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IMPROVED PACKAGE OF PRACTICES AND VARIETIES TO SUSTAIN THE PRODUCTIVITY OF GROUNDNUT IN MID-WESTERN PLAIN ZONE OF UTTAR PRADESH

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ABSTRACT

Groundnut is one of the most important oilseeds crop in India, which plays a major role in supplementing the income of small and marginal farmers of Budaun district in Mid-Western Plain Zone of Uttar Pradesh. One of the major constraints of traditional groundnut farming is low productivity due to non-adoption of recommended package of practices and improved varieties. To replace this anomaly, Krishi Vigyan Kendra Ujhani,Budaun under Sardar Vallabhbhai Patel University of Agricultural & Technology, Meerut (UP) had conducted frontline demonstrations (FLDs) at adopted farmer's fields during 2005 to 2009.Cultivation practices comprised under FLD viz., use of improved variety, line sowing, balanced application of fertilizers, timely weed management and control of insect-pest through insecticide -pesticides at economic threshold level showed that the yield of groundnut increased from 13.17% to 29.49% percent over farmer's practice during the demonstration period from 2005 to 2009.The technology gap of 271 kg/ha as minimum during 2009 to maximum of 531 kg/ha at the initial stage of study (2005) shows the gap in demonstration yield over potential yield, but the above gap reduced subsequently in the following years.The front line demonstrations recorded higher average gross returns (Rs. 23988/ha) and net return (Rs. 12287/ha) with higher cost:benefit ratio (2.03) compared to farmers practice(Rs. 19518/ha,Rs.9141/ha and 1.86, respectively). The results suggest that higher profitability and economic viability of groundnut demonstrations under local agro-ecological situation.

Key words: Client Satisfaction Index,Frontline demonstration, Technology gap, Extension gap, Technology index, Groundnut.

Groundnut (*Arachishypogaea* L.) is the most important oilseed crop of the country. It is mainly grown in Gujarat, Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, Orissa, Rajasthan and Punjab. It is the major source of income especially even to the marginal and small farmers of the growing areas. The seeds are rich in oil (38-50%), protein, calcium, potassium, phosphorus, magnesium and vitamins. Groundnuts have also considerable medicinal value. They are reported to be useful in the treatment of disease such as haemophilia, stomatitis, and diarrhoea.

Most of the world production of groundnuts is crushed for oil that is used mainly for cooking. The press cake from oil extraction is a feed rich in protein but is also used to produce groundnut flour, which is used in many human foods. The seeds or kernels are eaten raw, boiled or roasted, made into confectionery and snack foods, and are used in soups or made into sauces to use

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on meat and rice dishes. The vegetative residues from the crop are excellent forage.

Because of its low water requirement (80-240 mm), rapeseed groundnut crops fit well in the rainfed cropping system. Uttar Pradesh accounts for 10.85% and 11.19% of area and production, respectively in the country with the average yield of 1149 kg/ha which is equivalent to the national average (1117 kg/ha).

The groundnut production scenario in the country has undergone a sea change. The main contributors to such transformations have been (i) availability of improved oilseeds production technology and its adoption, (ii) expansion of cultivated area, (iii) price support policy and (iv) institutional support, particularly establishment of technology mission on oilseeds in 1986 (Hegde, 2004). The improved technology packages were also found to be financially attractive. Yet, adoption levels for severalcomponents of the improved technology were low, emphasizing the need for better dissemination (Kiresur*et al.*, 2001). Several biotic, abiotic and socio-economic constraints inhibit exploitation of the yield potential and these needs to be addressed. The state-wise yields obtained both under improved technology and farmers' practice ranges from 12 to 110% between states and the national average being 36%. The additional production that can be attained by exploiting the yield gap at national level is about 2 million tonnes (Kumar and Chauhan, 2005).

