genotype means, week bonds among the seeds constituents. Electrical conductivity was affected by early and late type of varieties.

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AN EVALUATION OF MICROFINANCE IN INDIA A STUDY WITH SPECIAL REFERENCE TO JOINT LIABILITY GROUP (JLG)

Aditya Singh[1]* and Chaman Prakash Sharma[2]

[1]College of Horticulture, SVPUA&T, Meerut
[2]Dept. of Economics, Ch. Charan Singh University, Meerut
***Corresponding Author: Email**- adi9219@gmail.com

Abstract

The National Bank for Agriculture and Rural Development (NABARD) has launched a Joint Liability Group scheme in 2004-05, to help the people like tenant farmers, sharecropper, oral lessees, etc, through formal banking system.The members should be homogeneous; both in terms of activities and in terms of the risk associated with such activities. The main aim of Joint Liability Group has been to facilitate mutual loan guarantee and implementation of joint liability agreement, making the members personally and jointly liable for payment of interest and loan obtained from the bank. The members should be integrated in their behaviour with honesty to repay the loans. India is home to almost one third of the world's poor, though many poverty alleviation programs are currently active in India, by central government and state government. Microfinance plays a major role in alleviating poverty and financial inclusion. In the past few decades, it has helped remarkably in eradicating poverty. Microfinance is not just about giving micro credit to the poor rather it is an economic development tool that's objective is to assist poor to come out of poverty. The main form of group-based credit is Self Help Group Bank Linkage Programme (SHG-BLP) and Joint Liability Group (JLG).This paper discusses about the Joint Liability Groups, and difference between SHG-BLP and JLG model. The JLGs have been presented in number and in percentage in this research paper region-wise and state-wise from 2010-11 to 2018-19. Loan sanctioned by banking sector to JLGs, region wise and state wise have been shown in percentage from 2010-11 to 2018-19.

Keywords: Joint Liability Groups, Poor, Microfinance, Percentage.

Joint Liability Group

India is an agrarian economy and even today more than sixty percent of the country's population depends on agriculture directly and indirectly. Agricultural related class resides in rural India. Out of the total farming, community more than eighty percent farmers are small and marginal farmers and they are economically poor. Due to this, they are below the poverty line and are financially and socially backward. Therefore, they do not get the benefits of national economic policies. To improve their status, they require economical help from Government banks and financial institutions. According to Noble Prize winner Amartya Sen, poverty is not only insufficient but also the absence of full capabilities, including security, and ability to participate in economic and political systems.

History of Joint Liability Group in India (JLG)

Provides institutional credit to small and marginal farmers, tenant farmers, and sharecroppers the National Bank for Agriculture and Rural Development (NABARD) has launched a Joint Liability Group scheme in 2004-05. This project was started in the form of a pilot project by NABARD in eight states with the support of thirteen Regional Rural Banks. Next two years, it spreads to all states and regions in India. JLG is an informal group consisting of minimum four to maximum 10 individual members but with the permission of particular bank number can be increased to 20 in exceptional case, they coming together for availing bank loan through group mechanism against mutual guarantee. To provide loans to such groups, NABARD will provide grants-in-aid to State Cooperative Banks and Regional Rural Banks for the formation and financing of the JLG. The members of the JLGs normally live in the same neighborhood or in the same village and are from the same socio-economic background and environment. They may be mostly engaged in the same production activities and are expected to know and trust each other well. The flexibility of the system, simplicity of documentation and cheaper credit seems to entice the potential borrower to this approach.

Joint Liability Group Models

Banks can finance the JLGs by adopting any one of the following two models:

Model: A-Financing Individuals in the Group

The group would be eligible for accessing separate individual loans from the financing bank. All members will be jointly responsible for the repayment of all loans taken by all the members of the group. The financing bank could assess the credit requirement, depending on the activities being undertaken and credit absorption capacity of the individual. However, there should be a reciprocal agreement and consensus about the amount of personal loan given to all members.

Model: B-Financing the Group

The Joint Liability Group would consist preferably of 4 to 10 individuals and function as one borrowing unit. The group will be eligible for loan access, which can be a joint finance requirement for all its members. In case of crop loan, the credit rating of the group will be dependent on the cultivable area available by each crop grown and by the member of the JLG. All the members will execute documents jointly.

Criteria for Selection of Joint Liability Group Members:

(a) JLGs can be formed primarily consisting of tenant farmers and small farmers cultivating land without possessing proper title of their land.

(b) Members should have the same social, economical status and background and who agrees to act as a Joint Liability Group.

(c) The group should be organized by the farmers who are likeminded and should not be imposed by the bank or others.

(d) Members should live in the same village area and know each other adequately for taking loan in a group or personally.

(e) Members should be involved in agricultural operations for continuous period of more than one year in the field of operations of bank branch.

(f) The group members should not be a defaulter to any other formal financial institution.

(g) The JLG should not be formed with all members of the same family and not more than one person from the same family should be included in the JLG.

(h) To ensure the role of leadership and to pursue the JLG activities, the group needs very active members. The selection of a good capable and active leader is necessary for the Joint Liability Group, which will eventually benefit all the members of the group.

Coverage

JLGs are livelihood groups, who come together on the strength of mutual guarantee to seek finance to pursue an economic activity. It targeted at middle-class customers engaged in financial activities like crop production and who are willing to jointly undertake to repay the loans taken by the groups. Unlike the Self- Help Group case, JLGs are reserved for tenants and small farmers in the form of credit groups, those who do not have proper title of their land or security to offer, but in need of

long term or seasonal credit to pursue their economic activities. Thus, the nature of regular savings by the group is voluntary. Loans were given based on mutual guarantee to individuals in a group or as group loans. JLGs are for 'not so poor' who have assets, which are productive but who cannot get loans because they have no papers (small farmers who take irrigated lands on lease) or have problems with accessing banks. They already have some linkages with markets who have surpluses. Credit is required for production, working capital.

Difference Between Self-Help Group and Joint Liability Group

Self-Help Group is a saving-based model that has been constituted primarily by women members. Facility of group formation in Self-Help Group is usually provided by NGO, MFI and banks, the group formation is followed by members who regularly contribute to the savings. The saving contribution may be collected on a weekly, fortnightly, or monthly basis and generally remain in the custody of the group's elected head till the group opens a bank account. It has been observed that the regular saving contribution may be depending upon the members' economic status. Keeping in mind the prevailing caste system in India, members are encouraged to create groups within the same community, and members belong to similar economic backgrounds. The size of each group varies from 12 to 20 depending upon geographical conditions, population density, and convenience of the community as well as the promoting NGO, etc. The members of the Self-Help Groups start borrowing money for different purposes at fixed interest rate, while the terms and conditions are set by members of the group. The SHG opens a savings bank account under the name of the group by submitting valid documents including group constitution, meeting minutes etc. Normally after the six-month period, the group becomes eligible for loan. Banks give loan in the name of the group after checking the latter record of inter- loaning and other books of accounts. NABARD has been one of the largest sponsors of Self-Help Group in India, in addition to NABARD State Governments have started various development schemes to promote Self-Help Groups across the country.

Joint Liability Group model, which is relatively new for Indian microfinance, is an adaptation of the Grameen model. Many organisations engaged in SHG promotion decided to opt for the JLG model owing to its easy scalability. The JLG has two significant advantages compared to the SHG. It is more compatible with the supply driven model of microfinance because of its shorter gestation period for turning creditworthy. On the other hand, a SHG takes about six months to become eligible for bank loan. Apart from this, a Joint Liability Group can become eligible for microcredit from next week of its formation. Like SHGs this model also works without any physical collateral, members borrow from MFI based on mutual guarantee. This means that if any member fails to repay on time, others pool together the default amount and make the repayment on a scheduled date. In many cases, MFI imposes a penalty on the overall group if any member fails or delays to repay their next loan on time.

MFI promoting JLGs, do not encourage people who do not have a steady flow of income. Unlike SHGs, JLG members do not undergo any extensive training in-group management and the group norms are formed by the MFIs usually. The loan given within the JLG model follows a cycle in which a certain amount is given to the group in the first cycle. On successful repayment of that amount, a higher amount is given in the second cycle and so on. The first cycle usually lasts up to a year and the JLGs need to make the repayment in 50 or 52 installments on a weekly basis. JLGs can have a personal savings account with MFI, however, considering the regulatory restriction on the collection of public deposit by organizations other than those regulated by the RBI; many MFIs are debarred from collecting savings from JLGs. Therefore, saving of JLGs created by MFIs is not an essential component, the centers and groups primarily work for financial intermediaries.

NGOs and banks work only as capable providers so that these groups can be able to move forward. The provision of mandatory saving in SHGs has been criticized as it ignores many people in the poor class because they are unable to save on a regular basis. JLGs are formed with the sole purpose of accessing loan from promoting agencies. Much of the time MFIs have taken the

initiative to form JLGs by asking members to organize themselves in groups if they want to get a loan. Unlike the SHGs savings with JLGs are not mandatory and the group is not encouraged for the purpose of making internal capital for loans between themselves.

All government schemes promoting SHGs have a big part of their budget for SHGs training and development. In fact, due to the process of internal capacity building, SHGs take a longer time to become eligible for a loan from MFI or bank. JLGs focus very little on capacity building because they are managed externally. The employees of promoting MFIs handle all operational requirements including record keeping and group management. JLGs are more focused and confine itself to the goal of providing finance to its members. While thinking from SHGs lenders perspective, it is relatively cost effective; banks have to spend very little in making the group creditworthy as in most instances this is done by the MFIs with grant money. Apart from this, the groups are taught to be self-managed and oriented towards making the self-reliant. MFI worker has to spend less time over group management and a single staff member may take care of a large number of groups resulting in low cost management. In JLG case, the groups are managed by MFIs, and are also responsible for the regular operations of the group employees. Thus, more employees are required to manage the JLGs compared to SHGs, which makes it an expensive model. Members may take care of a large number of groups resulting in low cost management. Thus, more employees are required to manage the JLGs compared to SHGs, which makes it an expensive model.

Size of Joint Liability Group

The group should be formed especially with 4 to 10 members to enable the group members to offer mutual guarantee. While informal group of up to twenty members could also be considered, such large groups are found to be not effective in fulfilling mutual guarantee obligations in the case of farmers. Therefore, smaller groups of farmers (4-10 members) are recommended for effective functioning of Joint Liability Groups.

Savings by Joint Liability Groups

The JLG is intended primarily to be a credit group. Therefore, savings by the JLG members are voluntary. The JLG members can be encouraged to open a personal no-frills account. If the JLG chooses to undertake savings as well as credit operations through the group mechanism, such groups should open a savings account in the name of JLG with at least two members being authorized to operate the account on behalf of the group.

Credit to JLGs to form Normal Business Activity Under Priority Sector

The purpose of this program is to provide benefits to the farmers for cultivation, whose personal capacity is not sufficient to take formal loans, credit to JLG can be considered as a direct agricultural advance under the priority sector. Banks may include lending to JLGs in their corporate plans and it can form part of the training programs of officers and members of related banks.

Promotional Grants to Banks for Forming, Nurturing, and Financing JLGs

Under the revised scheme, NABARD decided to provide some incentives to banks through grants on an annual basis for the first three years for JLG nutrition and construction. NABARD would also extend need-based promotional support training, exposure visits, experience sharing etc. for banks staff.

Review of Literature

(10) found thatNABARD started the concept of Joint Liability Group in 2004-05 as a pilot project in eight states of India. The purpose of this paper is to bring out the level of success of NABARD in Gujarat state, with the help of brief, case studies; attempts have been made to understand the response of villagers in Gujarat towards JLG initiative of NABARD. (11) found that microfinance acts as a financial service for entrepreneurs and small business persons. However, the JLG chooses to manage savings and credit operations through the group system, such a group should open a savings account in the name of JLGs, with at least two members being authorized to operate the account on behalf of the

group. Financial position of SHG members is better as compared to JLGs members because ability to save regularly is a pre-condition to become a member of SHGs and hence women can afford to learn new skills or complete education. JLG concept has given stability to their business due to assured supply of funds and now they can think of expanding the activities.(12) stated the important work of NABARD in India is the introduction of Joint Liability Group. There has been several positive changes that have taken place across the country since the inception of Joint Liability Group. Being member of Joint Liability Group has enhanced the living circumstances of the people in terms of sustainability. This paper focuses on the extent of group cohesiveness and sustainable livelihood among Joint Liability Group members mostly comprising women.(13) examined that JLG initiative gave a relief to the rural poor through collateral free credit for sustaining livelihood and support. The study is based on primary data that has been collected through the interview of JLG members and other stakeholders. Credit has also played role in empowering these poor people in decision-making process. The study recommends possible solutions that can further aid in long-term sustainability of livelihood and use the synergy from social capital in a more productive way.(14) presented that financing to JLG is a good business proposal. It needs group dynamics, simplified documentation, timely repayment culture, and prospects of credit betterment to clients. Keeping in view the need and findings of the studies, NABARD has issued comprehensive guidelines to banks focusing on small and marginal farmers and other customers under non-agricultural activities.(15) have giventwo separate delivery models, including community empowerment (SHGs) models and financially skilled (JLG) model in India. While SHG is a slow development model and unique to India while based on Bangladesh's rural model, JLG is a credit based fast growing model. This article describes two models and tries to develop comparisons between them with many issues.(5) highlighted the main purpose of Joint Liability Group has been to facilitate mutual loan guarantee and execution of joint liability agreement, making the members severally and jointly liable for payment of interest and repayment of loan obtained from the bank. Members must integrate their behavior with good faith in repaying debt and dealing with potential problems.(2). (2014) found that according to the latest research done by the World Bank, there are about one-third of the world's poor people living in India. Microfinance plays an important role in financial inclusion in the past few decades; it has done commendable work in eradicating poverty. Microfinance is not only about providing micro credit to the poor, but also it is an economic tool that's purpose is to help the poor get out of poverty. Microfinance institutions work as banks and in some sense, it is better than banks.

Methodology

This study is mainly based on the secondary data. The necessary data are collected from 'The Status of Micro Finance in India,' other sources include journals, magazines, and websites. This study takes into account only the Joint Liability Groups, which are linked with Commercial Banks, Regional Rural Banks, and Cooperative Banks. Moreover, it focuses only on the loan amount disbursed to the JLGs by these three banking units.

Objectives of the Study

(1) To examine the progress of JLGs region wise and state wise.

(2) To analysis the flow of credit under JLG model region wise and state wise.

Table 1: Region wise number of Joint liability Groups promoted during 2010-11 to 2018-19.

Region Years	Northern Region	North Eastern Region	Eastern Region	Central Region	Western Region	Southern Region	All India
2010-11	1603	7215	54620	17601	986	59020	141045
2011-12	6010	9259	68512	13635	5147	89099	191662
2012-13	7809	14987	58648	42924	15912	56259	196539
2013-14	16068	7178	63602	49053	26867	45103	207871
2014-15	45708	10093	121320	76069	77422	126024	456636
2015-16	35331	15827	164626	88641	89131	178799	572355

2016-17	50402	24153	234019	109134	88112	195803	701623
2017-18	79078	51334	371763	114786	99869	302569	1019399
2018-19	132272	78013	617555	160272	146290	469254	1603656
Grand total	374281	218059	1754665	672115	549736	1521930	5090786
percent	7.35	4.28	34.47	13.20	10.80	29.90	100.00

Source: Status of microfinance in India 2010-11 to 2018-19.

Region-wise spread of JLGs during 2010-11 to 2018-19 is given in table; it is evident from the table that the Eastern Region occupied highest number of the JLGs (34.47 percent) out of 5090786JLGs in the country. As against this, the Southern Region has 29.90 percent of the total JLGs in the country, followed by 10.80 percent in the western Region and 13.20 percent in Central Region.The Northern and Northern-Eastern Region accounts 7.35 and 4.28 percent of the total JLGs in the country.

Table: 2 Cumulative number of Joint Liability Groups as on 31 March 2019

Sr.No.	Name of the State	Cumulative No. of JLGs promoted as on 31.03.2017	No. of JLGs promoted during 2017-18	No. of JLGs promoted during 2018-19	Cumulative No. of JLGs promoted as on 31.03.2019	Percentage
	CENTRAL REGION					**(13.20)**
1	Chhattisgarh	36752	24184	29984	90920	**1.79**
2	Madhya Pradesh	164832	52266	69848	286946	**5.64**
3	Uttarakhand	11054	4930	8523	24507	**0.48**
4	Uttar Pradesh	184419	33406	51917	269742	**5.30**
	Sub total	**397057**	114786	160272	672115	
	EASTERN REGION					**(34.47)**
5	Andaman & Nicobar	561	41	20	622	**0.01**
6	Bihar	252394	99069	156079	507542	**9.97**
7	Jharkhand	19084	20035	26660	65779	**1.29**
8	Odisha	260432	73774	213998	548204	**10.77**
9	West Bengal	232876	178844	220798	632518	**12.42**
	Sub total	**765347**	371763	617555	1754665	
	NORTH EASTERN REGION					**(4.28)**
10	Arunachal Pradesh	4	6	0	10	**0.00**
11	Assam	74952	26372	50006	151330	**2.97**
12	Manipur	750	1274	912	2936	**0.06**
13	Meghalaya	1772	136	190	2098	**0.04**
14	Mizoram	2030	154	122	2306	**0.05**
15	Nagaland	1341	272	33	1646	**0.03**
16	Sikkim	1137	717	993	2847	**0.06**
17	Tripura	6726	22403	25757	54886	**1.08**
	Sub total	**88712**	51334	78013	218059	
	NORTHERN REGION					**(7.35)**
18	Chandigarh	10	0	0	10	**0.00**
19	Haryana	14223	13005	25301	52529	**1.03**
20	Himachal Pradesh	3692	710	1178	5580	**0.11**
21	Jammu and Kashmir	1703	4364	1262	7329	**0.14**
22	New Delhi	2778	885	1305	4968	**0.10**
23	Punjab	33727	19734	37872	91333	**1.79**
24	Rajasthan	106798	40380	65354	212532	**4.17**
	Sub total	**162931**	79078	132272	374281	
	SOUTHERN REGION					**(29.90)**

25	Andhra Pradesh	131929	14072	13807	159808	**3.14**
26	Karnataka	208131	100392	127678	436201	**8.57**
27	Kerala	99750	37817	91634	229201	**4.50**
28	Lakshadweep UT	0		0	0	**0.00**
29	Puducherry	1165	405	577	2147	**0.04**
30	Tamil Nadu	273384	139473	227148	640005	**12.57**
31	Telangana	35748	10410	8410	54568	**1.07**
	Sub total	**750107**	302569	469254	1521930	
	WESTERN REGION					**(10.80)**
32	DAMAN and DIU UT	0	2	1	3	
33	D and N HAVELI UT	0	0	0	0	**0.00**
34	Goa	4872	2213	2607	9692	**0.19**
35	Gujarat	121783	32613	39765	194161	**3.81**
36	Maharashtra	176922	65041	103917	345880	**6.79**
	Sub Total	**303577**	99869	146290	549736	
	Grand Total	**2467731**	1019399	1603656	5090786	100.00

Source: NABARD, Status of microfinance in India 2018-19.

The state-wise number of JLGs financed by bank till 31st March 2017 is provided in table. A total of 2467731 JLGs have been financed by banks from 2010-11 to 2016-17. The table shows that, the state Tamilnadu accounted for the largest JLGs financed by banks up to March 2017 (11.07 percent), followed by Orissa (10.55 percent), Punjab (1.36 percent), Bihar (10.22 percent). Madhya Pradesh (6.67 percent), Rajasthan (4.32 percent), Assam (3.03 percent), Maharahtra (7.16 percent). Andhra Pradesh (5.34 percent), Karnataka (8.43 percent), and Kerala (4.04 percent) Uttar Pradesh (7.47 percent). It is less than one percent in some of the states like Arunachal Pradesh, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, New Delhi, Sikkim, Uttarakhand, Andaman, and Nikobar Islands. This shows the regional inequalities in the number of JLG financed by bank in the country.

Table: 3 Region-wise loan disbursed to Joint liability Groups during (2010-11 to 2018-19)

(Amt. in lakh)

Region Years	Northern Region	North Eastern Region	Eastern Region	Central Region	Western Region	Southern Region	All India
2010-11	3518.3	3099.78	26647.46	3237.09	493.12	77533.7	114529.45
2011-12	7459.89	2751.3	22126.21	13358.3	5283.81	119059.54	170039.05
2012-13	7677.76	14253.52	33475.1	22809.61	18387.82	87161.13	183764.94
2013-14	16706.54	9040.1	58320.52	31512.1	18475.92	87960.78	222015.96
2014-15	43734.31	12603.49	110411.2	65012.51	66337.94	143469.38	441568.83
2015-16	21153.26	25426.7	147508.2	78518.09	78277.69	265188.42	616072.33
2016-17	71826.3	38313.82	251924.2	135381.28	119128.86	334542.83	951117.33
2017-18	116267.22	53147.71	354437.17	174357.93	159938.27	537366.25	1395514.55
2018-19	218725.63	90666.8	938742.04	326307.22	302897.58	1217348.12	3094687.39
Grand Total	507069.21	249303.22	1943592.11	850494.13	769221.01	2869630.15	7189309.83
Percent	7.05	3.47	27.03	11.83	10.70	39.92	100.00

Source: Status of microfinance in India 2010-11 to 2018-19.

Region-wise loan disbursed to JLGs up to 2018-19 is given in table. It is evident from the table that the Southern Region occupied the highest loan in percentage, (39.92 percent) out of total 7189309.83 lack rupees to JLGs in the country. As against this, Eastern Region has 27.03 per cent of the total loan disbursed to JLGs in the country, followed by 11.83 percent in Central Region and 10.70 percent in Western Region. The Northern and Northern-Eastern Region accounts 7.05 and 3.47 percent of the total loan disbursed in the country.