Budaun district has the sizeable area (728 ha) under groundnut cultivation but the productivity level is very-very low (749 kg/ha) during 2010-11.Therefore, keeping the above point in view, the FLDs on groundnut using integrated crop management technology was started with the objectives of showing the productive potentials of thenew production technologies under real farm situation over the locally cultivated groundnut crop.

MATERIALS AND METHODS

The present study was carried out by the Krishi VigyanKendra, Ujhani (Budaun) under Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut during *kharif* season from2005 to 2009 (05years) at the farmers' fields of different villages ofBudaun district in Mid-Western Plain Zone of Uttar Pradesh.In total 53 frontline demonstrations in 30ha area in different villages were conducted. Materials for the demonstrations with respect to FLDs and farmers' practices weregiven in Table 1. In case of farmers practice plots, existingpractices being used by farmers were followed. In general,soils of the area under study were sandy loam in texture and medium to low in fertility status. The FLDs were conducted to study the gaps between the potential yieldand demonstration yield, extension gapand technologyindex.

In the present evaluation study, the data on outputof groundnut cultivation were collected from FLD plots,besides the data on local practices commonly adopted bythe farmers of this region were also collected.In demonstration plots, a few critical inputs in theform of quality seed, balanced fertilizers, agro-chemicalsetc. were provided and non-monetary inputs like timelysowing in lines and timely weeding were also performed,whereas, traditional practices

Table 1. Details of package of practices followed in the Front Line Demonstrations

S.No.	Inputs	Quantity per hectare	
		Demonstration	Farmers practice
1	Groundnut variety	TG 26	Kaushal
2	Seed rate	80 kg	80 kg
3	Carbendazim	2 g/kg seed	-
4	MOP	50 kg	-
5	Di-ammonium phosphate (DAP)	130 kg	100 kg
6	Urea	50 kg	50kg
7	Zinc Sulphate (21%)	20 kg	-
8	Sulphur	10 kg	-
9	Chloropyriphos	3.0 litre	2.00 litre
10	Propiconazole	500 ml	-
11	Weeding	Use of Pendimethalin	Manual weeding

were maintained in case oflocal checks. The demonstration farmers were facilitatedby KVK scientists in performing field operations likesowing, spraying, weeding, harvesting etc. during thecourse of training and visits. The technologiesdemonstrated are mentioned in Table 1 and compared withlocal practices.

The technology gap, extension gap and technology index were calculated using the following formulae given by(Samui*et al.*, 2000).

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - yield under existing practice

Technology index = {(Potential yield - Demonstration yield)/Potential yield} x 100

The satisfaction level of participating as well as neighbouring farmers' for the performance of improved variety demonstrated was also assessed. In all, 265 participating farmers' were selected to measure satisfaction level of farmers' for the performance of improved variety demonstrated. The selected respondents were interviewed personally with the help of a pre-tested and well-structured interview schedule. Client Satisfaction Index was calculated as below.

Client satisfaction index = (Individual score obtained/ Maximum score possible) x 100

The data collected were tabulated and statistically analysed to interpret the results. The economic-parameters (gross return, net return and C: B ratio) were worked out on the basis of prevailing market prices of inputs and Minimum Support Prices of outputs.

RESULTS AND DISCUSSION

Groundnut Yield

The data (Table 2) indicated that the frontline demonstration has given a good impact over the farming community of Budaun district as they were motivated by the new agricultural technologies applied in the demonstrations. Results of 53 frontline demonstrations conductedduring 2005 to 2009 in 30 ha area on farmers'fields indicated thatthe cultivation practices comprised under FLD *viz*., useof improved variety (TG 26), balanced application of fertilizers (N:P:K@45:60:30 kg/ha with 20 kg $ZnSO_4$& 10 kg S /ha),line sowing, timely weed management and control of groundnuttikka disease& termiteaphid through fungicide &insecticide, produced on an average1353 kg/ha groundnut yield, which was 24.08%higher compared to prevailing farmers practice (1094 kg/ ha).

Technology and Extension gap

The technology gap observed may be attributed tothe dissimilarity in the soil fertility status and weatherconditions. Hence, variety wise location specificrecommendation appears to be necessary to minimize thetechnology gap for yield level in different situations.The extension gaps ranged from 158to298 kg/ ha during the period of demonstration emphasized theneed to educate the farmers through various means forthe adoption of improved agricultural productiontechnologies to reverse this trend of wide extension gap.More and more use of latest production technologieswith high yielding varieties will subsequently changethis alarming trend of galloping extension gap. Thenew technologies will eventually lead to the farmersto discontinuance of old varieties with the newtechnology.

Technology index

The technology index shows the feasibility of theevolved technology at the farmers' fields. The lower thevalue of technology index more is the feasibility of thetechnology. The data (Table 2) showed that maximum technology index value 29.50%was noticed in the year 2007 followed by 28.33% (2005) whereas, minimum value of technology index of 15.06 % in the year 2008, it may be due to uneven &erratic rainfall and vagaries of weather conditions in the area.The finding of the present study is in line with the findings of Hiremathand Nagaraju

Table 2. Yield performance of groundnutunder FLDs at farmers' field

Year	No. of demo.	Area (ha)	Yield (kg/ha)		% yield Increase over FP	Techno-logy gap (kg/ha)	Exten-sion gap (kg/ha)	Techno-logy Index (%)
			Demon-stration	Farmers practice				
2005	14	10	1290	1030	25.24	510	260	28.33
2006	05	05	1318	1020	29.22	482	298	26.78
2007	10	05	1269	980	29.49	531	289	29.50
2008	11	05	1529	1240	23.31	271	289	15.06
2009	13	05	1358	1200	13.17	442	158	24.56
Mean	53	30	1353	1094	24.08	447	259	24.84

(2009), Dhaka*et al.* (2010)and Ali and Gupta (2012).

Cost of cultivation, Gross and Net return

The economics (Cost of cultivation, gross & net return) of groundnut under front line demonstrations were estimated and the results have been presented in Table 3. The front line demonstrations recorded higher average gross returns (Rs. 23988/ha) and net return (Rs. 12287/ha) with higher cost:benefit ratio (2.03) compared to farmers practice. These results are in line with the findings of Hiremathand Nagaraju (2009).

Additional cost of cultivation & Return and C: B Ratio

Further,data (Table 4) shows that the average additional cost of cultivation (Rs.1324/ha) under integrated crop management demonstrations and has yielded additional net returns of Rs. 3145 per hectare with incremental benefit cost ratio of 0.17. The results suggest that higher profitability and economic viability ofgroundnut demonstrations under local agro-ecological situation.This

Table 3. Economic performance of groundnut under FLDs at farmers' field

Year	Cost of cultivation (Rs./ha)		Gross return (Rs./ha)		Net return (Rs./ha)	
	Demonstr-ation	Farmers practice	Demonstr-ation	Farmers practice	Demonstr-ation	Farmers practice
2005	10796	9896	19608	15656	8812	5760
2006	10950	9800	20034	15504	9084	5704
2007	11460	10100	19670	15190	8210	5090
2008	12189	10464	32109	26040	19920	15576
2009	13110	11623	28518	25200	15408	13577
Mean	11701	10377	23988	19518	12287	9141

Sell price of groundnut was Rs. 1520, 1520, 1550, 2100 and 2100 per quintal in 2005, 2006, 2007, 2008 and 2009, respectively.

Table 4. Additional economic performance of groundnut under FLDs at farmers' field

Year	Additional Cost of cultivation (Rs./ha) in Demonstration	Additional Return (Rs./ha) in Demonstration	C : B Ratio	
			Demonstration	Farmers practice
2005	900	3052	1.82	1.58
2006	1150	3379	1.83	1.58
2007	1360	3119	1.72	1.50
2008	1725	4344	2.63	2.49
2009	1487	1831	2.18	2.17
Mean	1324	3145	2.03	1.86

might be due to higher production under FLDs as compared to the prevailing farmers practice in all the three years. Similar results were also reported by Hiremathand Nagaraju (2009).