Table: 4 Cumulative bank loan disbursed to Joint Liability Groups as on 31 March 2019: (Amt. in lakh)

Sr. No.	Name of the State	Cumulative Loan disbursed as on 31.03.2017	Loan Disbursed during 2017-18	Loan Disbursed during 2018-19	Cumulative Loan disbursed as on 31.03.2019	Percentage
	CENTRAL REGION					**(11.83)**
1	Chhattisgarh	39348.51	31451.9	44900.49	115700.9	**1.61**
2	Madhya Pradesh	161087.52	69958.52	149264.3	380310.34	**5.29**
3	Uttarakhand	16165.42	6068.85	11674.6	33908.87	**0.47**
4	Uttar Pradesh	133227.53	66878.66	120467.83	320574.02	**4.46**
	Sub total	**349828.98**	**174357.93**	**326307.22**	**850494.13**	
	EASTERN REGION					**(27.03)**
5	Andaman & Nicobar	807.26	50.15	36.3	893.71	**0.01**
6	Bihar	265977.31	137751.25	254311.92	658040.48	**9.15**
7	Jharkhand	22352.31	27438	44929.11	94719.42	**1.32**
8	Odisha	213533.41	89907.95	448515.47	751956.83	**10.46**
9	West Bengal	147742.61	99289.82	190949.24	437981.67	**6.09**
	Sub total	**650412.9**	**354437.17**	**938742.04**	**1943592.1**	
	NORTH EAS.REGION					**(3.47)**
10	Arunachal Pradesh	2.3	16.41	0	18.71	**0.00**
11	Assam	88991.33	40530.56	64069.21	193591.1	**2.69**
12	Manipur	617.97	538.67	1260.87	2417.51	**0.03**
13	Meghalaya	1646.34	250.36	314.98	2211.68	**0.03**
14	Mizoram	2815.02	387.95	317.09	3520.06	**0.05**
15	Nagaland	1418.63	724.94	23.33	2166.9	**0.03**
16	Sikkim	1177.67	824.41	1297.37	3299.45	**0.05**
17	Tripura	8819.45	9874.41	23383.95	42077.81	**0.59**
	Sub total	**105488.71**	**53147.71**	**90666.8**	**249303.22**	
	NORTHERN REGION					**(7.05)**
18	Chandigarh	2.81	0	0	2.81	**0.00**
19	Haryana	22397.25	19595.66	39610.83	81603.74	**1.14**
20	Himachal Pradesh	3920.91	1066.72	1234.47	6222.1	**0.09**
21	Jammu and Kashmir	865.56	4741.46	1343.38	6950.4	**0.10**
22	New Delhi	2989.89	2028.04	1911.35	6929.28	**0.10**
23	Punjab	42748.14	31258.92	62921.09	136928.15	**1.90**
24	Rajasthan	99151.8	57576.42	111704.51	268432.73	**3.73**
	Sub total	172076.36	116267.22	218725.63	507069.21	
	SOUTHERN REGION					**(39.92)**
25	Andhra Pradesh	164745.95	35002.24	36810.66	236558.85	**3.29**
26	Karnataka	263456.84	157087.52	250054.56	670598.92	**9.33**
27	Kerala	156245.76	82065.62	242227.15	480538.53	**6.68**
28	Lakshadweep UT	0	0	0	0	**0.00**
29	Puducherry	2031.34	801.62	767.25	3600.21	**0.05**
30	Tamil Nadu	466341.2	239341.07	677530.99	1383213.3	**19.24**
31	Telangana	62094.69	23068.18	9957.51	95120.38	**1.32**
	Sub total	**1114915.78**	**537366.25**	**1217348.1**	**2869630.2**	
	WESTERN REGION					**(10.70)**
32	DAMAN and DIU UT	0	2.68	1.91	4.59	**0.00**
33	D and N HAVELI UT	0	0	0	0	**0.00**
34	Goa	4858.61	3726.85	4829.82	13415.28	**0.19**
35	Gujarat	116010.32	48679.97	69371.15	234061.44	**3.26**
rarsid8456 56336	Maharashtra	185516.23	107528.77	228694.7	521739.7	**7.26**
	Sub Total	**306385.16**	**159938.27**	**302897.58**	**769221.01**	
	Grand Total	**2699107.89**	**1395514.55**	**3094687.4**	**7189309.8**	**100.00**

Source: NABARD, Status of microfinance in India 2018-19.

The state-wise loan disbursed to JLGs as on 31 March 2017 is provided in table. As on 31 March 2017, a total of 2699107.89 rupees loan have been disbursed by bank. Since 2010-11 to 2016-17, the table shows that the state Tamil Nadu received the largest loan disbursed by banks (17.28 percent), followed by Bihar (9.85 percent), Punjab (1.58 percent), Madhya Pradesh (5.97 percent), Rajasthan (3.67 percent), Assam (3.30 percent), Maharashtra (6.87 percent), Andhra Pradesh (6.10 percent), Karnataka (9.76 percent), Orissa (7.91 percent) and Kerala (5.79 percent) Uttar Pradesh (4.94 percent). It is less than one percent in some of the states like Arunachal Pradesh, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya Mizoram, Nagaland, New Delhi, Sikkim, Uttarakhand, Andaman, and Nikobar Islands.

Conclusion

Joint Liability Groups are the changing face of microfinance in rural India and play an important role in positive manner in terms of the ability of microfinance to attract more funds and therefore increase outreach. Therefore, the JLGs are the instruments of micro finance, which becomes a powerful tool for rural development. For sustainable development of poor in rural economy, focus must be on development of rural infrastructure and rural agriculture based economy. The loans disbursed have risen faster than the promotion of groups. This is evident from number of groups promoted, and total loans disbursed.

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NUCLEOTIDE SEQUENCE ANALYSIS OF PHENYLKETONURIA USING MATLAB

Vineeta Verma[1], Vaishali[1], Sharmila[2] and Amit Kumar[3]

[1]SardarVallabhbhai Patel University of Agriculture and Technology, Meerut, U.P., India
[2]Government Girls Ploytechnic, Bareilly, U.P., India
[3]Invertis University, Bareilly, U.P., India

Abstract

Phenylketonuria (PKU) is a genetic disorder inherited from a person's parents (2). In PKU, the phenylalanine can build up to harmful levels in the body, causing intellectual disability and other serious health problems. In this paper we find the nucleotide sequence of both, a Phenylketonuria (PKU) patients and a homo sapiens (normal human) and then compare their nucleotide density and codon count with the help of MATLAB functions. We find that in nucleotide sequence and Base count of affected phenylketonuria disease patient is different from a normal homo sapiens.Thymine is more in affected person than normal person.

Keywords: Phenylketonuria, phenylalanine, thymine.

Introduction

Phenylketonuria (PKU) is an inborn error of metabolism involving impaired metabolism of phenylalanine, one of the amino acids. Phenylketonuria is caused by absent or virtually absent phenylalanine hydroxylase (PAH) enzyme activity(1). Phenylalanine hydroxylase is an enzyme that catalyzes the hydroxylation of the aromatic side-chain of phenylalanine to generate tyrosine.PheOH is one of three members of the biopterin. The condition is also known as "phenylalanine hydroxylase deficiency".

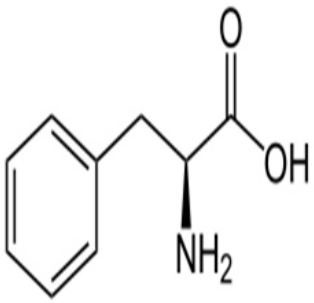


Fig1: Structure of Phenylalanine

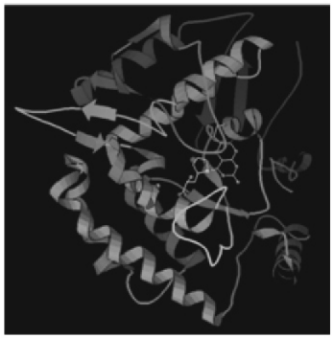


Fig 2: 3D Structure of Phenylalanine Hydroxylase

PKU is an inherited disease. PKU is inherited in families in an autosomal recessive pattern (3). Autosomal recessive inheritance means that a person has two copies of the gene that is altered. Usually, each parent of an individual who has PKU carries one copy of the altered gene(r). Since each parent also has a normal gene(R), they do not show signs or symptoms of PKU.Gene alterations (mutations) in the PAH gene cause PKU (12).

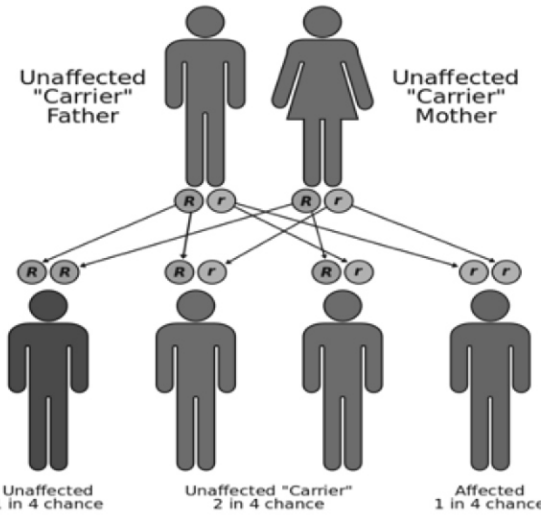


Fig3: Phenylketonuria is inherited in Autosomal recessive

PKU is commonly included in the newborn screening panel of most countries, with varied detection techniques. Screening for PKU is done with bacterial inhibition assay (Guthrie test), immunoassays using fluorometric or photometric detection, or amino acid measurement using tandem mass spectrometry (MS/MS% chance any child they have will be born with the disorder, a 50% chance the child will be a carrier, and a 25% chance the child will neither develop nor be a carrier for the disease.

PKU is an autosomal recessive metabolic genetic disorder. If both parents are carriers for PKU, there is a 25PKU is characterized by homozygous or compound heterozygous mutations in the gene for the hepatic enzyme phenylalanine hydroxylase (PAH), rendering it nonfunctional.

This enzyme is necessary to metabolize the amino acid phenylalanine (Phe) to the amino acid tyrosine (Tyr). When PAH activity is reduced, phenylalanine accumulates and is converted into phenylpyruvate (also known as phenylketone), which can be detected in the urine.

Carriers of a single PKU allele do not exhibit symptoms of the disease but appear to be protected to some extent against the fungal toxin ochratoxin A. The PAH gene is located on chromosome 12 in the bands 12q22-q24.1. More than 400 disease-causing mutations have been found in the PAH gene. This is an example ofallelic genetic heterogeneity.

Phenylalanine is one of the essential amino acids and is required for normal growth and maintenance of life. Concerns about the safety of phenylalanine from aspartame center largely on hypothetical changes in neurotransmitter levels as well as ratios of neurotransmitters to each other in the blood and brain that could lead to neurological symptoms. People with the genetic disorder phenylketonuria are advised to avoid aspartame as they have a decreased ability to metabolize phenylalanine. Common foods such as milk, meat, and fruits provide far greater amounts of these metabolites in a diet than does aspartame.

Treatment

PKU is not curable. However, if PKU is diagnosed early enough, an affected newborncan grow up with normal brain development by managing and controlling phenylalanine ("Phe") levels through diet, or a combination of diet and medication.

When Phe cannot be metabolized by the body, a typical diet that would be healthy for people without PKU causes abnormally high levels of Phe to accumulate in the blood, which is toxic to the brain (13). If left untreated, complications of PKU include severe intellectual disability, brain function abnormalities, microcephaly, mood disorders, irregular motor functioning, and behavioral problems such as attention deficit hyperactivity disorder, as well as physical symptoms such as a "musty" odor, eczema, and unusually light skin and hair coloration .PKU can be very sensitive to quick changes in Phe levels causing a "Protein ,accumulates over time they may experience concentration, confusion and mood problems, as well as eczema and other symptoms. For children, developmental problems may occur if levels are elevated frequently or remain elevated for a significant amount of time.

Epidemiology

The average number of new cases of PKU varies in different human populations. Since PKU has autosomal recessive inheritance, consanguineous marriage is an important risk factor [5,6]; thus, countries with a high prevalence of consanguineous marriages have high disease prevalence [7,8]. PKU varies among ethnic groups,

races, and geographic regions. For example, In Japan, the incidence is reportedly 1:108,822 [9]. Turkey, with an incidence of 1:6,000, and Iran, with an incidence of 1:4,698, are among the countries with the highest PKU incidences [10,11].

Matlab

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typically uses in Math and computation, Algorithm development, Modeling, simulation, and prototyping, Data analysis, exploration, and visualization, Scientific and engineering graphics, Application development, including Graphical User Interface building. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning and it allows to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language.

MATLAB enables you to access datasets from a wide variety of sources including databases, custom file formats, and web services; apply leading-edge analysis methods to your signal, image, video, molecular, and other datasets (14).



Fig 4: Logo of MATLAB

Nucleotide Sequence Analysis

Phenylketonuria is a genetic disorder inherited from a person's parents. To find the nucleotide sequence of a Phenylketonuria patient through MATLAB, we open the ncbi web site with the help of web function i.e.web('http://www.ncbi.nlm.nih.gov/'). To store the nucleotide sequence we declare a phenylalaninehydroxylase variable, which can be access by the function getgenbank with accession number 'S75699'. After retrieve nucleotide sequence, nucleotide density will be find by the function ntdensity with phenylalaninehydroxylase as argument and then calculate base count with basecount function withargumentphenylalaninehydroxylase and draw a pie chart with arguments phenylalaninehydroxylase, chart and pie arguments in basecount function. A new window will be open with uiopen functionfor pie chart. Calculate dimer count from dimercount function with passing the arguments phenylalaninehydroxylase, chart and bar arguments to show the results in a bar chart.Count the number of codon from codoncount function by passing the phenylalaninehydroxylase as an argument. All functions are available in API library in MATLAB.

Similarly the nucleotide sequence, nucleotide density and base count, dimer count and codon count of a normal human (homo sapiens) will be calculated from the accession number 'AY563525'.

Results

After finding the nucleotide sequence, nucleotide density and base count, dimer count and codon count of Phenylketonuria patient accession number S75699 and a normal human (homo sapiens) accession number 'AY563525' we analyses that Nucleotide density of affected and normal person is having much difference.

Nucleotide Density Comparison

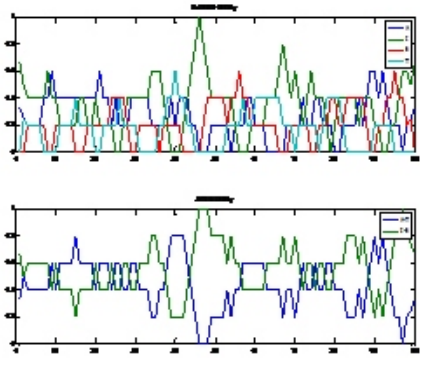


Fig 5. (a): Affected Person

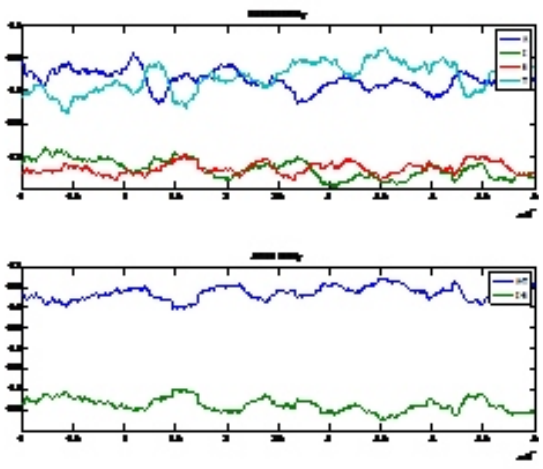


Fig 5. (b): Normal Person

In figure 5(a) and 5 (b) dark blue line (—) shows number of adenine (A), green line (—) shows number of Cytosine (C), red line (—) shows number of guanine (G) and light blue line (—) shows number of thymine (T) in nucleotide density and in A-T C-G density graph dark blue line (—) shows A-T density and green line (—) shows C-G density of affected Phenylketonuria and a normal homo sapiens. We can see in figure 5(a) and figure 5(b) nucleotide density and A-T C-G density of affected Phenylketonuria is much different from a normal homo sapiens.

Base Count Comparison Between Pie Chart



Fig 6. (a): Affected Person **Fig 6.** (b): Normal Person

In pie graph figure 6(a) shows the base count of affected Phenylketonuria and figure 6 (b) shows the base count of a normal homo sapiens. In both figures dark blue color is for adenine, brown for thymine, yellow color for guanine and light blue for cytosine. We can see that an affected Phenylketonuria having more thymine and less adenine in their nucleotide sequence as compare to a normal homo sapiens.

Dimer Count Comparison Between Bar

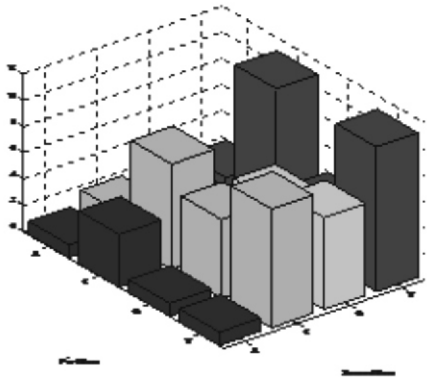


Fig 7. (a): Affected Person

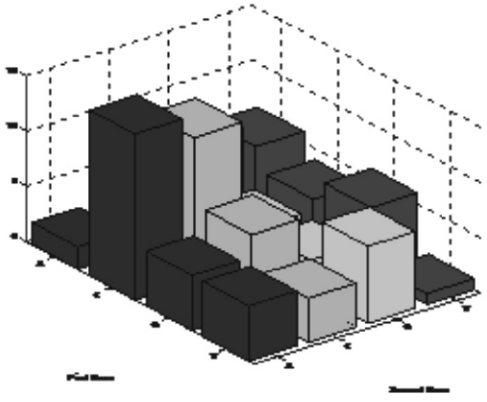


Fig 7. (b): Normal Person

In bar graph figure 7(a) shows the dimer count of affected Phenylketonuria and figure 7 (b) shows the dimer count of a normal homo sapiens. In both figures dark blue color is for adenine, brown for thymine, yellow color for guanine and light blue for cytosine. We can see that an affected Phenylketonuria having more CT, TC dimers and less AC, AG, CA and CC dimers as compare to a normal homo sapiens.

Conclusion

In a nucleotide sequence the nucleotide density and A-T C-G density of affected Phenylketonuria is much different from a normal homo sapiens. We found that Phenylketonuria patient having more thymine and less adenine in their nucleotide sequence and more CT, TC dimers and less AC, AG, CA and CC dimers as compare to a normal homo sapiens.

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STUDY ON EFFECT OF DIFFERENT LEVELS OF READY MIX FORMULATION OF SULFOSULFURON AND METSULFURON-METHYL ON WEED INSFESTATION IN WHEAT (*TRITICUM ASTIVUM*)

Yogander Kumar, V.P. Singh and Piyush Kumar

College of Agriculture, CCS Haryana Agricultural University, Hisar-125004, Haryana.
***Corresponding Author: Email**- narwal_y@rediffmail.com

Abstract

The present investigation was carried as field experiment which was conducted at Agronomy Research Area of the Department of Agronomy, Chaudhary Charan Singh, Haryana Agricultural University, Hisar (India). The experimental field was dominated by *Phalaris minor, Melilotus indica, Rumex retroflexus, Anagallis arvensis, Lathyrus abhaca* and *Chenopodium album* during both the years. Application of sulfosulfuron + metsulfuron-methyl reduced the dry matter accumulation in all the weeds upto 100% when applied @ 40g ha ^{1} at 60 DAS during both the years.Decreased microbial population (total bacteria, fungi and Azotobacter) was observed in sulfosulfuron + metsulfuron-methyl treated plots just after application of herbicide. From the present studies, it can be concluded that sulfosulfuron + metsulfuron-methyl can be applied @ 40 g ha ^{1} for excellent control of complex weed flora in wheat.

Key Words: Levels, Ready mix formulation of sulfosulfuron and metsulfuron-methyl, weed.

Introduction

Wheat crop is infested with both the grassy weeds (*Phalaris minor, Avena ludoviciana, Poa annua* etc.) and broad leaf weeds (*Chenopodium album, Anagallis arvensis, Melilotus indica, Lathyrus aphaca, Vicia sativa, Fumaria parviflora, Rumex retroflexus, Convolvulus arvensis* and *Cirsium arvense*). Phalaris minor is the dominant weed found intensively in rice-wheat cropping system and it alone affects wheat yield up to 40 per cent (5). The losses in wheat yield caused by weeds ranges between 25-50 per cent depending upon weed species, density of weeds and the crop, soil moisture and fertility status and emergence pattern of weeds in relation of crop (2). Among different methods of weed management, herbicides are most preferably used by growers. Isoproturon was the most effective and economical herbcides for controlling Phalaris minor in wheat (6), (16) , but with the passage of time and continuous use, isoproturon has not only allowed shift in weed flora in favour of broad leaf weeds, but has also resulted in the evolution of resistant biotypes (8). For control of broad leaf weeds, mainly 2, 4-D (Na salt), 2, 4-D (Ester) or metsulfuron-methyl either alone or with urea herbicides have been used. For the management of complex weed flora in wheat particularly in resistance affected areas, there was no suitable herbicide available with the farmers. Use of 2, 4-D or metsulfuron-methyl tank mixed with clodinofop or fenoxaprop leads to antagonisms (15). In such situations, sequential application of aforesaid herbicides was recommended, however, it adds to leads to the cost of application. But ready mix formulation of sulfosulfuron and metsulfuron-methyl (Total) may be suitable alternative herbicides under such situations.

Materials And Method

Experimental Site and Location

The present investigation entitled, "Studies on the persistence of ready mix formulation of sulfosulfuron and metsulfuron-methyl (Total) applied in wheat" was carried out in two phases. The field experiment was conducted in 2005-06 and 2006-07 at Agronomy Research Area, and laboratory and pot experiments were carried out during 2006-07 only in weed management laboratory and green house of the Department of Agronomy, Chaudhary Charan Singh, Haryana Agricultural University, Hisar (India). Hisar is located at 215.2 metres above mean sea level with a latitude of 29º10' North and longitude of 75º36' East.

Weather and Climate

Climate of Hisar is semi-arid with hot and dry dessicating winds accompanied by frequent dust storms of high velocity in summer, severe cold during winter and humid warm monsoon seasons. The mean maximum temperature sometimes exceeds 48ºC during summer while minimum temperature falls to the level of 0ºC accompanied by frost in winter.

The mean annual rainfall is around 400 mm and the total rain as well as its distribution is subjected to great variations. About 85 percent of the total rains are received from South-West monsoon during July, August and early September. A few showers of cyclonic rains also occur during December, January & late spring. The meteorological data were recorded at the meteorological observatory located near Agronomy Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

Soil Analysis

Chemical Analysis of Soil

For chemical analysis of soil of the experimental field, the soil samples (0-15 cm) were taken from five random places in the field. The samples taken from all places were mixed thoroughly, dried under shade and ground into fine powdery mass and were analysed for chemical constituents. The observation recorded and methods used are presented in (Table 1)

Mechanical Analysis of Soil

For mechanical analysis of the soil, the composite soil samples were analyzed by International Pipette Method (11). On the basis of mechanical composition, presented in (Table 2), the soil is categorized as sandy loam in texture.

Table 1. Chemical composition of soil of experimental field

Components	2005-06	2006-07	Methods employed
Organic carbon (%)	0.35	0.36	Walkley and Black's wet oxidation method (7)
apH	8.2	8.2	pH meter with glass electrode in 1:2 soil water suspension (7)
EC (dSm-1 at 25ºC)	0.43	0.44	Conductivity bridge method in 1:2 soil water suspension (12)
Available nitrogen (kg ha-1)	208.0	211.0	Alkaline permanganate method (13)
Available phosphorus (kg ha-1)	15.1	16.2	Olsen's method (10)
Available potassium (kg ha-1)	407	409	Flame Photometeric method (12)

Table 2. Mechanical composition of soil of experimental field

Components	2005-06	2006-07	Method
Sand (%)	61.58	61.37	International pipette method (11)
Silt (%)	20.32	20.34	
Clay (%)	18.20	18.29	

Experimental Treatment Combinations

Herbicide	Dose (g ha ^{1})
H_1 (sulfosulfurons + metsulfuron)	0
H_2 (sulfosulfurons + metsulfuron)	20
H_3 (sulfosulfurons + metsulfuron)	40
H_4 (sulfosulfurons + metsulfuron)	80

Replications : Four
Design : Split Plot
Variety : WH 711
Gross plot size : 10.0 m x 6.0 m
Net plot size : 9.0 m x 5.5 m

Layout of the treatments in experiment-1 has been shown in Fig. 2.

Characterization of Herbicides Used

Total is ready mix formation of sulfosulfuron and metsulfuron methyl. Therefore, the information of sulfosulfuron and metsulfuron methyl individually has been given in table 3 and 4 respectively.

Table 3. Properties of sulfosulfuron

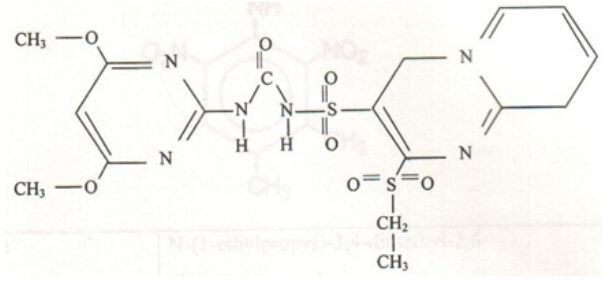
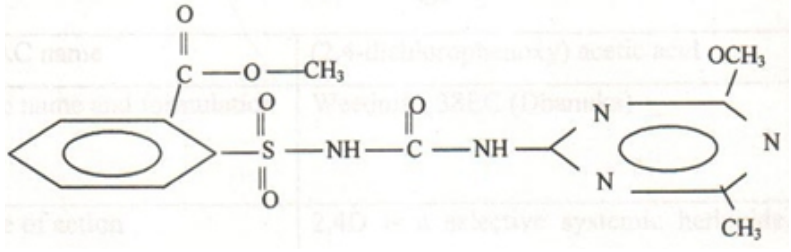
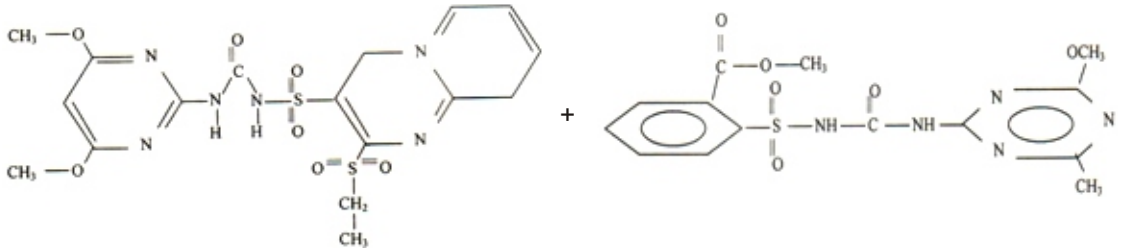
(i)	Common name	:	Sulfosulfuron (ISO proposed)
(ii)	Molecular formula	:	C16H18H6O7S2
(iii)	Chemical structure		
(iv)	IUPAC name	:	1- {2-Ethylsulfonylimidazo- [1, 2-a] pyridine-3-yl) sulfgonyl} 3-(4, 6-dimethoxypyrimidin-2-yl) urea
(v)	Trade name and formulation		Sf-10, 75% WG (UPL) Leader 75% WG (monsento)
(vi)	Mode of action	:	It is mainly used against grassy weeds but also control broad leaf weeds to low extent. It inhibits the ALS enzymes, which is involved in the synthesis of branched chain amino acids (leucine, isoleucine and valine), essential for production of new cells. It is readily absorbed by both roots and foliage and translocated in both the xylem and phloem to the site of action. Affected plants exhibit stunting, interveinal chlorosis, chlorrotic banding on grass leaves, red leaf venation, purpling, root pruning and gradual death.

Table 4. Properites of Metsulfuron-methyl

(i)	Common name	:	Metsulfuron-methyl
(ii)	Herbicide group	:	Sulfonylurea
(iii)	Molecular formula	:	$C_{14}H_{15}N_5O_6S$
(iv)	Chemical structure		
(v)	IUPAC name	:	Methyl-2-[3-(4-methyoxy-6-methyl-1, 3, 5-triazin-2-yl) urediosulfphonyl] benzoate
(vi)	Trade name and formulation		Algrip, 20% WP (Dupont)
(vii)	Mode of action	:	It enters the plant through the root zone and foliage. Inside the susceptible plants it acts by inhibiting the biosynthesis of acetolactate synthase (ALS), a key enzyme required in the biosynthesis of essential amino acids valine and isoleucine, in plants. This results in rapid inhibition of plant cell division and growth.



Sufosulfuron + Metsulfuron-methyl
75% + 5%

Sulfosulfuron + metsulfuron-methyl (Ready mix)
Trade name 'Total'

Weed studies

Weed Intensity

The determination of weed intensity was done by quadrant method described by(9). Weed population (individual dominant weed) was recorded from three quadrats (0.25 m2 each) placed at random in each plot at 30,60,90 days after sowing and at harvest and were expressed on per square meter basis. The values thus obtained were subjected to square root transformation) before analysis.

Dry Matter Accumulation by Weeds

The samples collected for recording weed intensity were utilized for weed dry matter accumulation. These samples were first dried in sun and then in oven at 65ºC for 72 hours.

Statistical analysis

Data collected during the study were statistically analyzed using the techniques of analysis of variance. The results were tested for treatment means by applying F-test of significance on the basis of null hypothesis suggested by (3). To judge the significance of difference between means of two treatments, critical difference (C.D.) was computed as follows:

$$\text{C.D.} \quad \frac{\sqrt{2\,\text{Error variance}}}{n} \text{x t 5\%}$$

Where
CD = Critical difference
n = Number of replications
t = Value from Fisher's table (1958) for error degree of freedom at 5 per cent level of significance

Results And Discussion

Weed Studies

Phalaris minor

Phalaris minor was present during both 2005-06 and 2006-07, and contributed about 22.62 and 22.48 per cent of total weed population at 60 DAS (Table 5). Density of Phalaris minor decreased correspondingly with increased concentration of sulfosulfuron + metsulfuron (R. mix). The weed density decreased up to 100 per cent with sulfosulfuron + metsulfuron application @ 40 and 80 g h-1 during both the years (Table 6).

Table 5. Density and relative density to dominant weeds in unweeded wheat plots at 60 DAS during 2005-06 and 2006-07

Scientific name	Density (No. m-2)	Relative Ddensity (%)		
	2005-06	2006-07	2005-06	2006-07
Phalaris minor	7.04	6.75	22.62	22.48
Melilotus indica	4.90	5.10	15.74	17.05
Rumex retroflexus	5.30	4.94	17.03	16.45
Anagallis arvensis	4.70	4.58	15.10	15.25
Lathyrus aphaca	3.67	3.28	11.79	10.92
Chenopodium album	5.51	5.35	17.70	17.82
Total	31.12	30.02		

Table 6. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on density (No. m-2) of Phalaris minor

Treatments	2005-06 Days After Sowing				2006-07 Days Aafter Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha-1								
0	5.94 (34.3)	7.04 (48.7)	6.93(47.2)	6.57(41.5)	5.69(31.4)	6.75(4.46)	6.61(42.8)	6.45(40.6)
20	5.92 (34.1)	2.40 (4.83)	2.27(4.2)	2.06(3.36)	5.63(30.8)	1.95(2.86)	1.70(1.9)	1.41(1.03)
40	5.91 (34.2)	1.00 (0.00)	1.00(0.0)	1.00(0.00)	5.66(31.1)	1.00(0.0)	1.00(0.0)	1.00(0.0)
80	5.93 (34.5)	1.00 (0.00)	1.00(0.0)	1.00(0.00)	5.69(30.8)	1.00(0.0)	1.00(0.0)	1.00(0.0)
SEm±	0.05		0.02	0.02	0.04	0.02	0.02	0.02
CD 5%	NS		0.08	0.07	NS	0.07	0.07	0.07

Note:Values are square root transformed (x + 1) and actual values are given in parentheses

Rumex Retroflexus

Sulfosulfuron + metsulfuron reduced the density 82 percent @ 20g ha-1 as compared to weedy check. At 40 and 80 g ha-1 the weed density reduced to an extent of 99.4 to 100 percent at 60, 90 DAS and at harvest during both the years. (Table 7).

Table7. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on density (No.m-2) of Rumex retroflexus

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha-1								
0	5.01 (24.1)	5.30 (27.2)	4.98 (23.9)	4.76 (21.7)	3.69	4.94 (23.4)	4.83 (22.4)	4.39 (18.4)
20	5.02 (24.2)	2.39 (4.89)	2.02 (3.1)	1.67 (1.83)	3.79	2.50 (5.46)	2.01 (3.16)	1.62 (1.66)
40	5.01 (24.1)	1.07 (0.16)	1.00 (0.0)	1.06 (0.0)	3.78	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	5.01 (24.1)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	3.78	1.00 (0.0)	1.00 (0.0)	1.00 (0.00)
SEm±	0.04	0.02	0.01	0.01	0.03	0.02	0.01	0.01
CD 5%	NS	0.06	0.05	0.53	NS	0.05	0.05	0.04

Note:Values are square root transformed (x + 1) and actual values are given in parentheses

Melilotus Indica

The relative density of Melilotus indica in the experimental field was found to be 16 and 17 per cent (Table 5) at 60 DAS in 2005-06 and 2006-07, respectively. A significant difference in the density of Melilotus indica was found at 60 and 90 DAS and at harvest stages under different. At 60 and 90 DAS and at harvest, the density of Melilotus indica was significanty more under weedy check compared to herbicide treated plots during both the crop seasons. The effect of sulfosulfuron + metsulfuron (R. mix) against the weed during both of the years of study and at all the crop growth stages was significant. At 60 DAS, application of sulfosulfuron + metsulfuron (R. mix) @ 20, 40 and 80 g h-1 reduced the density of M. indica up to 82, 99 and 100 per cent respectively during 2005-06 and 77, 100 and 100 per cent, respectively during 2006-07 (Table 8).

Table 8. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on density (No. m-2) of Melilotus indica

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha-1								
0	3.6	4.9 (23.5)	4.3 (15.7)	4.0 (15.7)	4.78 (21.9)	5.12 (25.3)	4.79 (2.20)	4.47 (19.1)
20	3.7	2.2 (4.1)	1.8 (0.99)	1.38 (0.99)	4.65 (20.6)	2.00 (3.1)	1.82 (2.23)	1.38 (0.96)
40	3.7	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	4.71 (21.2)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	3.7	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	4.69 (21.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm±	0.03	0.01	0.01	0.01	0.03	0.02	0.01	0.01
CD 5%	NS	0.05	0.04	0.04	NS	0.05	0.05	0.04

Anagallis Arvensis

At 60 DAS, application of sulfosulfuron + metsulfuron at 20, 40 and 80 g h ^{1} reduced the density to the extent of 92 to 100 per cent during both the years (Table 9).

Table 9. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on density (No. m ^{2}) of Anagallis arvensis

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha ^{1}								
0	4.21 (16.8)	4.70 (21.1)	4.85 (22.6)	4.50 (19.3)	3.92 (14.4)	4.58 (20.0)	4.46 (18.9)	4.36 (18.0)
20	4.20 (16.6)	1.66 (1.80)	1.13 (0.29)	1.00 (0.0)	3.98 (14.8)	1.53 (1.36)	1.04 (0.10)	1.00 (0.0)
40	4.11 (15.9)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	3.87 (14.6)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	4.18 (16.5)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	3.91 (14.3)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm±	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.01
CD 5%	NS	0.65	0.05	0.55	NS	0.05	0.04	0.04

Note: Values are square root transformed (x + 1) and actual values are given in parentheses

Lathyrus Aphaca

At 60 DAS, the maximum density of L. aphaca was recorded in weedy check. Sulfosulfuron + metsulfuron @ 20g ha ^{1} reduced the density upto 86 per cent whereas at 40 and 80 g ha ^{1}, it controlled L. aphaca up to 100 per cent during both the years. Similar pattern was also recorded at 90 DAS and at harvest during both the year (Table 10).

Table 10. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on density (No. m ^{2}) of Lathyrus aphaca

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha ^{1}								
0	2.99 (8.00)	3.67 (12.5)	3.41 (10.6)	2.83 (7.10)	2.86 (7.20)	3.28 (4.84)	3.00 (8.06)	2.82 (7.03)
20	2.99 (8.08)	1.63 (1.70)	1.48 (1.22)	1.20 (0.46)	2.81 (6.91)	1.48 (1.23)	1.18 (0.43)	1.00 (0.0)
40	3.02 (8.15)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	2.85 (7.12)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	2.99 (8.00)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	2.79 (6.82)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm±	0.02	0.01	0.01	0.009	0.02	0.01	0.01	0.00
CD 5%	NS	0.03	0.03	0.02	NS	0.03	0.03	0.03

Note: Values are square root transformed (x + 1) and actual values are given in parentheses

Chenopodium Album

The maximum density of C. album was recorded at 60 DAS in weedy check. Sulfosulfuron + metsulfuron application @ 20 g h ^{1} reduced the density by 69 and 84% during 2005-06 and 2006-07, respectively. However, at 40 and 80 g ha ^{1}, it reduced the density up to 100% at 60 DAS during both the crop seasons (Table 11).

Table 11. Effect of and sulfosulfuron + metsulfuron (R. mix) treatments on density (No. m ^{2}) of Chenopodium album

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha ^{1}								
0	5.08 (24.8)	5.51 (29.4)	5.82 (32.9)	5.91 (34.0)	4.94 (23.4)	5.35 (27.7)	5.06 (24.6)	4.69 (21.0)
20	5.16 (25.6)	2.30 (8.10)	1.75 (2.10)	1.37 (0.90)	5.03 (24.4)	1.98 (3.06)	1.61 (1.63)	1.23 (0.56)
40	5.19 (26.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	5.05 (24.5)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	5.16 (25.6)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	5.06 (24.7)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm±	0.04	0.02	0.02	0.02	0.04	0.02	0.01	0.01
CD 5%	NS	0.06	0.06	0.06	NS	0.06	0.05	0.05

Note: Values are square root transformed (x + 1) and actual values are given in parentheses

Dry Matter Accumulation by Weeds

Dry Matter Accumulation by Phalaris Minor

Dry matter accumulation by P. minor was maximum in weedy check at harvest. The application of sulfosulfuron + metsulfuron reduced the dry matter of P. minor very effectively at all doses of herbicide compared to weedy check. Sulfosulfuron + metsulfuron (R. mix) when applied @ 20 g ha ^{1} significantly reduced the dry matter of compared to untreated plots. The higher dose @ 40 and 80 g ha ^{1} of sulfosulfuron + metsulfuron controlled P. minor to 100% during both the years (Table 12).

Table 12. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on dry matter accumulation by Phalaris minor (g m ^{2}) at different crop growth stages

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha ^{1}								
0	2.30	4.9 (2.3)	7.6 (58.3)	8.9 (79.5)	1.73 (2.02)	5.37 (28.0)	7.93 (62.0)	8.58 (72.7)
20	2.41	1.5 (1.4)	1.7 (2.0)	1.7 (2.1)	1.75 (2.07)	1.44 (1.10)	1.60 (1.56)	1.45 (1.33)
40	2.39	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.74 (2.03)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
80	2.23	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.76 (2.09)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm±	0.04	0.01	0.07	0.03	0.01	0.02	0.03	0.03
CD 5%	0.11	0.05	0.08	0.10	NS	0.06	0.09	0.09

Note: Values are square root transformed (x + 1) and actual values are given in parentheses

Dry Matter Accumulation by Broadleaf Weeds

All the doses of sulfosulfuron + metsulfuron (R. mix) reduced the dry weight of broad leaf weeds significantly at 20, 40 and 80 g ha ^{1}. However at 40 and 80g ha ^{1}, it reduced the dry weight of weeds by 100% at 60 and 90 DAS and at harvest during both the years of experimentation (Table 13).

Table 13. Effect of sulfosulfuron + metsulfuron (R. mix) treatments on dry matter of broad leaf weeds (g m ^{2}) at different crop growth stages

Treatments	2005-06 Days After Sowing				2006-07 Days After Sowing			
	30	60	90	At Harvest	30	60	90	At Harvest
Doses of (SSN + MSN) g ha^{-1}								
0	6.13	6.8 (42.4)	7.4 (54.3)	7.9 (62.7)	2.45 (5.0)	6.2 (38.6)	0.72 (52.3)	7.6 (58.3)
20	6.14	1.8 (2.4)	2.1 (3.6)	1.9 (2.7)	2.44 (5.0)	1.7 (1.9)	1.9 (2.8)	2.0 (3.3)
40	6.21	1.0 (0.0)	1.00 (0.0)	1.00 (0.0)	2.46 (5.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
80	6.10	1.0 (0.0)	1.00 (0.0)	1.00 (0.0)	2.50 (5.2)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
SEm±	0.10	0.03	0.03	0.03	0.01	0.03	0.02	0.03
CD 5%	NS	0.09	0.08	0.09	NS	0.09	0.08	0.09

Note: Values are square root transformed (x + 1) and actual values are given in parentheses

Density of Weeds

The effect of sulfosufluron + metsulfuron-methyl on weeds confirmed that by applying herbicide at a specific dose, selective control of weeds could be achieved in wheat. The density of Phalaris minor at 60 DAS was reduced upto 90, 100 and 100 per cent by application of 20, 40 and 80 g ha ^{1} sulfosufluron + metsulfuron as compared to weedy check. Different doses of sulfosufluron + metsulfuron reduced the population of *Melilotus indica, Rumex retroflexus, Anagallis arvensis, Lathyrus aphaca* and *Chenopodium album* to the tune of 82 to 100, 82.1 to 100, 92 to 100, 86-100 and 69 to 100 per cent, respectively over weedy check in 2005-06 and 2006-07. The efficient control of mostly broad leaves weeds by sulfosufluron + metsulfuron was also reported by (1) and poor efficiency of sulfosulfuron against Rumex refroflexus by (14).

Dry Weight of Weeds

Herbicide reduced the dry matter accumulation of all the weeds up to 100 per cent @ 40 g ha-1 at 60 DAS. The reduced dry weight of various grass as well as broad leaf weeds due to sulfosulfuron has already been found by (4).

Conclusion

The experimental field was dominated by *Phalaris minor, Melilotus indica, Rumex retroflexus, Anagallis arvensis, Lathyrus abhaca* and *Chenopodium album* during both the years. Application of sulfosulfuron + metsulfuron-methyl reduced the dry matter accumulation in all the weeds upto 100% when applied @ 40g ha ^{1} at 60 DAS during both the years.