Farmer's satisfaction

The extent of satisfaction level of respondent farmers over performance of demonstrated technology was measured by Client Satisfaction Index (CSI) and results presented in **Table** 5. It is observedthat majority of the respondent farmers expressed high (45.67%) to the medium (33.58%) level of satisfaction regarding the performance of FLDs, whereas, very few (20.75%) of respondents expressed lower level of satisfaction. The higher to medium level of satisfaction with respect to performance of demonstrated technology indicate stronger conviction, physical and mental involvement of in the frontline demonstrations which in turn would lead to higher adoption. The results are in close conformitywith the results of Kumaran and Vijayaragavan (2005) and Dhaka *et al.* (2010).

Table 5. Extent of farmers satisfaction over performance of FLDs (n=265)

Satisfaction level	Number	Per cent
High	121	45.67
Medium	89	33.58
Low	55	20.75

CONCLUSION

It may be concluded that the frontline demonstrations onintegrated crop management technology in groundnut crop has found more productive, profitable and feasible in Mid-Western Plain Zone of Uttar Pradeshas compared to prevailing farmers practiceunder real farm situations.Farmers were motivated by results of demonstrations of integrated crop management practices ingroundnut and they would adopt these technologies in the coming years.This will substantially increase the incomeas well as the livelihood of the farming community.

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EPIDEMIOLOGY AND MANAGEMENT OF ALTERNARIA BLIGHT OF MUSTARD CAUSED BY *ALTERNARIA BRASSICAE*

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ABSTRACT

Environmental factors *viz*. minimum and maximum temperature, relative humidity(R.H.) and date of sowing have significantly effects in the disease development of indian mustard (Brassica juncea L.). In the year 2002-2003, the disease appeared in the field in second fortnight of November when maximum and minimum average temperatures were 27.55°C and 9.25°C respectively with 59.40 per cent relative humidity. The disease incidence increased rapidly up to the second fortnight of December in all the sowing dates. In IDM, Early sowing (18 October) reduced the disease incidence significantly and enhanced the yield during both the year in comparison to late sown crop *ie*. 18th November .The 1st spraying of Ridomil MZ – 72 WP (0.25%) followed by to spraying of corbendazim (0.05%) + Mancozeb (0.2%) gave the significant response in reducing the disease intensity and also increasing the yield in both dates of sowing during the year 2001-2002 and 2002-2003.

Indian mustard (Brassica juncea L. czern and con) is one of the major oil seed crop cultivated in India as well as all over the world. In north India mostly crop is grown for edible oil and cake for man and animal (Thakur, 1975). The crops are grown in both the tropical as well as of the temperate zone and require relative cool temperature for satisfactory growth. Crop is grown in *rabi* season from September to November in our country. The mustard crop is grown well in these areas having 24-40 cm of rainfall. In India, Utter Pradesh is the second largest producer of rapeseeds mustard after Rajasthan, having an area of 1.2 million hectare with the production of 0.7 million tones. The average productivity of mustard in India is 9.68 q/ha respectively which is much below than international standard (13.0 q/ha). The main reasons of low productivity are disease. Mustard crop is affected by more than twenty fungal, bacterial, viral, mycoplasmal, phanrogamic parasites and physiological disease. Among them the spot disease caused by *Alternaria brassica* (Berk) Sacc. is one of the most wide spread and destructive disease of mustard. Under natural condition this leaf blight disease of mustard appear throughout the world and appeare each year in crop field (Khan et al. 1998) .The disease is caused by *Alternaria brassicae and Alternaria brassicicola*, single or concomitantly(Khan *et al* 1998) relative frequency of the two species varries with region and crop stage . The disease was first reported by Dey (1945) in Utter Pradesh which caused severe losses in yield. Khan *et.al.* (1998) have reported 26.5% infection by *Alternaria brassicola* and 22.6% by by *Alternaria brassicae* , where as rest 50.90% is accounted for concomitant infection of two species. The leaf blight may cause yield lass of 46-47% in yellow sarson and 35-38% in mustered kolte, *et.al,* (1978). The quantitative loss, seed quality in terms of seed size, seed colour and oil contents are also reduced due to the fungus infection. The degree of infection depends