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A STUDY ON SOCIO-ECONOMIC STATUS OF BULB CROPS VEGETABLE GROWERS IN BIJNOR DISTRICT OF WESTERN UTTAR PRADESH

Desh Pal Singh[1*], Satya Prakash[2], Vikas Malik[3], Krishna Kumar Singh[1], Shakuntala Gupta[1]

[1]Krishi Vigyan Kendra, Nagina (Bijnor), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.
[2]College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.
[3]Krishi Vigyan Kendra, Shamli, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.

Abstract

Total area under vegetables cultivation in India is 10259 thousand hectares with 184394 thousand metric tons production in 2017-18.. Out of total area of land under vegetables, onion occupies 1285 thousand hectares area with 23262 thousand metric tons production in 2017- 18. In the Bijnor district of the Uttar Pradesh, bulb crops-grown 1.01 thousand hectares area. Bulb crops grown in diverse agro climatic conditions faces differential biotic and abiotic stress limiting the production and productivity of bulb crops that in influenced the economic condition of bulb crops Growers. The purpose of the present study was to examine the socio-economic status of bulb crops growers in Bijnor district of Western Uttar Pradesh. The result of the analysis shows that 37.27 percent of respondent fall within the age range of 46 to 60 years, other backward caste (53.64 percent), education level-literate (80.00 percent), family type-joint family (72.27 percent), family member-4 to 6 members (68.64), land holding size-less than 1 hectare (53.64 percent), irrigation facilities-own (79.09 percent), 72.73 percent of respondents were engaged in farming activities only and 25.00 percent respondent were doing farming with business. 41.82 percent respondent got more than Rs 300000.00 annual income, 32.27 percent respondent have their own pumping set and electric motor and 52.73 percent respondent has not participated in any technical programme.

Keywords: Socio-economic status; bulb crops growers; respondent.

The group of bulb crops includes onion, garlic, leek, shallot and chive. These belong to the family Amaryallidaceae and genus Allium. They are grown in India as winter vegetables. It is consumed either raw or cooked along with spices and vegetables. Primary the bulbs used as vegetables. The flowering shoot known as Scape is also used as vegetable. It is rich in minerals like phosphorus and calcium and carbohydrates. It also contains Protein and Vitamin C. Among the Allium cultivated species, onion is an important vegetable crop grown in almost all parts of the world. The major onion growing countries in the world are China, India, USA and Turkey and other important countries are Italy, Egypt, Netherlands, Russia, Thailand, Indonesia, Korea, Japan and Brazil. In India, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Punjab, Haryana, Rajasthan, Uttar Pradesh, Bihar and Madhya Pradesh are the most important onion growing states. It is valued for its bulbs having characteristic odour, flavour and pungency, which is due to the presence of a volatile oil known as allyl-propyl-disulphide. Pungency is formed by enzymatic reaction when tissues are broken. Bulbs are suited for storage for a long period and

for long distance transport. The red colour of onion bulb is due to the presence of pigment anthocyanin and yellow colour due to "Quercetain". It is used as salad and cooked in many ways in curries, fried, boiled, baked and used in making soups, pickles etc. Value addition in onion is done by marketing dehydrated onions and onion flakes. Garlic is also important foreign exchange earner for India. It is consumed almost in every home kitchen garden for seasoning and flavouring the food and also consumed by almost all people who take onion. Garlic has higher nutritive value than other bulb crops. It is rich in proteins, phosphorous, potassium, calcium, magnesium and carbohydrates. Ascorbic acid content is very high in green garlic.

The healthy bulbs of garlic contains an amino acid called as Allin. It is a odourless, colourless and water soluble amino acid. On crushing the garlic bulbs the enzyme allinase breaks down into allin to produce allicin of which the principal ingredient is odoriferous Diallyl disulphide. Garlic contains about 0.1 percent volatile oil. The chief constituent of the volatile oil are diallyl disulphide (60 percent), diallyl trisulphide (20 percent), allyl, propyl disulphide (6 percent), a small quantity of diethyl disulphide and probably diallyl polysulphides. The typical flavor of garlic is due to the presence of Chemical Allicin plus Diallyl disulphide.

Total area under vegetables cultivation in India is 10259 thousand hectares with 184394 thousand metric tons production in 2017-18.. Out of total area of land under vegetables, onion occupies 1285 thousand hectares area with 23262 thousand metric tons production in 2017- 18 . In the Bijnor district of the Uttar Pradesh, bulb crops-grown 1.01 thousand hectares area [1]. Socio-economic condition particularly age, education, income, land holding size and extension contact greatly influenced the knowledge level of the bulb crop growers.

Materials and Methods

This study was conducted in Bijnor district of Western Uttar Pradesh. Bijnor district comprise of 11 blocks. Two villages from each block were selected randomly on the basis of bulb crops vegetables availability. Thus the total number of 22 villages was selected for the investigation and 10 bulb crops vegetables growers were selected from all selected villages. Thus the total sample size was of 220 respondents. The responses of bulb crops vegetables growers were collected through comprehensive schedule developed by researcher later the responses were tabulated. The data were analysed and find out the percentage and frequency [2,3].

Percentage

The frequency of a particular cell was divided by the total number of respondents in that particular category and multiplied by hundred.

Percentage (%)

$$\frac{\text{Actual no. of respondent}}{\text{Respondents or Score}} \quad 100$$

Mean

It was calculated to the average value of particular score. The formula is given below

$$\text{Mean Score} \frac{\text{Total scores on particular item}}{\text{No of Respondents}}$$

Results and Discussion

Socio-economic Status of the Bulb Crops Growers

Age

Among the socio-economic status characteristics, age is one of the most important character in understanding their view about the particular problems, by a large age indicates extent of maturity in particular individuals. In that sense age becomes more important to examine the response.

Table 1. Distribution of bulb crops growers according to their age

SN	Categories (Years)	Bulb crops growers	
		Frequency	Percentage
1	Young (15-30)	51	23.18
2	Lower middle (31-45)	67	30.45
3	Middle (46-60)	82	37.27
4	Old age (>61)	20	9.09
	Total	**220**	**100**

Table 1 indicates that majority of the bulb crops growers belonging to the middle age (37.27%) followed by lower middle age (30.45%); young age (23.18%) and old age (9.09%) bulb crops growers respectively. These same trends were also reported by many researchers [4,5,6,7].

Caste

Table 2. Distribution of bulb crops growers according to their caste

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	General caste	81	36.82
2	Other backward caste	118	53.64
3	Scheduled caste/ Scheduled Tribes	21	9.55
	Total	**220**	**100**

Table 2 focuses that a maximum number of the bulb crops growers belonging to general caste category. Out of total sample size highest percentage of bulb crops growers (53.64) belonged to other backward caste followed by 36.82 and 9.55 percent belongs to general caste category and scheduled caste and schedule tribes caste categories, respectively. The data revealed that the other backward caste person was having dominance in all type of horticultural activities of the village because of being more involve in vegetable production. The lower caste category person did not come together on single platform. This was also observed as one of the main reason due to which the rate of participation of all categories person is lower in training, meeting and development activities [8,9]. Thus, it is concluded that the majority of bulb crops growers (55.45) percent were belong to other backward caste.

Education

It is well known fact that education is one of the most important characteristics that might affect the person's attitudes and the way of looking and understanding any particular social phenomena. In a way, the response of an individual is likely to be determined by his educational status and therefore it becomes imperative to know the educational background of the bulb crops growers. Hence the variable 'Educational level' was investigated by the researcher and the data pertaining to education is presented in a given in Table 3.

Table 3. Distribution of bulb crops growers according to their education

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Illiterate	44	20.00
2	Literate	176	80.00
(a)	Can read and write	20	11.36
(b)	Primary School	38	21.59
(c)	Junior High School	27	15.34
(d)	High School	49	27.84
(e)	Intermediate	33	18.75
(f)	Graduate	7	3.98
(g)	Post Graduate	2	1.14
	Total	**220**	**100**

Table 3 revealed that 80.00 percent majority of the bulb crops growers was literate as against illiterate person (20.00 percent). Further, the educational standard of literate bulb crops grove in descending order was found as 27.84 percent, 21.59 percent, 18.75 percent, 15.34 percent, 11.36 percent, 3.98 percent and 1.14 percent were of High school, Intermediate, Primary school, Junior High school, Can read and write, Graduate and Postgraduate and about respectively [9,10].

Family Type

The type of family in which a person live and gets socialized has immense important in deciding his or her values, beliefs and behavior patterns which are likely to affects his or her attitudes towards a particular problem. Hence, the family type plays its own role in giving the response of an individual and therefore it was thought important to understand the family type of the bulb crops growers.

Table 4. Distribution of bulb crops growers according to their family type

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Single Family	61	27.73
2	Joint Family	159	72.27
	Total	**220**	**100**

Table 4 indicate that 72.27 percent bulb crops growers were associated with joint family system while 27.73 percent bulb crops growers were belonged to single family system hence the joint family system was dominated in the study area [5,10].

Family Size

Family size is also an important factor that influences the dominancy in the society. These influencers are shown in the Table 5.

Table 5. Distribution of bulb crops growers according to their family size

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Up to 3 member	54	24.55
2	4 to 6 member	151	68.64
3	7 and above	15	6.82
	Total	**220**	**100**

It is evident from the Table 5 that the highest percentage (68.64) of the bulb crops growers was belongs to the family who had 4 to 6 member in their family. 24.55 percent bulb crops grower's family belongs to that family who had three members and 6.82 percent bulb crops growers family belongs to that family who had more than 7 family members. It may be concluded that still there is dominancy of joint family system with 4 to 6 member in the study area. Similarly to reported that the most of bulb crops growers were lived in joint family system and had 4 to 6 family members.

Size of Land Holding

Size of land holding is also more important factor in socio- economic status of the farmer's family. Land holding in the study areas of bulb crops growers is given in Table 6.

Table 6. Distribution of bulb crops growers according to their size of land holding

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Marginal (<1 ha)	118	53.64
2	Small (1-2 ha)	67	30.45
3	Medium (2-5 ha)	30	13.64
4	Large (>5 ha)	5	2.27
	Total	**220**	**100**

Table 6. Indicates that the maximum bulb crops growers (53.64) percent were found in the land holding category of marginal bulb crops growers (less than 1.0 ha.) followed by 30.45 percent bulb crops growers have small land holding category (1 to 2 ha.), 13.64 percent bulb crops growers have medium land holding categories (2 to 5 ha.), and 2.27 percent bulb crops growers who had more than 5 hectare land. Some researcher also found the same trend that large land holding families grows bulb crops [3,9,10].

Irrigation Facility

Table 7. Distribution of bulb crops growers according to their irrigation facility

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Own (Diesel Engine, Tube well)	174	79.09
2	Hired (Govt. Tube well & Private Tube well)	32	14.55
3	Natural (Canal, River, Lake)	14	6.36
	Total	**220**	**100**

It is clear from the Table 7 that the 79.09% farmers have their owned irrigation sources (diesel engine and tube well). Along with the 14.55 percent bulb crops growers use to hire irrigation sources like government and private tube well. Only 6.36 percent bulb crops growers use to natural irrigation sources like canal, river and lakes. The result showed that the most of the bulb crops growers were not dependent on natural sources and they did not hired government or private tube well. It showed that the strong economic condition of the bulb crops growers of the study area.

Bulb Crops Growers Occupation

Person's occupations have a bearing on his or her personality and so also the ways of looking at the problem before him. The quality of life is also determined by an individual's occupations and the income he drives from it. Occupation of an individual also socialized him or her in a particular fashion which in turn reflects his or her pattern of behaviors and his or her extent understanding of particular phenomena. In other worlds the person response to a problem is possible determined by the type of occupations who is engaged in and hence venerable occupations was investigated by the researcher and data pertaining to occupation is presented in given in Table 8.

Table 8. Distribution of bulb crops growers according to their occupation

SN	Categories	Bulb crops growers			
		Occupation		Subsidiary occupation	
		Frequency	Percentage	Frequency	Percentage
1	Agriculture Labour	00	00	00	00
2	Caste based occupation	17	7.73	16	7.27
3	Service	23	10.45	00	00
4	Agriculture (Bulb Crops Farming & Agriculture)	160	72.73	128	58.18
5	Business	11	5.00	55	25.00
6	Agro-based Enterprises	09	4.09	21	9.55
	Total	**220**	**100**	**220**	**100**

It is clear from the about table that the bulb crops growers was the main occupation 72.73 percent followed by service 10.45 percent, caste based occupations 7.73 percent, business 5.00 percent and agro-based enterprises 4.09 percent, respectively. In case of subsidiary occupations, the maximum 58.18 percent of the bulb crops growers belong to agriculture bulb crops family category followed by business bulb crops family 25.00 percent, agro based enterprises 9.55 percent and caste based occupations 7.27 percent, respectively and anyone was responses were given by bulb crops growers as a agriculture labour and service. Similar finding were also reported by who reported that the main occupation of bulb crops growers was bulb crops farming, with subsidiary occupations including sugar cane and dairy farming and rendering of other services [8,9,10,11].

Annual Income

Income of a person plays important role in shaping the economic conditions of an individual which in turn is likely to have a bearing on the response about the problem posted to him. The researcher, therefore in this study attempted to investigate the income as variable and the data related to income of the bulb crops growers is presented in Table 9.

Table 9. Distribution of bulb crops growers according to their annual income

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Up to Rs.1,00,000	35	15.91
2	Rs. 1,00,001 to 2,00,000	40	18.18
3	Rs. 2,00,001 to 3,00,000	53	24.09
4	Above Rs. 3,00,001	92	41.82
	Total	**220**	**100**

The annual income of the bulb crops Growers were showed in Table 9 that 41.82 percent bulb crops Growers fall in the income group of rupees above 3,00,000/ followed by 24.09 percent farmers whose income is between rupees 200000 to 300000 lac, 18.18 percent farmers whose income is between 100000 to 200000 and 15.91 percent bulb crops growers whose income is upto 100000, respectively. The above finding of the table showed that about 40.00 percent of bulb crops growers fall in the income group of rupees above 300000/ lac.

Farm Power

Farm power machinery is also a character which indicates the socio-economic status of the bulb crops growers. Farm machinery status of the bulb crops growers is given in Table 10.

Table 10. Distribution of bulb crops growers according to their farm power

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	Jhhota buggi	45	20.45
2	Tractor with all required impalements	92	41.82
3	Pumping set/ Eclectic Motors	71	32.27
4	Power sprayer	12	5.45
	Total	**220**	**100**

The Table 10 indicates that the 41.82 percent bulb crops growers were found having their tractor with all required implements followed by 32.27 percent,20.45 percent and 5.45 percent there are pumping set/electric motors, jhhota buggi and power sprayer, respectively. The results showed that the bulb crops growers were good in their materials possession and it is a good to know that the crops growers were improving themselves as it is good for the cultivation of bulb crops and improve the production technologies.

Social Participation

Social participation of a person in various events and gathering shows his degree of involvement in his social and cultural life. This is likely to have an impact on this views and attitudes about the particular problem. Keeping this in mind variable social participations was considered for the investigation and data of the same is presented in a cursory glance over the data depicted in the Table 11.

Table 11. Distribution of bulb crops growers according to their social participation

SN	Categories	Bulb crops growers	
		Frequency	Percentage
1	No participation	116	52.73
2	Participation in one organization	71	32.27
3	Participation in two organization	20	9.09
4	Participation in more than two organization	13	5.91
	Total	**220**	**100**

The Table 11 indicates that out of 220 bulb crops growers, 52.73 percent bulb crops growers showed no participation in any organization followed by 32.27 percent bulb crops growers who were participated in one organization, 9.09 percent bulb crops growers who were participated in two organizations and remaining 5.91 percent bulb crops growers who were participated in more than two organization, respectively and no one was found as office bearer member of any organization.

Conclusion

Based on the finding of this study, it could be concluded that bulb crops production in the study area is profitable but there are many constraints like advantage of other agricultural crops over the bulb crops because sugarcane is dominant crop in Western Uttar Pradesh and it is hardy crop and give more return per unit area in any situations. The farm specific techniques and training are not upto the mark so this can encourage farmers to remain in the bulb crops farming that means none of the farmers achieved their maximum efficiency level to grow bulb crops. Bijnor distinct has much potential to grow bulb crops farming because Bijnor has diverse agro climate. There result can call for policies aimed at encouraging new bulb crops growers especially the youths who are agile and stronger to grow bulb crops and the experienced ones to remain in bulb crops farming.

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A STUDY ON SOCIO-ECONOMIC STATUS OF COLE CROPS VEGETABLE GROWERS IN BIJNOR DISTRICT OF WESTERN UTTAR PRADESH

Desh Pal Singh[1*], Satya Prakash[2], Vikas Malik[3], Krishna Kumar Singh[1], Shakuntala Gupta[1]

[1]Krishi Vigyan Kendra, Nagina (Bijnor), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.
[2]College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.
[3]Krishi Vigyan Kendra, Shamli, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India.

Abstract

Total area under vegetables cultivation in India is 10259 thousand hectares with 184394 thousand metric tons production in 2017-18. Out of total area of land under vegetables, cauliflower and cabbage occupies 453 and 399 thousand hectares area with 8668 and 9037 thousand metric tons production in 2017- 18 ,respectively. In the Bijnor district of the Uttar Pradesh, cole crops-grown 5.41 thousand hectares area. Cole crops grown in diverse agro climatic conditions faces differential biotic and abiotic stress limiting the production and productivity of cole crops that in influenced the economic condition of cole crops Growers. The purpose of the present study was to examine the socio-economic status of cole crops growers in Bijnor district of Western Uttar Pradesh. The result of the analysis shows that 40.00 percent of respondent fall within the age range of 46 to 60 years, other backward caste (55.45 percent), education level-literate (84.09 percent), family type-joint family (73.18 percent), family member-4 to 6 members (65.00), land holding size-less than 1 hectare (52.00 percent), irrigation facilities-own (80.00 percent), 73.64 percent of respondents were engaged in farming activities only and 26.36 percent respondent were doing farming with business. 40.00 percent respondent got more than Rs 300000.00 annual income, 40.45 percent respondent have their own pumping set and electric motor and 55.45 percent respondent has not participated in any technical programme.

Keywords: Socio-economic status; cole crops growers; respondent.

The word "cole" was derived from the word "Caules" means stem. Cole vegetables are a group of highly differentiated plants originated from a single wild ancestor species Brassica oleracea var. sylvestris, commonly known as wild cliff cabbage known as "Cole worts" or wild cabbage. They belongs to family Cruciferae and genus Brassica. Cole crops are the most popular vegetables grown in India during winter season. The most important six varieties of Brassica species / crops in cole group grown in India are cauliflower (*Brassica oleracea var. botrytis*), cabbage. (*Brassica oleracea var. capitata*), knol-khol (*Brassica oleracea var. gongiloides or caulorapa*), burssel sprout (*Brassica oleracea var. gemmifera*), sprouting broccoli (*Brassica oleracea var. italica*) and kale (*Brassica oleracea var. acephala*). They are rich sources of vitamin C. Cabbage juice is used as a remedy against poisonous monsoon. Some extract of these cole crops are used to cover wounds and ulcers. They are eaten raw as well as cooked. They have protective property against bowel cancer. All brassica species contain glucosinolates, which is crushed leaves is broken down by the enzyme myrosinge giving a bitter taste. Broccoli is also gaining popularity

among Indians due to its high medicinal value. A large variety of cole crops are grown in India, of which cauliflower (*Brassica oleracea var. botrytis*), cabbage. (*Brassica oleracea var. capitata*) and knol-khol (*Brassica oleracea var. gongiloides or caulorapa*) are the major ones. Apart from these vegetable like, burssel sprout (*Brassica oleracea var. gemmifera*), sprouting broccoli (*Brassica oleracea var. italica*) and kale (*Brassica oleracea var. acephala*) are also grown in sizeable areas. Although cole vegetable is grown throughout of the country, the major growing state are Uttar Pradesh Plains, Haryana, Rajasthan, Orissa, Uttranchal (Nainital, Pithaurgarh and Dehradun), Himachal Pradesh (Shimla, Kullu and Sirmour), Bihar (Santhal, Pargana, Purina, Katihar, Sitamarhi, Samastipur, Saharsa, Dhanbad, Patna, Nalanda, West and East Champaran, Muzzafarpur, Vaishali, Bhagalpur, Darbangha and Madhubani), Gujarat (Mehsana, Khera, Ahmedabad and Baroda), Maharashtra (Nasik, Nagpur and Kolhapur) and (Hassan, Bangalore (Rural and Urban), Kolar and Mysore). Apart from India, the other major producers of cauliflower in the world are China, France,Italy, UK, USA, Spain, Poland, Germany and Pakistan. India is the largest producer of cauliflower in the world. Total area under vegetables cultivation in India is 10259 thousand hectares with 184394 thousand metric tons production in 2017-18.. Out of total area of land under vegetables, cauliflower and cabbage occupies 453 and 399 thousand hectares area with 8668 and 9037 thousand metric tons production in 2017- 18 ,respectively. In the Bijnor district of the Uttar Pradesh, cole crops-grown 5.41 thousand hectares area [1]. Socio-economic condition particularly age, education, income, land holding size and extension contact greatly influenced the knowledge level of the farmers. The farmers should be sufficiently exposed to the technological developments so that they will develop confidence as well as competency and adopt improved practices resulting in area expansion, better production and productivity. Bijnor district has much potential to grow cole vegetables farming because district has diverse agro climatic condition so it is essential to find out the socio- economic status of cole vegetable growers for planning of policies and extension strategies in the distinct.

Materials and Methods

This study was conducted in Bijnor district of Western Uttar Pradesh. Bijnor district comprise of 11 blocks. Two villages from each block were selected randomly on the basis of cole crops vegetables availability. Thus the total number of 22 villages was selected for the investigation and 10 cole crops vegetables growers were selected from all selected villages. Thus the total sample size was of 220 respondents. The responses of cole crops vegetables growers were collected through comprehensive schedule developed by researcher later the responses were tabulated. The data were analysed and find out the percentage and frequency [2,3].

Percentage

The frequency of a particular cell was divided by the total number of respondents in that particular category and multiplied by hundred.

Percentage (%)

$$\frac{\text{Actual no. of respondent}}{\text{Respondents or Score}} \quad 100$$

Mean

It was calculated to the average value of particular score. The formula is given below

$$\text{Mean Score} \frac{\text{Total scores on particular item}}{\text{No of Respondents}}$$

Results and Discussion

Socio-economic Status of the Cole Crops Growers

Age

Among the socio-economic status characteristics, age is one of the most important character in understanding their view about the particular problems, by a large age indicates extent of maturity in particular individuals. In that sense age becomes more important to examine the response.

Table 1 indicates that majority of the cole crops growers belonging to the middle age (40.00%) followed by lower middle age (27.73%); young age (22.27%) and old age (10.00%) cole crops growers respectively. These same trends were also reported by many researchers [4,5,6,7].

Table 1. Distribution of cole crops growers according to their age

SN	Categories (Years)	Cole crops growers	
		Frequency	Percentage
1	Young (15-30)	49	22.27
2	Lower middle (31-45)	61	27.73
3	Middle (46-60)	88	40.00
4	Old age (>61)	22	10.00
	Total	**220**	**100**

Caste

Table 2 focuses that a maximum number of the cole crops growers belonging to general caste category. Out of total sample size highest percentage of cole crops growers (55.45) belonged to other backward caste followed by 35.91 and 08.64 percent belongs to general caste category and scheduled caste and schedule tribes caste categories respectively. The data revealed that the other backward caste person was having dominance in all type of horticultural activities of the village because of being more involve in vegetable production. The lower caste category person did not come together on single platform. This was also observed as one of the main reason due to which the rate of participation of all categories person is lower in training, meeting and development activities [8,9]. Thus, it is concluded that the majority of cole crops growers (55.45) percent were belong to other backward caste.

Table 2. Distribution of cole crops growers according to their caste

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	General caste	79	35.91
2	Other backward caste	122	55.45
3	Scheduled caste/ Scheduled Tribes	19	08.64
	Total	**220**	**100**

Education

It is well known fact that education is one of the most important characteristics that might affect the person's attitudes and the way of looking and understanding any particular social phenomena. In a way, the response of an individual is likely to be determined by his educational status and therefore it becomes imperative to know the educational background of the cole crops growers. Hence the variable 'Educational level' was investigated by the researcher and the data pertaining to education is presented in a given in Table 3.

Table 3 revealed that 84.09 percent majority of the cole crops growers was literate as against illiterate person (15.91 percent). Further, the educational standard of literate cole crops grove in descending order was found as 28.11 percent, 24.86 percent, 21.08 percent, 15.14 percent, 6.49 percent, 3.24 percent and 1.08 percent were of High school, Intermediate, Primary school, Junior High school, Can read and write, Graduate and Postgraduate and about respectively [9,10].

Table 3. Distribution of cole crops growers according to their education

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Illiterate	35	15.91
2	Literate	185	84.09
(a)	Can read and write	12	6.49
(b)	Primary School	39	21.08
(c)	Junior High School	28	15.14
(d)	High School	52	28.11
(e)	Intermediate	46	24.86
(f)	Graduate	6	3.24
(g)	Post Graduate	2	1.08
	Total	**220**	**100**

Family Type

The type of family in which a person live and gets socialized has immense important in deciding his or her values, beliefs and behavior patterns which are likely to affects his or her attitudes towards a particular problem. Hence, the family type plays its own role in giving the response of an individual and therefore it was thought important to understand the family type of the cole crops growers.

Table 4 indicate that 73.18 percent cole crops growers were associated with joint family system while 26.82 percent cole crops growers were belonged to single family system hence the joint family system was dominated in the study area [5,10].

Table 4. Distribution of cole crops growers according to their family type

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Single Family	59	26.82
2	Joint Family	161	73.18
	Total	**220**	**100**

Family Size

Family size is also an important factor that influences the dominancy in the society. These influencers are shown in the Table 5.

Table 5. Distribution of cole crops growers according to their family size

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Up to 3 member	64	29.09
2	4 to 6 member	143	65.00
3	7 and above	13	5.91
	Total	**220**	**100**

It is evident from the Table 5 that the highest percentage (65.00) of the cole crops growers was belongs to the family who had 4 to 6 member in their family. 29.09 percent cole crops grower's family belongs to that family who had three members and 5.91 percent cole crops growers family belongs to that family who had more than 7 family members. It may be concluded that still there is dominancy of joint family system with 4 to 6 member in the study area. Similarly to reported that the most of mango growers were lived in joint family system and had 4 to 6 family members.

Size of Land Holding

Size of land holding is also more important factor in socio- economic status of the farmer's family. Land holding in the study areas of cole crops growers is given in Table 6.

Table 6. Distribution of cole crops growers according to their size of land holding

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Marginal (<1 ha)	115	52.27
2	Small (1-2 ha)	68	30.91
3	Medium (2-5 ha)	31	14.09
4	Large (>5 ha)	6	2.73
	Total	**220**	**100**

Table 6 indicates that the maximum cole crops growers (52.27) percent were found in the land holding category of marginal cole crops growers (less than 1.0 ha.) followed by 30.91 percent cole crops growers have small land holding category (1 to 2 ha.), 14.09 percent cole crops growers have medium land holding categories (2 to 5 ha.), and 2.73 percent cole crops growers who had more than 5 hectare land. Some researcher also found the same trend that large land holding families grows cole crops [3,9,10].

Irrigation Facility

It is clear from the Table 7 that the 80.00% farmers have their owned irrigation sources (diesel engine and tube well). Along with the 13.18 percent cole crops growers use to hire irrigation sources like government and private tube well. Only 6.82 percent cole crops growers use to natural irrigation sources like canal, river and lakes. The result showed that the most of the 13.18 percent cole crops growers use to hire irrigation sources like government and private tube well. Only 6.82 percent cole crops growers use to natural irrigation sources like canal, river and lakes. The result showed that the most of the cole crops growers were not dependent on natural sources and they did not hired government or private tube well. It showed that the strong economic condition of the cole crops growers of the study area.

Table 7. Distribution of cole crops growers according to their irrigation facility

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Own (Diesel Engine, Tube well)	176	80.00
2	Hired (Govt. Tube well & Private Tube well)	29	13.18
3	Natural (Canal, River, Lake)	15	6.82
	Total	**220**	**100**

Cole Crops Growers Occupation

Person's occupations have a bearing on his or her personality and so also the ways of looking at the problem before him. The quality of life is also determined by an individual's occupations and the income he drives from it. Occupation of an individual also socialized him or her in a particular fashion which in turn reflects his or her pattern of behaviors and his or her extent understanding of particular phenomena. In other worlds the person response to a problem is possible determined by

the type of occupations who is engaged in and hence venerable occupations was investigated by the researcher and data pertaining to occupation is presented in given in Table 8.

Table 8. Distribution of cole crops growers according to their occupation

SN	Categories	Cole crops growers			
		Occupation	Subsidiary occupation		
		Frequency	Percentage	Frequency	Percentage
1	Agriculture Labour	00	00	00	00
2	Caste based occupation	15	6.82	14	6.36
3	Service	21	9.55	00	00
4	Agriculture (Cole Crops Farming & Agriculture)	162	73.64	129	58.64
5	Business	12	5.45	58	26.36
6	Agro-based Enterprises	10	4.55	19	8.64
	Total	**220**	**100**	**220**	**100**

It is clear from the about table that the cole crops growers was the main occupation 73.64 percent followed by service 9.55 percent, caste based occupations 6.82 percent, business 5.45 percent and agro-based enterprises 4.55 percent, respectively. In case of subsidiary occupations, the maximum 58.64 percent of the cole crops growers belong to agriculture cole crops family category followed by business cole crops family 26.36 percent, agro based enterprises 8.64 percent and caste based occupations 6.36 percent, respectively and anyone was responses were given by cole crops growers as a agriculture labour and service. Similar finding were also reported by who reported that the main occupation of cole crops growers was cole crops farming, with subsidiary occupations including sugar cane and dairy farming and rendering of other services [8,9,10,11].

Annual Income

Income of a person plays important role in shaping the economic conditions of an individual which in turn is likely to have a bearing on the response about the problem posted to him. The researcher, therefore in this study attempted to investigate the income as variable and the data related to income of the cole crops growers is presented in Table 9.

Table 9. Distribution of cole crops growers according to their annual income

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Up to Rs.1,00,000	36	16.36
2	Rs. 1,00,001 to 2,00,000	41	18.64
3	Rs. 2,00,001 to 3,00,000	55	25.00
4	Above Rs. 3,00,001	88	40.00
	Total	**220**	**100**

The annual income of the cole crops Growers were showed in Table 9 that 40.00 percent cole crops Growers fall in the income group of rupees above 3,00,000/ followed by 25.00 percent farmers whose income is between rupees 200000 to 300000 lac, 18.64 percent farmers whose income is between 100000 to 200000 and 16.36 percent cole crops growers whose income is upto 100000, respectively. The above finding of the table showed that about 40.00 percent of cole crops growers fall in the income group of rupees above 300000/ lac.

Farm Power

Farm power machinery is also a character which indicates the socio-economic status of the cole crops growers. Farm machinery status of the cole crops growers is given in Table 10

Table 10. Distribution of cole crops growers according to their farm power

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	Jhhota buggi	40	18.18
2	Tractor with all required impalements	89	40.45
3	Pumping set/ Eclectic Motors	73	33.18
4	Power sprayer	18	8.18
	Total	220	100

The Table 10 indicates that the 40.45 percent cole crops growers were found having their tractor with all required implements followed by 33.18 percent,18.18 percent and 8.18 percent there are pumping set/electric motors, jhhota buggi and power sprayer, respectively. The results showed that the cole crops growers were good in their materials possession and it is a good to know that the crops growers were improving themselves as it is good for the cultivation of cole crops and improve the production technologies.

Social Participation

Social participation of a person in various events and gathering shows his degree of involvement in his social and cultural life. This is likely to have an impact on this views and attitudes about the particular problem. Keeping this in mind variable social participations was considered for the investigation and data of the same is presented in a cursory glance over the data depicted in the Table 11.

Table 11. Distribution of cole crops growers according to their social participation

SN	Categories	Cole crops growers	
		Frequency	Percentage
1	No participation	122	55.45
2	Participation in one organization	76	34.55
3	Participation in two organization	12	5.45
4	Participation in more than two organization	10	4.55
	Total	**220**	**100**

The Table 11 indicates that out of 220 cole crops growers, 55.45 percent cole crops growers showed no participation in any organization followed by 34.55 percent cole crops growers who were participated in one organization, 5.45 percent cole crops growers who were participated in two organizations and remaining 4.55 percent cole crops growers who were participated in more than two organization, respectively and no one was found as office bearer member of any organization.

Conclusion

Based on the finding of this study, it could be concluded that cole crops production in the study area is profitable but there are many constraints like advantage of other agricultural crops over the cole crops because sugarcane is dominant crop in Western Uttar Pradesh and it is hardy crop and give more return per unit area in any situations. The farm specific techniques and training are not upto the mark so this can encourage farmers to remain in the cole crops farming that means none of the farmers achieved their maximum efficiency level to grow cole crops. Bijnor distinct has much potential to grow cole crops farming because Bijnor has diverse agro climate. There result can call for policies aimed at encouraging new cole crops growers especially the youths who are agile and stronger to grow cole crops and the experienced ones to remain in cole crops farming.

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PARTICIPATION OF RURAL WOMEN IN DECISION MAKING PATTERN ON FARM AND HOUSEHOLD RELATED ACTIVITIES

Anuradha Ranjan Kumari[1*], Satya Prakash[2] and Kamlesh Meena[3]

[1]Krishi Vigyan Kendra (DRRPCAU) Bhagwanpur Hat, Siwan, Bihar
[2]College of Horticulture, SVPUA&T, Meerut U.P.
[3]Agronomy, Krishi Vigyan Kendra (ICAR-IIVR) Malhana Deoria UP.
***Corresponding Author: Email**- anuradha_rau@rediffmail.com

Abstract

In Indian Society both husband and wife participate in different household activities. Their role are generally complementary not only in physical participation in farm but also in the decision making process concerning major land use activities. Women play a pivotal and potentially benefiting role in all-round growth of resource poor farm families. But often they are neglected in decision making on farm and house hold matters which are mostly managed by them. Participation in decision making process especially in economic activities is an indication of empowerment. The present study attempts to investigate the level of women economic empowerment in resource poor farm families by analyzing their extent of participation in decision making on farm and house hold related economic activities. The study was conducted in Deoria district of Uttar Pradesh. Out of sixteen blocks three blocks i.e. Salempur, Bhatpar Rani and Bhatni were selected for this study. From each block three villages selected and from each village ten resource poor farm families were selected randomly from nine villages, thus a total 90 couples (180 respondents) were selected for the purpose of the study. The study revealed that wives played a major role to jointly decide purchasing or hiring of land (41.11 - 42.22%), borrowing for agriculture (35.55 - 40.00%) and selling of produce (20.00 - 38.88%). Decisions for milking and processing of milk, utilization of dung and sale of milk and milk products were dominantly taken by wives (86.66%, 54.44% and 17.77% respectively), where purchase and sale of animals (37.77 - 40.00%), type and number of animals to be kept (30.00 - 37.77%) and adoption of new animal husbandry practices (28.88 - 33.33%). Household economic decisions on building new house, household purchasing, selected of occupation for children, Marriage of the children, education of children and financial activities were mainly taken jointly (36.66-41.11%, 34.44-35.55%, 33.33-34.44%, 24.44-32.33% and 24.44-30.00% respectively). The findings of the study indicate higher level of women economic empowerment in animal husbandry and household sectors.

Keywords: Economic empowerment, Resource-poor farm families, Household related economic activities, Participation, Rural women and decision making.

Introduction

Women empowerment especially economic empowerment is very important as it gives security to a woman. It is very crucial for progress of the society. Women play a pivotal and potentially benefiting role in all-round growth of resource-poor farm families. But often they are neglected in decision making on farm and household matters which are mostly managed by them. Participation in decision making process especially in economic activities is an indication of empowerment .In Indian society; both husband and

wife participate in different household activities. Their role are generally complementary, not only in physical participation in farm but also in the decision making process concerning major land use activities. In some of these activities, women take sole or joint decisions. Joint decisions were made in purchase and sale of land and management of animals where independent decisions were made in storage and marketing of produce (15). Women played a major role in land management decision making process (14). Women were found to take 73 per cent decision concerning household consumption, 55.74 per cent production decision and 38.74 per cent in investment decision making in land management (12). (16) also observed that women of the household made 20 per cent land use decisions. In male headed household, 15 to 34 per cent of the females played major roles in land management decision making where their decisions were accepted in regard to farm production activities (13).

Globalization has offered tremendous opportunities for overall growth and development of both men and women. It has altered the socio-economic status, life style and life condition of women. Globalization has given women a stronger voice. People are more accepting of women's rights. There has been an increased emphasis on women's rights at the grass roots level. Women started to participate in social activities and their economic conditions have also improved. Even there, women at village level are not getting the benefits of the developmental programmes. Women influence the farmer in many ways. She influences the farmer in selection of crop, developing the farm with irrigation and other facilities, adoption of latest technologies, timely harvesting, a sifting the farmer in post harvesting and storage, timely marketing of the produce and in savings for the future. In spite of all these, women are not given proper attention. But the globalization has provided many ways and means for the overall development and empowerment of women.

A resource-poor farmer cannot be entirely dependent on outside laborers to work in his farm, instead all the able family members including the females of the family have to be involved themselves in various farming practices. Though women bear a crucial and potentially benefiting role in all round growth of resource poor farm families, they face indirect negligence and economic insecurity rendering their very simple but necessary wants to fulfill. Often they are not asked to take any decision in farm and household matters which are mostly managed by them. Participation in decision making especially in economic matters is a clear indication of empowerment. In the present study, an attempt has been made to investigate the level of women economic empowerment in resource-poor farm families by analyzing their extent of participation in decision making on farm and household related economic activities.

Methodology

The study was conducted in Deoria district of Uttar Pradesh. Out of sixteen blocks, three blocks i.e. Salempur, Bhatpar Rani and Bhatni were selected for this study. From each block three villages selected and from each village ten resource poor farm families were selected randomly from nine villages, thus a total 90 couples (180 respondents) were selected for the purpose of the study. A comprehensive list of important economic activities pertaining to farm (Crop cultivation and animal husbandry) and house hold activities was prepared in consultation with the experts, available literature and farmers of non-sampling area. The possible combinations taken for decision making were husband (H), Wife (W), along with spouse (HW) and in consultation with others i.e. including children, family members and relatives, neighbors and fellow progressive farmers and experts. Data were collected with the help of a pretested structured interview schedule by personal interview method. Appropriate statistical tools were used for analysis of data. In order to measure the extent of association or agreement between husbands and wife responses.

Results and Discussion

In the present study, participation of wives of the selected farm families in decision making on crop cultivation, animal husbandry and household related economic activities was delineated by taking into consideration both husband's and wife's responses.

Women participation in decision making on crop cultivation related economic activities: There

are many decisions involved in crop cultivation related economic activities starting from selection of cropping pattern and cultivars to adoption of innovation. The data presented in Table 1 and Table 2 reveal an overall picture of decision making pattern observed in farm households. Decision regarding selection of cropping pattern and cultivars was found mostly taken by husband (64.44%). Capital allocation to different crops was reported mainly decided by husband (57.77%) followed by both husband and wife (17.17-25.55%). Decision regarding procurement of inputs (type of inputs to be procured and the source of procurement of input) was found mainly taken by husband (70.00%).

Table 1. Decision making pattern on crop cultivation related to economic activities

[Husband's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Selection of cropping pattern and Cultivars	58	64.44	0	0.00	3	3.33	29	32.22
Capital allocation to different crop	52	57.77	2	2.22	23	25.55	13	14.44
Procurement of inputs	63	70.00	1	1.11	4	4.44	22	24.44
Selling of produce	28	31.11	3	3.33	18	20.00	41	45.55
Purchasing or hiring of land	19	21.11	4	4.44	37	41.11	30	33.33
Borrowing for agriculture	31	34.44	2	2.22	32	35.55	15	16.66
Adoption of innovation	29	32.22	0	0.00	11	12.22	50	55.55

Decisions related to selling of produce like place of sale and quantities of sale were mainly taken jointly (20.00-38.88%) followed by husband alone (31.11%). The individual husband decision was observed lower in this case, because it was reported as the most important decision taken by the resource-poor farm families as profit is involved in this decision and collective decision used to be beneficial in this case. Purchasing or hiring of land was mostly decided jointly (41.11-42.22%) followed by husband alone (21.11%). Decisions pertaining to borrowing for agriculture (source, quantity, mode of repayment involved etc.) were predominantly taken jointly (35.55-40.00%) followed by husband alone (34.44%). Adoption of innovations regarding improved farming practices was mainly decided in consultation with others (45.55- 55.55%). The major finding coming out from the above results is the higher degree of collectivity in decision making pattern and this will increase the degree of rationality in decisions which is most important for the resource-poor farm families. Some deviations were found in district regarding decision making pattern of farm households in crop cultivation related economic activities. Husband and wife joint participation in taking decision regarding purchase or hiring of land and borrowing of agriculture.

Table 2 . Decision making pattern on crop cultivation related to economic activities

[Wife's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Selection of cropping pattern and Cultivars	41	45.55	6	6.66	10	11.11	33	36.66
Capital allocation to different crop	43	47.77	7	7.77	16	17.77	24	26.66
Procurement of inputs	40	44.44	5	5.55	14	15.55	31	34.44
Selling of produce	33	36.66	9	10.00	35	38.88	13	14.44
Purchasing or hiring of land	28	31.11	7	7.77	38	42.22	17	18.88
Borrowing for agriculture	30	33.33	2	2.22	36	40.00	22	24.44
Adoption of innovation	21	23.33	3	3.33	25	27.77	41	45.55

The overall finding of the study regarding decision making pattern in crop cultivation related economic activities finds some correspondence with the following studies. Roy (2015) reported that males were dominant decision maker in the areas of selection of cropping pattern and cultivars, capital allocation to different crops and procurement of inputs whereas decisions were mainly taken jointly in case of purchasing or hiring of land, selling of produce and borrowing for agriculture. (5) reported higher extent of joint decision making in case of marketing of produce. (4) observed that men performed the dominative role in various decisions related to economic activities of vegetable cultivation while the role of women in majority of the cases was supportive in nature. (6) found very low or negligible role of female members in decision making regarding farm credit, investment of added profit and adoption of innovative technologies. (2) observed higher number of farm women in low category of decision making regarding agricultural operations. (1) reported that women's decision was negligible in farm activities like sale & purchase of land and taking of loan & advances.

Women participation in decision making on animal husbandry related economic activities: Data presented in Table 3 and Table 4 give an idea about decision making pattern in animal husbandry related economic activities. It can be concluded that wives relatively dominated their spouses in decision making on this part. They mainly took decisions regarding milking and processing of milk by deciding type and quantity of milk processing (86.66%) followed by utilization of dung in terms of quantity and type (54.44%) and quantity and place of sale of milk and milk products (47.77%).

Table 3: Decision making pattern in animal husbandry related economic activities

[Husband's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Type and number of animals to be kept	31	34.44	24	26.66	27	30.00	8	8.58
Milking and processing of milk	12	13.33	57	63.33	16	17.77	5	5.55
Purchase of feed, dairy utensils, concentrates	19	21.11	33	36.66	28	31.11	10	11.11
Purchase and sale of animals	27	30.00	20	22.22	34	37.77	9	10.00
Sale of milk and milk products	25	27.77	46	51.11	15	16.66	4	4.44
Utilization of dung	14	15.55	53	58.88	11	12.22	12	13.33
Adoption of new animal husbandry practices	26	28.88	15	16.66	30	33.33	19	21.11

Majority of the wives reported that milk is the major nutritional source in their family and milk products like ghee is mainly prepared for family consumption. Feeding of children and other family members was entirely taken care of by wives. As a consequence, the wives mainly used to decide how much quantities of milk and ghee should be retained for family consumption and how much quantities of these should be given for sale. The greater involvement of wives in animal husbandry activities increased their economic decision making ability. Joint decision was found predominant in case of purchase and sale of animals which deals with type and number of animals to be purchased/sale (37.77-40.00%) followed by type and number of animals to be kept (30.00-37.77%) and adoption of new animal husbandry farming practices which includes adoption, rejection, discontinue etc. (28.88-33.33%). Individual husband decision was observed predominant in case of type and number of animals to be kept (34.44%) followed by purchase and sale of animals (30.00%) and adoption of new animal husbandry practices (28.88%). Consultation of others was mostly taken in case of adoption of new animal husbandry practices (21.11-31.11%). The decision making pattern in animal husbandry related economic activities varies from District to District. In Deoria district joint decision was taken in case of purchase of feed and concentrates, sale of milk and milk products.

The overall finding of the study regarding decision making pattern in animal husbandry related economic activities shows communality with some findings of the following researchers. (7) also reported predominant join participation in deciding type and number of livestock to be kept. (11) observed that decision pertaining to the number of animals to be reared was mostly made by both men and women. (9) reported that females mainly decided the type and quantity of milk products to be prepared. (3) found that tribal farm women play dominant role in making decisions related to animal husbandry enterprise.

Table 4: Decision making pattern in household related economic activities

[Wife's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Type and number of animals to be kept	30	33.33	20	22.22	34	37.77	6	6.66
Milking and processing of milk	3	3.33	78	86.66	4	4.44	5	5.55
Purchase of feed, dairy utensils, concentrates	33	36.66	18	20.00	24	26.66	5	5.55
Purchase and sale of animals	24	26.66	19	21.11	16	40.00	11	12.22
Sale of milk and milk products	18	20.00	43	47.77	22	24.44	7	7.77
Utilization of dung	4	4.44	49	54.44	33	36.66	4	4.4
Adoption of new animal husbandry practices	22	24.44	14	15.55	26	28.88	28	31.11

Women participation in decision making on household related economic activities: It can be observed from Table 5 and Table 6 that individual husband participation in decision making on household related economic activities was not found predominant in any activity and their relatively higher involvement in financial activities was observed in taking decision regarding building new house (37.77%) followed by household purchasing (32.22%) and education of children (22.22%).

Table 5: Decision making pattern in household related economic activities

[Husband's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Building new house	34	37.77	12	13.33	37	41.11	7	7.77
Household purchasing	29	32.22	16	17.77	32	35.55	13	14.44
Education of children	20	22.22	25	27.77	22	24.44	23	25.55
Selection of occupation for children	15	16.66	27	30.00	31	34.44	17	18.88
Marriage of the children	16	17.77	18	20.00	26	28.88	30	33.33
Financial activities	43	47.77	17	18.88	22	24.44	8	8.88

Husband-wife joint participation was found predominant in decision making regarding building of new house that deals with deciding place, process, type, renovation, etc. (36.66-41.11%) followed by household purchasing which includes type, place of purchase, mode of payment, etc. (34.44-35.55%), selection of occupation for children which involves deciding type of occupation, place of occupation, etc. (33.33-34.44%), education of children in term of selection of school, selection of private teacher, level of education to be given, etc. (24.44-32.22%) and financial activities related to saving, borrowing, repayment, etc. (24.44-30.00%). Marriage of the children was found mainly decided in consultation with others involving family members and relatives (33.33-43.33%).

Table 6: Decision making pattern in household related economic activities

[Wife's response (N=120)]

Activities	H		W		HW		Others	
	F	%	F	%	F	%	F	%
Building new house	28	31.11	20	22.22	33	36.66	9	10.00
Household purchasing	23	25.55	30	33.33	31	34.44	6	6.66
Education of children	19	21.11	26	28.88	29	32.22	35	38.88
Selection of occupation for children	22	24.44	31	34.44	30	33.33	7	7.77
Marriage of the children	15	16.66	24	26.66	12	13.33	39	43.33
Financial activities	32	35.55	23	25.55	27	30.00	8	8.88

The overall finding of the study regarding decision making pattern in household related economic activities finds some conformity with the following studies. (3) found predominant joint participation amongst tribal households in decision making regarding construction of new house, children's marriage and selling & purchasing of ornaments. (1) reported higher degree of joint decision making in household related financial matters like income of the family and savings in the family.

Conclusion

There are many matters where rational decisions are sought. These matters include establishment matters, farm management matters, child related matters, social and religious matters as well as financial matters like saving, borrowing, repayment, etc. If the rational and proper decisions are not taken in these matters, a family face problem, which adversely affects the family living. Again, analysis of decision making pattern in household activities reveals a clear picture of the position and importance of every member in the family and identifies the key decision maker of the family in household related activities. Analysis of women participation in decision making on farm and household related economic activities of a resource-poor farm family is essential to delineate the level of women economic empowerment in that family. Here an attempt had been taken in this direction. From the present study it can be summarized that males were dominant decision maker in the areas of selection of cropping pattern and cultivars, capital allocation to different crops and procurement of inputs whereas decisions were mainly taken jointly in case of purchasing or hiring of land, selling of produce and borrowing for agriculture. Most of the decisions related to animal husbandry were taken either by wives or jointly. Decisions regarding milking and processing of milk, utilization of dung and sale of milk and milk products were dominantly taken by wives, where purchase and sale of animals, type an number of animals to be kept and adoption of new animal husbandry practices were mainly decided jointly. Decisions for building new house, household purchasing, education of children, selection of occupation for children and financial activities were mainly taken jointly by husband and wife. Considering the extent of involvement of female members of the family in decision making process of farm and household related economic activities, it can be inferred that there is satisfactory level of women economic empowerment in resource-poor farm families and the findings of the study imply the necessity of training and capacity building of the women folk in the areas where they are key decision maker so that they can make right decisions.

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MARIGOLD INTERCROPPING WITH CABBAGE FOR PEST MANAGEMENT AND ADDITIONAL INCOME OF FARMERS

Anuradha Ranjan Kumari[1*], Satya Prakash[2] and S. K. Mandal[3]

[1]Krishi Vigyan Kendra (DRRPCAU) Bhagwanpur Hat, Siwan, Bihar
[2]College of Horticulture, SVPUA&T, Meerut U.P.
[3]Krishi Vigyan Kendra (DRRPCAU) Bhagwanpur Hat, Siwan, Bihar
***Corresponding Author: Email**- anuradha_rau@rediffmail.com

Abstract

Cabbage is the most popular winter Vegetable in India. Presently it is available in the market round the year. It is rich in mineral matters and Vitamin A, B, B2 and C. It is grown at large scale by the Vegetable growers, most of the Vegetable Growers were growing Cabbage as sole crop and got average yield 216 qt/ha with the Rs 181 lakhs/ha/year net return, the income of farmers was not good because quality of cabbage was deteriorate due to infestation of pest. To keeping in view Marigold intercropping with cabbage was promoted through transfer of production technologies. In this system Marigold Variety (Pusa Narangi) and Cabbage Variety (Golden Acer) nursery were sown in First week of August. Seeds of both crops (Cabbage & Marigold) and nursery beds were treated before sowing for the prevention of Damping- off disease. In This technology Farmer got the cabbage yield 160 qt/ha with good quality and marigold flowers yield 82qt/ha with the net return Rs 2.85 lack/ha. Pest attack on cabbage crop was minimising due to marigold crop. It's also proved by (7), resulting quality were better than sole crop of cabbage. With this technique Farmer income increase 57.45%.On the basis of this result this technique is suitable to the farmers. Now this technique is adopting by farmers at large level. Cabbage @ Rs 1200/qt, Marigold @ Rs2500/qt, Cost of Cultivation alone crop Rs 75000/ha and intercrop Rs 120,000.

Keyword: Marigold, cabbage, intercropping, Pest Management, Doubling Farmers Income.

Introduction

Cabbage is the one of oldest cultivated Vegetables used by ancient Greek and Romans. It is grown mainly as a winter crop in the plains of India. The main crop is grown in northern India where the winter temperature is relatively low. It is grown as kitchen garden and truck gardens in India. Cabbage is used as salad, boiled vegetable, cooked in curries, Pickled as well as dehydrated vegetable. Vegetable growers are growing this crop September to June as sole crop. Growers are not gating good return. Keeping in view this study was carried marigold intercropping with Cabbage. On the basis of result this study will play the significantly role towards increasing the income of the vegetable growers.

Methodology

To keeping in view of the increasing income of farmers this study was carried out during 2019 - 2020 in districts Siwan in Bihar State. For these studies 24 farmers were selected from 6 villages covering two blocks Bhadaria and Maharajganj. Cabbage (Variety - Golden Acer) And Marigold (Variety-Pusa Basanti) nursery were raising in the first week of August under low tunnel playhouse. Seeds of both crops were treated by Captan@2gram/kg Seed before the Sowing. Nursery beds were also treated for the Control of Damping-off disease. In the first week of September cabbage transplanted at the distance of 75 cm line to line and 30 cm plant to plant distance and Marigold transplanted 45 cm plant to plant distance between two rows of cabbage. After that Cultural practices done as per need time to time and Observation were recorded. . Observation is given below.

Results And Discussion

Table 1. Details of Marigold intercropping with Cabbage

Name of crop	Variety	Row to row distance (cm)	Transplanting	Plat to plant distance (cm)	Seed rate/ha	Application of fertilizers (kg/ha)		
						N	P	K
Cabbage (Main crop)	Golden Acer	75	Is week of September	30	350gram	180	60	50
Marigold (Intercrop)	Pusa Basanti	75	2 week of Feb.	45	750gram	80	40	40

Table: 2. Marigold intercropping with Cabbage.

S. No.	Detail	Marigold intercropping with Cabbage	Sole crop of Cabbage
1.	Main crop	Cabbage(Golden Acer)	Cabbage (Golden Acer)
2.	Intercrop	Marigold (Pusa Basanti)	——
3.	Sowing time	Sowing Time of Nursery. Cabbage And Marigold First week of August.	Sowing Time of Nursery. Cabbage First week of August.
4.	Transplanting	First Week of September	First week of September
5.	Seed rate	Cabbage-350gm/ha Marigold-750gm/ha	Cabbage-500gm/ha
6.	Average Cost of Cultivation	Rs.- 1.12 Lakh/ha	Rs-0.782Lakh/ha
7.	Average Production	Cabbage-160 qt/ha Flower-82qt/ha	216qt/ha
8.	Pest Incidence	2-3%	15-18%
9.	Average Rate	Cabbage-Rs 1200/qt Marigold Flower 2500/qt	Cabbage-Rs 1200/qt
10.	Average Total Return-	Rs-3.97 Lacs	Rs-2.59200Lakhs
11.	Average Net Return	Rs-2.85Lakhs	Rs-1.81 Lakhs
12.	Income increased	57.45%	-

Note- Cabbage @Rs 1200/qt, Flower @Rs 2500/qt

In table No. 2 data shows that plantation time of Marigold intercropping with Cabbage and Sole crop of Cabbage were same in the first week of September. Seed requirement of cabbage 350 gm and Marigold 750 gm/ha in intercrop and in sole crop of cabbage seed was 500 gm/ha. Cost of Cultivation in intercrop was 1.12 Lacs and in Sole crop, it was 0.782 Lacs/ha.

Crop yield was found in marigold inter crop with Cabbage 160qt and marigold flower 82 qt/ha and in sole crop cabbage yield was 216 qt/ha. Total Return in intercrop was 3.97 Lacs and in sole crop

it was Rs 2.59/ha and net return in intercrop was found Rs 2.85 Lacs/ha and in sole crop it was Rs 1, 81 Lacs/ha. It was Significant higher than sole Crop of Cabbage. Income was increased 57.45% in Marigold with Cabbage intercropping system in comparison to sole crop of Cabbage. Different pest incidence also reduced (7) due to Marigold inter cropping with cabbage reduced in comparison to sole crop it became 2-3% in place of 15-18% ,Study of (1) and Iamba K, Yoba S. (2019) also proved. On the above basis study revealed that Marigold intercropping with Cabbage system is suitable towards the increasing the income of Vegetables growers.

Conclusion

On the basis of present investigation Marigold inter cropping with Cabbage proves that Marigold intercropping with Cabbage cropping system increasing the 57.45% income of vegetable growers in comparison to the sole crop of Cabbage cultivation .Pest incidence also reduced in this cropping system it became 2-3% instead of 15-18%,and cabbage quality was found better. It is also proved by Study of (7). This Investigation is profitable in comparison to sole crop of Cabbage. Thus Marigold intercropping with Cabbage cultivation should be promoted for increasing the farmer's income. In this Cropping System natural resources like soil and water are also proper utilized and input use efficiency also increased.

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MARKER ASSISTED SELECTION IN PLANT BREEDING: CURRENT STATUS, CHALLENGES AND FUTURE OPPORTUNITIES

M.K. Sarma[1], Nizamuddin Ahmed[1], Daizi Durba Saharia[1] and AK Sarma

[1]Department of Plant Breeding and Genetics, BN College of Agriculture, Assam Agricultural University, Biswanath Chariali, Assam- 784 176
[2]ICAR - Indian Institute of Wheat and Barley Research, Kernal, Haryana
***Corresponding Author: Email**- mk.sbnca@gmail.com

Abstract

Conventional plant breeding along with biotechnological approaches has made a remarkable success in accelerating crop improvement programme worldwide during last few decades. Plant breeders has been facing newer challenges of trait specific breeding, speeding up of selection process, increased susceptibility of pests and diseases, need for resistance towards abiotic stresses particularly climatic adversities etc. Acceleration of the selection process is a must for plant breeding to cope up with the newer challenges. In accelerated breeding, molecular marker technology has been proved to be the most promising one. In this paper, an attempt has been made to give a comprehensive account of molecular markers, marker assisted selection and their current status of application, the challenges and future scopes.

Key Words: Molecular Marker, Marker Assisted Selection, Plant Breeding, Current Status, Challenges and opportunities

Introduction

The conventional plant breeding in combination with advances in molecular biology and biotechnological tools has made remarkable progress in accelerating crop breeding over last few decades. However, the task of crop improvement has never been free from newer challenges. With the increased demand of food production, there has been growing need to speed up the selection approach in crop improvement programme. Plant breeders constantly faces a multitude of problems and constrains during the process which often makes the task exhaustive and difficult. Plant breeders must respond to many changes to make a plant breeding programme successful. Firstly, there has been need for developing trait specific varieties to cope up with the fast changes in agricultural practices. Secondly, the increased susceptibility of crops towards new pests and diseases has necessitated search for new resistance genes and techniques for identification and transfer. Finally, the changing consumer preferences and demand has also created a need for development of genotypes with specific characteristics (6).

The task of increasing crop yields represents an unprecedented challenge for plant breeders and agricultural scientists (6). The mounting water scarcity, decreasing cultivable area and environmental degradation of arable land, inevitable emergence of new races and biotypes of pathogens and pests, increasing pollution and possible adverse effects of climate change are some of the notable factors which needs to be counter acted through advanced breeding approaches.

Although, conventional breeding approaches are still playing a vital role in yield improvement, it is primarily based on phenotypic selection of superior individuals among segregating progenies derived from hybridization where genotype-environment interactions puts forth much confusions. To overcome this, new approaches based biotechnology will be needed to maximize the probability of success (27). One area of biotechnology, the DNA marker technology, offers great promise for plant breeding. Biotechnology and applications of molecular markers in combination with conventional practices of plant breeding has created new directions for plant breeding as interdisciplinary science for crop improvement (31). Owing to genetic linkage with traits under selection, DNA markers can be utilized to detect the presence of allelic variation in the genes underlying their respective traits. Molecular markers have widely been used as a new era of plant molecular research. It involves DNA fingerprinting to detect polymorphism among different individuals. It has become a basic tool in crop improvement via plant breeding methods (1). The use of DNA markers in plant breeding is called marker-assisted selection (MAS) and it forms a component of the new discipline of 'Molecular Breeding'. Plant geneticists and a growing number of plant breeders consider molecular marker assisted selection (MAS) a useful additional tool in plant breeding programmes to optimize selection efficiency (17, 42). In the underlying sections, a comprehensive account of molecular markers, their use in plant breeding, current status, challenges and the future opportunities is presented.

What are Markers?

The genetic marker is a DNA sequence with a known chromosomal location showing a strong association with a particular trait of interest and thereby, the gene governing the trait. Genetic markers are closely related with the target gene and they act as sign or flags (11)

Genetic markers are the biological features that are determined by allelic forms of genes or genetic loci and can be transmitted from one generation to another, and thus they can be used as experimental probes or tags to keep track of an individual, a tissue, a cell, a nucleus, a chromosome or a gene.

Ideal markers must show high level of polymorphism, co-dominant, ease of allele detection, distributed thoroughly throughout the genome, economical, neutral, reproducibility and ease to use. DNA marker polymorphism should be expressed in all cells and tissues of the plant irrespective of developmental stage (39).

Types of Markers

Since the inception of conventional plant breeding in the beginning of the 20th century, breeders recognized certain phenotypic and apparently neutral characteristics of crop plants, which coincide with specific expressions of traits of importance. Thereby, those characteristics were supposed to 'mark' the desired or undesired individuals and are called 'phenotypic markers'. Their function is based on genetic linkage between the genes for the characteristics and the important traits. As phenotypic markers are rather rare and not available in every segregating population, their scale of application is limited. Therefore, in the next phase the protein-based markers (Isozymes) were seen to attaract the attention of plant breeders. It was evident that about 26 widely used detection systems with up to ten loci per system became available (32). These markers, were also not able to play a significant role in selection programme owing to their limited availability and other drawbacks. However with the advent of the DNA markers, the whole scenario changed towards a very promising direction leading to the successful development of the marker assisted selection. The discovery of DNA markers, i.e., the unexpressed DNA sequence differences at or nearby loci for genes of interest, resulted in a (theoretically) unlimited number of potential markers (26). This paved the dramatic development in the use of molecular markers in plant breeding and genetic studies.

Genetic markers are broadly grouped into two categories: classical markers and DNA / molecular markers. Morphological, cytological and biochemical markers are types of classical markers and some examples of DNA markers are restriction fragment length polymorphism

(RFLP), amplified fragment length polymorphism (AFLP), simple sequence repeats (SSRs), single-nucleotide polymorphism (SNP) and diversity arrays technology (DArT) markers. DNA markers have developed into many systems based on different polymorphism-detecting techniques or methods (southern blotting - nuclear acid hybridization, PCR - polymerase chain reaction, and DNA sequencing) (21). They may differ from each other in a variety of ways-such as their technical requirements (e.g. whether they can be automated or require use of radioactivity); the amount of time, money and labour needed; the number of genetic markers that can be detected throughout the genome; and the amount of genetic variation found at each marker in a given population. The information provided to the breeder by the markers varies depending on the type of marker system used. (10).

DNA markers are also called molecular markers in general and play a major role in molecular breeding. Depending on application and species involved, ideal DNA markers for efficient use in marker-assisted breeding should meet the following criteria (Guo-Liang Jiang, 2013):

1. High level of polymorphism
2. Even distribution across the whole genome (not clustered in certain regions)
3. Co-dominance in expression (so that heterozygotes can be distinguished from homozygotes)
4. Clear distinct allelic features (so that the different alleles can be easily identified)
5. Single copy and no pleiotropic effect
6. Low cost to use (or cost-efficient marker development and genotyping)
7. Easy assay/detection and automation
8. High availability (un-restricted use) and suitability to be duplicated/multiplexed (so that the data can be accumulated and shared between laboratories)
9. Genome-specific in nature (especially with polyploids)
10. No detrimental effect on phenotype

Marker Assisted Selection (MAS)

The molecular marker systems described above allow high-density DNA marker maps (i.e. with many markers of known location, interspersed at relatively short intervals throughout the genome) to be constructed for a range of economically important crops, thus providing the framework needed for eventual applications of MAS. Using the marker map, putative genes affecting traits of interest can then be detected by testing for statistical associations between marker variants and any trait of interest. These traits might be genetically simple, eg., many traits for disease resistance in plants are controlled by one or a few genes (48). Alternatively, they could be genetically complex quantitative traits, involving many genes (i.e., so-called quantitative trait loci -QTL) and environmental effects. Most economically important agronomic traits tend to fall into this category.

Having identified markers physically located beside or even within genes of interest, in the next step it is now possible to carry out MAS, i.e., to select identifiable marker variants (alleles) in order to select for non-identifiable favorable variants of the genes of interest.

The mechanism of marker assisted selection can be explained with relative ease by taking the classical hypothetical situation mentioned in the book 'Marker-Assisted Selection- Current status and future perspectives in crops, livestock, forestry and fish' published by FAO (2007) where a molecular marker M (with two alleles M1 and M2), identified using a DNA assay, is known to be located on a chromosome close to a gene of interest Q (with a variant Q1 that increases yield and a variant Q2 that decreases yield),that is, as yet, unknown. If a given individual in the population has the alleles M1 and Q1 on one chromosome and M2 and Q2 on the other chromosome, then any of its progeny receiving the M1 allele will have a high probability (how high depends on how close M and Q are to each other on the chromosome) of also carrying the favorable Q1allele,and thus would be preferred for selection purposes. On the other hand, those that inherit the M2 allele will tend to have inherited the unfavorable Q2 allele, and so would not be preferred for selection. With conventional selection which relies on phenotypic values, it is not possible to use this kind of information. Thus, MAS can be defined as selection for a trait based on genotype using associated markers rather than the phenotype of the trait (20).

The success of MAS is influenced by the relationship between the markers and the genes of interest. (14) distinguished three kinds of relationship:

1. The molecular marker is located within the gene of interest (i.e. within the gene Q, using the example above). In this situation, one can refer to gene-assisted selection (GAS). This is the most favorable situation for MAS since, by following inheritance of the M alleles, inheritance of the Q alleles is followed directly. On the other hand, these kinds of markers are the most uncommon and are thus the most difficult to find.
2. The marker is in linkage disequilibrium (LD) with Q throughout the whole population. LD is the tendency of certain combinations of alleles (e.g. M1 and Q1) to be inherited together. Population wide LD can be found when markers and genes of interest are physically very close to each other and/or when lines or breeds have been crossed in recent generations. Selection using these markers can be called LD-MAS.
3. The marker is not in linkage disequilibrium (i.e. it is in linkage equilibrium [LE]) with Q throughout the whole population. Selection using these markers can be called LE-MAS. This is the most difficult situation for applying MAS.

The universal nature of molecular markers and genes implies that MAS can, in theory, be applied to any agriculturally important species. Indeed, active research programmes were devoted to build molecular marker maps and detecting QTLs for potential use in MAS programmes in a wide range of crop, livestock, forest tree and fish species. (12) assayed 30 per cent loci of Drosophila pseudo obscura and found it to encode electrophoretically distinguishable proteins, hence denied the concept of little polymorphism for the first time. Designing efficient molecular markers depends upon the nature and type of polymorphism. Many plant genomes have been fully sequenced recently, e.g., Arabidopsis, rice, mustard etc. (25).

In addition, MAS can be applied to support an existing conventional breeding programme which has been proved to be more fruitful for complex traits because phenotypic selection helps to retain the minor QTL and to select loci involved in epistatic interactions (24). These programmes use strategies such as, recurrent selection (i.e. using within-breed or within-line selection, important in livestock); development of crossbreds or hybrids (by crossing several improved lines or breeds) and introgression (where a target gene is introduced from, for example, a low-productive line or breed (donor) into a productive line (recipient) that lacks the target gene (a strategy especially important in plants). MAS can be incorporated into any one of these strategies (e.g. for marker assisted introgression by using markers to accelerate introduction of the target gene). Alternatively, novel breeding strategies can be developed to harness the new possibilities that MAS raises.

According (30) five main points must be considered before the use of any DNA markers for MAS. These includes-

1. **Reliability:** Molecular markers should co-segregate or tightly linked to traits of interest, preferably less than 5 cM genetic distance. The use of flanking markers or intragenic markers will greatly increase the reliability of the markers to predict phenotype.
2. **DNA quantity and quality:** Some marker techniques require large amounts and high quality DNA, which may sometimes be difficult to obtain in practice, and this adds to the cost of the procedures.
3. **Technical procedure:** Molecular markers should have high reproducibility across laboratories and transferability between researchers. The level of simplicity and time required for the technique are critical considerations. High-throughput simple and quick methods are highly desirable.
4. **Level of polymorphism:** Ideally, the marker should be highly polymorphic in breeding material and it should be co-dominant for differentiation of homozygous and heterozygous individuals in segregating progenies.
5. **Cost:** Molecular markers should be user-friendly, cheap and easy to use for efficient screening of large populations. The marker assay must be cost-effective in order for MAS to be feasible.

MAS Over Conventional Breeding

Traits primarily considered in any plant genetic improvement programmes are quantitative in nature i.e. they are controlled by many genes (minor genes). These are influenced greatly by various environmental factors and the underlying genes have small effects on the

phenotype observed. In classical genetic improvement programmes, selection is carried out based on observable phenotypes without knowing which genes are actually being selected. The development of molecular markers was therefore a great breakthrough to overcome this key limitation. As (48) wrote: "Before the advent of DNA marker technology, the idea of rapidly uncovering the loci controlling complex, multigenic traits seemed like a dream. Suddenly, it was difficult to open a plant genetics journal without finding dozens of papers seeking to pinpoint many, if not most, agriculturally relevant genes".

Using Molecular marker-assisted selection (MAS) plants can be selected for genomic regions that are involved in the expression of traits of interest. With the development and availability of an array of molecular markers, marker assisted selection has become possible for traits both governed by major genes as well as quantitative trait loci (10).

(36) pointed out the advantages of the use of DNA markers for screening and selecting of plants in a breeding program:

1. As DNA marker based genotypes can be obtained from almost any plant tissue, plants can be screened already at the seedling stage or even as seeds, thus allowing early selection for traits which may be expressed in adult plants only (i.e. grain or fruit quality, male sterility, photoperiod sensitivity). With the availability of pre flowering genotypic information MAS allows for controlled pollination, e.g. in marker-assisted recurrent selection.
2. Target alleles that are difficult, expensive and/or time consuming to score phenotypically can be selected with the assistance of markers (e.g. environmentally sensitive traits, as DNA markers are mostly neutral to environmental variation).
3. Selections can be made on a single plant basis where this would not be possible by phenotypic selection. Poor heritability does not pose a problem if selection is based on marker information.
4. For traits with complex inheritance every individual genetic component contributing to the trait can be selected separately. Also, multiple characters that would normally be epistatic (i.e. they show a certain positive or negative effect only in combination with each other) can be maintained and ultimately fixed.
5. Recessive genes can be maintained without the need for progeny tests in each generation, as homozygous and heterozygous plants can be distinguished with the aid of (codominant) markers. In backcrossing, DNA markers can help to minimize linkage drag around the target gene and reduce the generations required to recover a recurrent parent's genetic background.
6. In the choice of parents in crossing programs markers can be applied too. Here they can either help to maximize diversity, and in this way support the exploitation of heterosis, or they can minimize diversity, if gene complexes built up in elite inbred germplasm are to be preserved.

Also, conventional backcrossing relies on the use of a screening method for selection of the target locus followed by phenotypic or visual selection for backcross progeny that most closely resemble the recurrent parent. The marker assisted back crossing (MABC) approach represents a clear advantage over conventional backcross breeding through the development of the ideal genotype in a short period of time, which could not be easily developed through conventional breeding (37).

Current Status of Applications of MAS in Crop Breeding

The technology of MAS has been taken with the most enthusiasm and expectation in the recent past accelerating plant breeding programme and stimulating tremendous investments in the development of molecular marker maps and research to detect associations between phenotypes and markers. Molecular marker maps have been constructed for a wide range of crop species.

Information on major plant projects (such as the sequencing of the entire plant genomes) can be found at www. ncbi.nlm.nih.gov/genomes/PLANTS/ Plant List.html.Many success stories of using MAS are available. Following are a few to site.

In pigeon pea, genetic diversity was studied at the molecular level through diversity arrays technology (DArT) among 96 accessions representing nearly 20 species of Cajanus including the cultivated one. The study successfully revealed

that most of the diversity was among the wild relatives of pigeon pea or between the wild and the cultivated species, but not among the cultivated accessions. Such narrow genetic base is likely to represent a serious impediment to breeding progress in pigeon pea (44). DArT markers have been considered very useful for MAS because of low cost (US$ 0.1 per data point), ultrahigh-throughput and extensive genome-wide coverage (22).

In common bean, introgression of major gene (s) using MAS resulted in the development of several lines resistant to rust (19, 40), anthracnose (2), BGYMV (28) and angular leaf spot (13). Also, two major QTLs controlling resistance to white mould in common bean (18) and a major QTL associated with root rot resistant in snap bean have been introgressed using MAS with realized gain in the target traits (34).

The near isogenic lines (NILs) of chickpea with resistance / susceptibility to Fusarium oxysporum f. sp. ciceris (Foc) were developed on the basis of selection made by closely linked markers in RIL population (8). Moreover, in common bean, two improved lines 'USPT-ANT-1' (carrying Co-42 gene for resistance to all known North American races of anthracnose) and 'USDK-CBB-15' (carrying QTL for bacterial blight resistance) have been registered in USA (28, 29).

The possible breeding schemes that can be used for gene pyramiding involving MAS and required population size in each segregating population were discussed in several recent reviews (22, 28, 29, 45, 46, 47). Marker-assisted pyramiding has been employed widely in cereal crops for combining multiple genes / QTLs controlling both qualitative (26) and quantitative (8) disease resistance.

MAS, in rice breeding, were mainly utilized for the pyramiding of disease resistances, namely bacterial blight and blast. The pyramided BB resistance genes, Xa4+xa5+Xa21, expressed strong resistance to virulent BB isolates of Korea compared with individual resistance genes that are moderately to completely susceptible (30). Marker assisted backcrossing was used effectively to transfer the submergence tolerance gene SUB1 into popular rice varieties. (37). The resistance genes xa5, xa13, and Xa21 were pyramided into an indica rice cultivar (PR106) using MAS that expressed strong resistance to BB races of India (38). (26) pyramided three major genes (Pi1, Piz-5 and Pita) using RFLP markers from three parents for rice blast into a single cultivar Co-39.

Using 280 molecular markers (comprising 134 RFLPs, 131 AFLPs and 15 microsatellites) and recording populations of rice lines for various plant water stress indicators, phenology, plant biomass, yield and yield components under irrigated and water stress conditions, (4) detected a number of putative QTL for drought resistance traits. (16) carried out genotyping of over 18 million polymorphic locations within Oryza sativa which allowed them to reconstruct the individual haplotype patterns shaping the genomic background of elite varieties used by farmers throughout the Americas. This led them to identify novel genetic markers for selection of varieties with high amylose content.

In 2006, two lines showing strong submergence tolerance were developed in rice by introgressing a locus conferring submergence tolerance from cultivar 'FR13A' into the variety 'Swarma' (43).

Up to now, MAS in rice breeding has mainly been utilized for the pyramiding of disease resistances, namely bacterial blight (e.g. 9, 38) and blast (33). In 2002, two cultivars resistant to bacterial leaf blight were released in Indonesia, which have been selected using MAS.

The University of California at Davis developed the first wheat variety Patwin (Hard White Spring wheat) through MAS which contains the introgressed stripe rust resistance gene Yr17 and leaf rust resistance gene Lr37 (25, 50) observed in wheat that, MAS combined with phenotypic screening was more effective than phenotypic screening alone for a major QTL on chromosome 3BS for Fusarium head blight resistance. In the USA the variety 'Tango', carrying two QTLs for adult resistance to stripe rust, was released in 2000 (24), claiming to be the first commercially released barley variety using MAS.

A brief summary of the current status regarding application of MAS in the different agricultural crops along with their linked genes is presented in Table 1.

Table 1: Selected examples of gene-marker associated for important traits in major crops (K. Choudhury, 2008)

Crop	Traits	Gene/QTL	Linked marker (s)
Rice	Blast resistance	Pi-1	RZ 336 and r 10
		Pi-2	
	Bacterial blight resistance	Xa-1	RG 64
		Xa-3	XNpb 235
		RTSV	XNpb 131
	Rice tugro virus resistance	Gm-2	RZ 262
		Gm-4	RG 329
	Gall midge resistance	Bph-1	R 1813
		Bph-(1)	XNpb 248
	Brown plant hopper resistance	Grh-1	RZ 404
		Sub-1	R 566
		OSA-3	RZ 698
	Green leaf hopper resistance	S-5	RG 457
	Submerge tolerance	TGMS	RG 213
	Salt tolerance	Fgr	RM 257
	Wide compatibility	Wx	RG 28
	Temperature sensitive male sterility	Se-1	Wx
		Sdg	RG 64
		Sh 4	R2182
	Grain aroma	Hm-1	R 250
	Amylose content		Umc 117
	Photoperiod sensitivity		
	Semi-dwarf stature		
	Shattering resistance		
	Northern com blight resistance		
Maize	Cytoplasmic male sterility	T, C and S cytoplasms	M112582, S81074 and AF 008647
	Enhanced lysine and tryptophan (QPM)	opaque-2	umc 1066, phi 112
	Days to pollenshed	QTL	Taqman probes
	Cyst nematode resistance	Con-Di	Cs E 20-2
	Leaf rust resistance	Lr 24	6 RFLP markers
	Powdery mildew resistance	Pm-1, Pm-2	RFLP marker
	Hessian fly resistance	H 6	Op AF 08, Op B01
	Root lesion nematode resistance	Rinn1	Xedo 347-7A
Wheat	Earliness per se	Eps-Am1	Xwg 241
	Loose smut resistance	T 10	SCAR marker
	Vernalization requirement	Vm-B1	(TG)3 primers
	Coleoptile colour	Re-A1, Rc-D1	Xgwm 913
	Flour colour	Major QTL	STS marker
Sorghum	Head smut resistance	shs	RFLP probes
	Fertility restoration	rf4	LW 7, LW 8
Soybean	Cyst nematode resistance	rhg 1	LW 7, LW 8
	Soybean mosaic virus resistance	Rsv	Sat 309 (SSR)
	Linolenic acid content	Fan	pB 194-1, pB 124
	Super nodulation ability	nts	PA-132
Chickpea	Double-podding	s	TA 80 (STMS)
Pea	Nodulation ability	Sym 9	A S/14, A 5/16
	Powdery mildew resistance	er	p 236 (RFLP)
	Fusarium wilt resistance	Fw	RFLP marker
Tomato	Meloidogyne incognita resistance	Mi	RAPD marker
	Yellow leaf curl virus resistance	Ty 1	RFLP marker
	Black mold resistance	QTL	RFLP markers

How to Increase Potential of MAS

Four different developments have the potential to further promote the use of molecular markers. They are based on the increasing amount of sequence information and marker density in the genomes of important crop species, as well as progress in knowledge of the physiological background of the interaction of the plant with the environment:

(a) Instead of linked markers, functional markers move into the focus of interest. Here, the difference in the sequence is not only linked to the marker with the speci?c trait expression, but directly responsible for the change in trait (3). Thus, linkage between marker and trait cannot be lost and the marker is fairly independent from the genetic background.

(b) Associations between markers and traits are calculated based on crossing-overs that happened during the history of a certain gene pool. They manifest themselves as linkage disequilibrium (LD) between the alleles of pairs of marker/gene loci. Typically, so-called LD- or association-mapping is used to identify QTLs. As many crossing-overs can have happened during time, they have, on the one hand, a higher resolution than QTL-mappings based on segregating populations, but on the other hand, linkage is only detectable through relatively short parts of the chromosome. Consequently, a high marker-density is necessary in these association studies, but on the other hand the so detected markers are valuable in a larger genetic background and there is no need for crossing in order to produce segregating populations (23).

(c) Prediction of the performance of a specific plant is based on the pattern of all markers in that plant instead of on single marker genes (Whole Genome Profiling) (33). This technique circumvents the need of first defining QTLs before using markers in order to select for complex traits.

(d) For the case of quantitative traits largely depending on environmental factors, genotype & environment interactions are integrated in the QTL analysis resulting in markers re?ecting the amount and direction of reaction of the plant to an environmental input. Those markers are valuable over a larger range of environments (5).

Current advances in plant genotyping has led to major progress in the knowledge of genetic architecture of traits of interest. It is increasingly important to develop decision support tools to help breeders and geneticists to conduct marker-assisted selection methods to assemble favorable alleles that are discovered. With this view, (41) came up with the idea of Opti MAS. It is a computer programme developed with the objective to valorize such results by helping breeders to create a given ideal genotype (ideotype) assembling favourable alleles from diverse parental origin.

Economic Aspects of Marker Application

Only few studies compared the economical aspects of conventional phenotypic selection and MAS. Landmark papers are the one by (15) and the companion paper by (32). (32) stated that "As most plant breeders well know, the cost of using DNA markers can vary greatly depending on the crop, the breeding application, the trait(s) being targeted, the availability of suitable marker. Well-designed case studies can help plant breeders make better decisions about choice of breeding strategy by generating detailed empirical information about the costs and time requirements of alternative selection methods."

(32) compared the costs for conventional and MAS methods for a particular breeding application. They introgressed an elite allele at a single dominant gene into an elite maize line and found that neither method showed clear superiority in terms of both cost and speed. Phenotypic selection schemes were less expensive, but MAS required less time. Thus, the decision for or against MAS is dependent on the availability of operating capital in the breeding program.

(15) compared the cost-effectiveness of conventional and marker-assisted maize breeding. They used the conversion of lines into quality protein maize (QPM) as an example and the results indicated that the use of microsatellite markers was cost-effective compared to phenotypic selection. The authors concluded that such detailed budget analyses, if used with detailed empirical data from actual breeding programs, could be very useful to improve the efficiency of existing protocols and to make decisions about future technology choices.

In general, the above studies show that no simple answer can be given to the question whether to apply MAS or phenotypic selection in a breeding program. It is generally accepted that MAS approach is much costlier than the phenotypic selection. On the other hand, even though MAS becomes more costly in comparison to conventional selection, it could be well justified as the time required to develop varieties are reduced considerably. At the cost saving the capital investment, it is, however, not justified to sacrifice the very advantage of MAS in speeding up of crop improvement programme.

Conclusion

Marker assisted selection (MAS) has already been proven valuable for breeding almost all the commercial crops. This is expected to increase as new genes and associated markers for economically important traits are identified. As an

example of current opportunities for MAS in wheat, protocols for over 20 trait-associated markers are posted on the web site MAS Wheat: Bringing Genomics to the Wheat Fields (http://maswheat. ucdavis.edu/). Knowledge of actual gene sequences and design of PCR primers for specific alleles, will make MAS more powerful and informative across a range of genetic backgrounds. More widespread use of MAS is also expected with the improvement of methods for marker analysis and identification of candidate genes for economic traits. The foreseeing economics will be a major driver of the application of MAS. For certain traits that are expensive or logistically difficult to evaluate, MAS is an appropriate alternative. Time savings obtained through MAS may be as important as cost savings where there are competitive markets for improved cultivars. Any cost change in DNA extraction or genotyping methods, or on the other hand, in phenotypic evaluation methods, will affect the relative economic benefits of MAS.

In summary, MAS is a methodology that has already proven its value in many plant breeding situations. It is likely to become more valuable as more and more number of genes are identified and their functions and interactions elucidated. Reduced costs and optimized strategies for integrating MAS with phenotypic selection are needed before the technology can reach its full potential.

Overall, marker assisted selection has proven to be a very useful technique in plant breeding. Through these techniques, plant breeders have been able to produce cultivars of agriculturally significant plants with genes for resistance to many diseases that were not possible before the advent of DNA technology. The eventual application of these technologies in practical breeding programmes will require further evidence of predictable and sustainable genetic advances using MAS. Until complex traits can be fully dissected, the application of MAS will be limited to genes of moderate-to large effect and to applications that do not endanger the response to conventional selection. Until then, observable phenotype will remain an important component of genetic improvement programmes, because it takes account of the collective effect of all genes (10).

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LORD RAVANA : WITH THE POWER OF THE UNCONTROLLED

Samir Kumar Kalra[1], Rajkumar[2], Vandana Kalra[3] and Bhuvan Chand Pandey[4]

[1]Senior Consultant & Professor of Neurosurgery, Sir Ganga Ram Hospital & Ganga Ram Institute of Medical Education & Research, New Delhi

[2]Vice Chancellor UP University of Medical Sciences, SafaiEtawah UP India 206130.

[3]Senior Consultant & Head of Department, Radiology, Delhi Heart & Lung Institute, New Delhi,

[4]Consultant Anaesthesia, Sir Ganga Ram Hospital & Ganga Ram Institute of Medical Education & Research, New Delhi

***Corresponding Author: Email**- kalraneuro@gmail.com,

Abstract

Ravana, the king of Rakshasas was a supreme scholar who was known to have 10 heads with 20 arms. Despite being a genius with extraordinary powers, he had negative shades of character. The ten heads he had are likened to ten cranial nerves a human possesses and both negative and positive characters of the nerves are described.

Key words: Ravana, Dasmukha, Cranial Nerve

Ravana is considered as the most powerful person ever on earth according to Hindu mythology. He was the king ofRakshasas and has been described as a supreme scholar, able ruler and extremelyintelligent person. He is depicted with 10 heads and 20 arms giving him the name of

DASHMUKHA (10 faced) or DASAGRIVA (10 headed). (1,2)He was a highly learned Brahmin who had mastery of all type of knowledge and arts of weaponry. He is known to have compiled Sama Veda with the relevant musical Svaras (notes).His Shiva Tandava Stotra is yet the most popular hymn ever sung in praise of Lord Shiva. The ten heads he possessed are considered to be epitome of multiplicities of his genius mind; each head having its own specific function.(3,4).These 10 heads are considered his most prized possession since they had his superpowers. The functions of these various heads had both the positive and negative sides to it. He wanted to overpower the Devas and so he chose to use the negative side of it which eventually brought about his downfall. (5,6) The interpretation of his 10 heads are the 10 emotions or senses in a human being and are namely:

1. Kaam (Lust)
2. Krodha (Anger)
3. Moha (Delusion)
4. Lobha (Greed)
5. Mada (Pride)
6. Maatsarya (Envy)
7. Manas (The Mind)
8. Buddhi (Intellect)
9. Chitta (Will)
10. Ahamkara (Ego)

Hindu traditions emphasize the importance of controlling one's senses. All above emotions have both positive and negative facets to them and it is upto us how we wish to use them.

Human beings are known to have twelve pairs of cranial nerves; and if III, IV and VI nerves are put together since their functionality is in unison, we do have 10 sets of cranial nerves. On a symbolic level, Lord Ravana could have had an extremely well developed Nervous System and each of his head could represent one individual cranial nerve.The functions of cranial nerves symbolically match the emotions that are described for his various Heads. In that era maybe the scholar who made his picture wanted to convey to the common man that these nerves work together for a common function; and in Lord Ravana each head depicted a different function. (Fifure 1) The different emotions and the various heads could be likened to the cranial nerves and could be described as ;

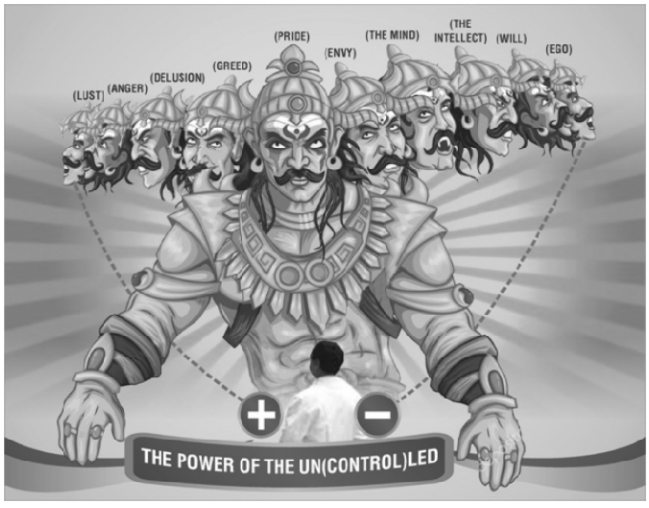


Figure 1: Lord Ravana each head depicted a different function

Kaam (Lust)

This emotion relates to Optic Nerve, which gives us the power to see. It is how you look at the world that decides your desires and that is how your functionalities will work. One can see it in either positive or negative shade and that is how things would appear to them.

Krodha (Anger)

Anger could relate to Facial nerve as it is brought out by the facial expressions which are controlled by the facial nerve. A dissatisfied or incomplete desired task can leave us angry and facial expressions follow this emotion. These emotions can be easily controlled and facial expressions could convey a lot.

Moha (Delusion)

This emotion could relate to Olfactory nerve since it controls sense of smell. Smell (olfaction) is responsible for our feel good emotion in response to any object or person and resultant "Moha" with it.

Lobha (Greed)

It is this sense which is root cause of majority of our problems and needs lot of self restrain. Symbolically it relates to Glossophayngeal Nerve which controls our ability to taste and swallow food which is the root cause of greed; desire for more.

Mada (Pride)

Pride could be symbolically represented by Spinal Accessory nerve as it controls our shoulder shrugging and head movements to other side; which is how our demeanor is when we are full of Mada (Pride).

Maatsarya (Envy)

Envy is expressed on our face but vividly depicted with our eyes. The eye movements are controlled by the three cranial nerve Oculomotor, Trochlear and Abducens together; and hence envy could be related to these nerves together.

Manas (Mind)

Vagus is a large Cranial nerve which is said to connect brain stem to the body and allows the brain to monitor and receive information about a lot of body's different functions. It is the control of your own body by mind that could be depicted by Vagus Nerve. This control can be both ways postive as well as negative.

Buddhi (Intellect)

Hypoglossal Nerve which controls majority of muscle movements of tongue and thus controls what you speak. What one speaks is reflecive of their intellect.

Chitt (Will)

A person's will is depicted by his face and this relates with the largest cranial nerve; that is Trigeminal nerve which is a mixed nerve which unifies the facial sensations with facial motor movements. The facial movements can be representative of a person's will.

Ahamkara (Ego)

Ego is a state of mind when a person does not listen to anyone and loses one's sense of balance. Both these functions; albiet hearing and balance are served by vestibulo-cochlear nerve which symbolically could represent this emotion.

Lord Ravana had the prized possession of ten heads which can be considered to be highly specialized to perform different functions individually as depicted by ten sets of cranial nerves. However the control lies in one's mind and that is where one can go right or wrong. The intellectuals of that age may have had some insights regarding the supernatural powers of Lord Ravana and may have described these in a pictorial way.Maybe the pictorial depiction was an attempt by them to show people both sides of a coin and make them decide upon the correct path .This description however is only from insights of the authors; and is it not the intention to hurt the feelings of any fraternity, medical or non-medical, religious or non-religious.

Ii is just a hypothetic analogy put forward by the Authors and has no scientific basis.The figure which we have made depicts the Lord with all his ten heads depicting different emotions represented by different cranial nerves with the positive and negative arms to each.

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IN VITRO POTATO PLANT IMPROVEMENT BY DIFFERENT PARTS AS EXPLANTS

Alok Kumar Singh[1*], Devendra Kumar[2], Reshu Chaudhary[3] and D.K. Dwivedi[1]

[1]Department of plant molecular biology and Genetic Engineering, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya -224229(U.P.), INDIA
[2]Department of Biotechnology & Life Sciences, Institute Bio-Medical Education Research, Mangalayatan University, Aligarh -202146 (U.P.), INDIA
[3]Department of Biotechnology,KVSCOS, Swami VivekanandSubharti University, Meerut, U.P.

***Corresponding Author: Email-** alokankur8483@gmail.com

Abstract

At present, a considerable progress in plant regeneration has been witnessed in potato using plant tissue culture techniques. The development of plantlets through tissue culture involves a key step i.e. explant choice and the method to be adopt for crop improvement. Plantlet regeneration through these advanced technologies classified in two broad applications viz., direct organogenesis and through callus regeneration. Callus regeneration has been proved the efficient strategy in plant improvement by transformation or involving genetic modification. Common growth characters of callus include complex relationships between explants, media composition and environmental conditions during incubation period. Some of the callus growth has strong and difficult pages to shape, while others easily split into smaller pieces, called "friable" callus. It may be colorless or different colors or sometimes with anthocyanin pigment as per the availability of light or dark conditions. The tissues or plant organs that do not normally develop callus due to cell injury, can also be induced through tissue culture techniques. Shoot induction as well as rooting are the key points in understanding the potential of tissue culture techniques in plant improvement.

Key words: Potato; Tissue culture; Callus; In vitro; Explant; Improvement

Introduction

Potato (*Solanum tuberosum* L.) is the world's most important vegetable crop. It ranks fourth in the world after wheat, rice, and corn. The highest amount of carbohydrates per day in each unit area between food plants make it unique among other crops. Potato known to be as the complete food security crop as it contains 80% water, 18% carbohydrates and 2-3% protein. In last 55 years, more than 35 potato varieties had been developed with improved production and productivity as well as many seed plot techniques to augment seed production abilities for a wide variety of agro-climatic conditions. In vitro tissue growth and storage is a method that allows for the separation and preservation of tissue structure and / or function termed as tissue culture (Tones, 1989). Tissue culture is often used to in vitro propagation of plant parts such as cell, tissue and organ under aseptic conditions in the synthetic environment.

Tissue culture techniques are widely used to produce pre-primary and virus free potato seeds known as microtubers. Many tissue culture techniques have been used in improvement of large number of potato cultivars. A lots of in vitro conservation protocols also had been developed for potatoes. Disease free plantlets with genetic uniformity can be produced by tissue culture techniques (14, 24, 27). The inclusion of callus in potatoes was first observed by (48). However, previous researches has shown that the inclusion of in-vitro callus in potato cultivars has been reported by a number of authors from various experiments including nodal (Khatun et al., 2003), internodal (19, 34), stem segment (4, 49), leaf discs (11, 7), and leaf explants (44).

It is vital to establish a system for crop rejuvenation through the callus culture of potato cultivars. The regenerated plantlets through callus are genetically similar, disease-free and can produce a large number of plantlets in a very rapid time period. The callus contains amorphous masses of freely organized parenchymatous cells from the growing cells of the parent tissue. Usually, due to injury, the callus is formed naturally at the end of the stem or root. In addition, it has now been well established that in a well-defined environment under controlled conditions, a piece of formal tissue can be organized into a callus (31). Common growth characteristics of callus include complex association between explant, media composition, geographical location, and environmental conditions during incubation. Some of the callus growth has strong texture and difficult to lignified, while others easily split into smaller pieces, termed as "friable" callus cultures. It may be colorless or different colors or dyed with anthocyanin depending on the presence of light or dark conditions during incubation period. Using traditional tissue techniques, callus formation can be implanted in plant organs or tissues that do not normally develop callus in response to injury.

Shoot induction as well as rooting are the important aspects of tissue culture techniques in achieving the power of traditional methods of crop improvement. Plant regeneration in potatoes has greatly improved in recent years. Successful vitro plant regeneration was achieved by examining various organs and tissue of potatoes such as leaf, stem, tuber disc and immature zygotic embryos. Much work has been done on potatoes to increase callus infusion, improve the frequency of plant regeneration from callus and investigate a factor affecting plant regeneration. Both callus insertion and plant regeneration from examiners require the availability of appropriate concentration and a combination of plant growth controls in the media. Many researchers are working to quantify the overall control of potato regenerative growth controls and as a result significant progress has been made in potato callus induction and plant regeneration (13, 8, 9, 44). Multiple research reports clearly suggested the link between genotype species, culture media and culture environment as these are the important factor in callus initiation and plant regeneration from callus under in vitro environment.

In-vitrocallus Induction and Plant Regeneration

It is important to dobetter research on potato protoplasts because without this we will not know much about the morphogenicity and quantity of potato leaves. The leaves are the first used to produce protoplasts. According to scientific reports, the callus can be produced from leaves as well as stem. (35) studied the callus formation and differentiation of plantlet regeneration using potato leaf segments grown in the MS medium with addition of various growth factors alone and in combination. Callus formation was moderately advanced with 5μM 2,4-D (2,4-dichlorophenoxy acetic acid) + 5μM IAA (Indole acetic acid) + 1.0μM Kinetin. Potato cultivar Nora produced little or no callus. Differentiation of callus to produce plantlets was much better in the medium containing 5μM IAA + 10μM Kinetin + 1μM GA3(Gibberalic acid). (22) reported callus induction from stem segment explants cultured with MS medium including 1.0 mg/L,2,4-D, 0.2 mg/L Kinetin and 0.2 mg/L NAA (Naphthalene acetic acid).The formation of callus started earlier, but morphogenesis occurred simultaneously. Regenerated plantlets were produced by callus from stem internodes of both monohaploid and dihaploid plants.

(37) conducted a study on the leaves of tissue system found indihaploids (>100 genotypes). This test was performed using a different combination of cytokinins, auxins and GA3. Zeatin was a more effective cytokinin than BAP (6-Benzylaminopurine). In addition, genotypic differences were noted in callus formation and shoot regeneration although the two traits were not related. (36) revived the wire shoots growing from callus developed from edges of leaf explants of four North Dakota potato genotypes. Optimal shoot regeneration occurred in explants cultured on MS medium with 3.5 mg/L IAA and 3.0-4.0 mg/L ZR (Zeatin riboside). Darkness favored shoot regeneration, while callus developing in the dark was etiolated, i.e., cream white in colour. There were apparent differences between genotypes in the time of shoot appearance and dark requirement. Ehsanpour and Jones (2000) developed one, two and three step methods of plant regeneration form stem culture of potato cultivar Delaware. The results showed that the one step procedure using a synthetic cytokinin was significantly improved the plant regeneration. In this culture, several buds and shoots were regenerated from stem culture while other methods using a culture medium supplemented with combination of GA3, BAP, NAA, Zeatin, 2-iP (Isopentenyl adenine) and IAA.

(50) produced somatic embryos from suspension cultures established from nodal section explants. This is a complex five step protocol in which callus initially induced by 4.0 mg/L 2,4-D is processed into cell suspension cultured on medium with 0.5 mg/L 2,4-D and 0.5 mg/L Kinetin and transferred to media with 1.0 mg/L and later 0.5 mg/L Zeatin. Somatic embryos were analyzed histologically and were shown to have a single origin. This protocol is more productive compared to protocols described for other species. Frequent rejuvenation within two weeks helped to maintain the ability of the somatic embryogenesis of cells. Theprotocol has indicated that GA3 is not required for any distribution measures of the propagation steps. Stages in somatic embryos development were characterized by proteins released in the medium.

AbdElaleemet al., (2009) pointed out that the leading degrees of callus formation were obtained with 3.0 mg/L 2,4-D or 2.0 mg/L 2,4-D + 2.0 mg/L BA (Benzyl adenine) in leaf explant. The TDZ (Thidiazuron) at 5.0 mg/L provided the highest 81% regeneration and number of shoot per callus (3.4 shoot) in short period of time for shoot formation (15 days). Khalafallaet al., (2009) reported that calli were induced from 1.0 cm2 tuber segment of potato cultivar Almera on MS medium supplemented with different doses (1.0 - 5.0 mg/L) of 2,4-D. The highest level of callus formation and hundred percent of explants produced nodular calli on MS medium within 7-12 days when supplemented with 2.0-5.0 mg/L of 2,4-D. (43) developed a standard protocol for callus induction and shoot regeneration in potato (*Solanum tuberosum* L.). The potato seedlings are used as a starting point to establish initial culture. The explants were raised on basal MS medium supplemented with various concentration of hormones and combinations were studied. Ten explants were cultured in each combination. A very high rate of callus formation on MS media supported by 2.0 - 4.0 mg/L of 2,4-D was observed. The sprout regeneration was seen when calli sub cultured on MS media supplemented with 1.0 - 4.0 mg/L of TDZ and 1.0 - 4.0 mg/L of BAP.

(15) used nodal segment in MS media supplemented with 2.0 mg/L 2,4-D and placed in a completely dark place with contrasting light and dark condition (1.83 m fluorescent tubes and illuminated 16 h daily with a light intensity of 1500 lux). The completely dark state is suitable for rapid callus formation within shortest time (10 to 13 days) and nodal explants emerge early (10 days). The explants node produced was most productive with the highest callus size (very massive degree of callus). At alternative light and dark condition, and the explants of internode at completely dark condition produced massive degree of callus. Nodal segments were cultured to investigate the stimulating effects of plant growth regulators on callus formation by various concentrations of growth regulators viz., BA, NAA and GA3 combinations to monitor its effect on callus formation. Plant growth regulators had significant effects on callus formation. The results indicated that the combination of BA and NAA with the concentration of 5.0 and 4.0 mg/L, respectively, produced very high amount of callus from nodal explants. Most of the brownish callus

was seen in the variety Desiree while large amount ofwhitish callus was produced with a cardinal variety (18).

The specific crop of two potato cultivars KufriChipsona 3 and KufriJyoti were developed for rapid frequency regeneration. Internodes extracted from field grown plants and inoculated on MS media were supplemented by various seven concentrations and combinations of auxins (NAA and IAA), cytokinins (BAP and Zeatin) and GA3 (6). The positive resuscitation of internodes was obtained when MS medium was augmented with 1.0 mg/L GA3, 0.01 mg/L IAA and 2.0 mg/L Zeatin. This combinationtaken lesser time to regenerate multiple shooting and roots in the internodes of cultivar KufriChipsona 3. In addition, by reducing, enlarging or changing the combination of growth regulators from a large scale, significant decrease in plant regeneration percent and number of shoots per plant were recorded.

The leaf explants of two potato cultivars namely KufriChipsona 3 and MP-97/644 enhanced callus induction and plant regeneration. A positive growth of callus from both the cultivars was observed on MS media containing 3.0 mg/L of 2,4-D and 1.0 mg/L of Kinetin. The medium was added with the various integration of BA, Kinetin and Ad SO_4 (Adenine sulfate) for shoot regeneration. Excellent shooting stimulation from callus was observed in MS media containing 1.5 mg/L BA and 25.0 mg/L Ad SO_4. The prescribed number of shoots/ callus clump was 21.00 in KufriChipsona 3 and 18.67 in MP97/644 after 60 days of incubation period. When the plants were transferred to green house, hardened within 10 days, about 99% plants were survived (28).

The effect of growth regulators with three different associations on the widespread propagation was examined on three potato cultivars Desiree, Kuroda and Cardinal. With the introduction of callus, the internodes of potato crops were grown on modified form of MS medium by supplementing with different hormones combination. The frequency of callus induction for all these treatments and cultivars were also recorded. In the callus inducing medium MS + 5.0 mg/L 2,4-D, explants showed the highest callus formation than two other combinations, whilethis induced callus provided better frequency for shoot induction medium MS + 3.0 mg/L Zeatin, Riboside. In the same source of media combination, the number of shoots perexplant was found in the cultivar Desiree which is very much different from the other media combinations. Overall, in vitro regeneration and multiplication energy was the highest for the cultivar Cardinal followed by Kuroda and Desiree. The interaction between the combinations of plant growth regulators and the different response of all parameters showed significant differences.

The tuber segments of potato cultivar Alpha were inoculated for callus formation, plant regeneration and in vitro rooting. As microtubers were transformed into stems, the efficiency of regeneration of microtuber discs was studied by Khadigaet al., (2015). Shoot regeneration from microtuber eye tissue has been previously reported by (47). It has also been reported that isolated pith or primary microtuber tissues can produce shoots in MS by Zn and IAA (38). Microtuber discs are complete and are used for intermediate regeneration containing Zn and IAA (25).

The response to tissue culture is highly dependent on explant type, source of explant even at genotype basis (24, 31, 27), also a significant genotypic difference in callus response between both types of potatoes investigatedby (5). Spunta varieties form the best callogenesis of all media compared to Kondor variants depending on the hormonal screening, there are a variety of variations in the required dates of callus initiation, the percentage of explants who developed callus, its texture, color and level of its formation.Shoots respond well to callus formation. (1) established an effective in vitro callogenesis of two types of potato varieties Sifra and Rodeo derived from leaf explants. The basal MS media was fortified with various combinations of auxins (2,4-D and NAA), cytokinins (Kin and BAP) using either alone or in combination. The highest rate of callus induction (96%) was observed from tubers of the cultivar Sifra in the MS medium containing 3.0 mg/L of 2,4-D. Regeneration of plantlets was also observed from tubers and tuberous callus of cultivar Sifra in the MS medium supplement with 3.0 mg/L of 2,4-D.

Salt Tolerance and Callus Cultures of Potato

Salinity is considered as the major abiotic constraint that limits the agricultural production and productivity worldwide (30). It affects the all major biological processes at cell development, photosynthesis, protein synthesis as well as lipid biosynthesis and metabolism. The salinity tolerance related studies conceived the specific ion concentrations and compounds of organic solutes as major mutations that lead to salt tolerance in the glycophytes (2, 21). Salinity tolerance is also known to be multigenic trait, and after exposure to stress, the changes occurring at the cellular level are due to genetic mutations and thus lead to the accumulation of proteins involved in stress tolerance (Bohnert and Jensen, 1996; (16).

The concept of in vitro selection is to exploit genetic diversity, which is known to occur in plants by testing cell culture for resistance to diseases, pests, herbicide or any abiotic suppression. Therefore, during stress conditions, one of the strategies that higher plants may have already used has been to reduce body growth and development (26, 40, 51). It is also possible to make better use of, and manage the resources available under the balance of healthy eating, osmotic and metabolic disorders. The reduction in growth, maintenance of cell water status and high antioxidant activities not only helps plants to save energy for protective purposes but also reduces the risk of injury (26, 32). Changes in callus morphology (brownish to black) in high salinity areas can be directly linked to cell death in high salinity areas.

The high levels of NaCl significantly suppressed the cultural growth of callus of potato varieties. The results of study also showed that it was possible to select salt-tolerant potato rows followed by active plant regeneration (Zahoor and Aftab, 2014). In the light of modern literature suggest a possible genetic mutation at the cellular level that led to the acquisition of salt tolerance that was more evident in the improved performance of proteins and antioxidant enzymes. The production of haploid technology and double haploid technology, anther/ in vitro anther culture/ microspore culture are the ways to develop agricultural elements. Apart from the fact that great success has been achieved in the production of haploids in other plant species, however, there are many factors that can contribute to the development and application of double haploid technology.

An in-depth understanding of the embryonic processes of microspores and the formation of haploid plants, which will ensure greater efficiency in the production of double haploid lines, is needed (45). Many authors have pointed out the needs of various potato varieties and the natural value of salts containing nitrogen, macro- and various microelements, amino acids, sugars, vitamin supplements and hormonal components, binding and marketing agents (3, 10, 39, 23). The use of MS-based media containing 1 - 4 M 6-BA is effective in reducing embryogenesis in potatoes in microspore culture. The frequency of embryoid formation (single germ-like structures) and the frequency of poly-embryoid formation in the test are up to 0.5 - 1.0% of the total microspores that have been alive for 24 days (Tikomirova and Tesla, 2020).

Future Prospects

Tissue culture techniques are widely used to produce pre-primary, virus free seed potatoes known as microtubers. Many tissue culture techniques have been used in a large number of potato cultivars. Recently the in vitro conservation protocol of potatoes has also been developed. It is important to do better research on potato protoplasts because without this we will not know much about the morphogenicity of potato leaves. Using traditional tissue culture techniques, callus formation can be induced in plant organs or tissues that do not normally develop callus in response to injury. Shoot production and rooting are important in achieving the power of tissue culture techniques of crop development. Further studies, relating to the genetic tolerance to salinity and osmotic stress as well as other abiotic constraints is needed, and tissue culture techniques can have the potential to achieve these future prospects of potato as well as other crop improvement.

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