on the weather parameter (temperature, R.H. & rainfall), age and bigour of plants. The management of disease through chemical is not economically and ecofriendly .Use of resistant varieties are not sufficient method for management of disease because these varieties taking a specific time for growth. The disease management by means of biological control is not fully covered against already established phyllosphare disease like alternaria blight. The cultural practices with the adjustment of chemical doses and keeping with the environmental factors are to be an appropriate approach for reducing the initial inoculums density of the pathogen. These practices (Epidemiological factors and cultural practices) are the method of sustainable disease management. The epidemiological and cultural practices are sustainable management method, there are also ecofriendly. Therefore keeping in this view present study was under taken with an objective to reducing the disease incidence and increases the yield through the adjustment of the epidemiological and cultural practices against this disease.

Methods and Materials

Effect epidemiological factors in management alternaria blight- The experiment was laid out in split plot design with one replication and four date of sowing at 15 days intervals stared from 1st October (2001-02). The cultivar Varuna was sown on four different dates in plot at 15 days interval in 5.0 m. x1.5m plot size with spacing 30x10cm for with two replications. Metrological data like temperature, rainfall, and R.H. were collected from metrological station Department of Agronomy, C.S.A. University of Agricultural. & Technology, Kanpur to find out the correlation among disease severity temperature and relative humidity. Recommended doses of fertilizer and insect control measures were followed. The diseases were recorded at 15 days interval after appearance of the disease of the maturity of last sown crop using 0-5scale as suggested by Conn *et al* (1990). Seed yield per plot will also be recorded and provided in kg/ha.

Integrated disease management- A field experiment was conducted during *Rabi* season in two consecutive years (2001-02 and 2002-03) at the oilseed farm of C.S. Azad University of Agricultural. & Technology, Kanpur to find out the effect of sowing date on occurrence of disease. The cultivar Varuna was sown on two different date at 30 days interval (*ie*.18th October , 18th November) in all the two consecutive years with three replication .a plot size was 5m x 3m. and recommended dose of N.P.K. was applied as half dose of Nitrogen and total amount of Phosphorus and Potash at the time of sowing and remaining half Nitrogen used as second time of foliar application .The certified seeds were collected from Seed Research Farm, C. S. Azad University of Agriculture and Technology, Kanpur and treated with Ziram @2.5 g /kg of seed. Forty or sixty leaves of mustard plant were randomly selected at one. The fungicides were sprayed after 50 days after sowing and repeated 70 and 90 days after sowing when pod formation indicated. The experiment was laid out in a factorial design. The trial was constituted with cross combination of two date of sowing. The PDI was recorded by using five point scales (0-5) Chenulu and Singh (1964). Leaves with no sign of infection received as score of zero, while these with the highest infection (40%)

received a score of 4th. Similarly leaves with 1-25, 26-50 and 51-75 % area covered with Alternaria blight received a score of I, .II and III respectively. The data on disease incidence was recorded at the maturing stage as per the scale suggested by Conn (1990). Grain yield of each plot of all the replication was also recorded.

Sowing date

D_1 =18th October,

D_2 =18th November

Spray of fungicide

S_1= First spray of Ridomil MZ 72 WP (0.25%) just after appearance of Alternaria blight followed by two spray of Mancozeb (0.2%) at 15 days interval.

S_2= First spray of Ridomil MZ 72 WP (0.25%) followed by two spray of Carbendazim (0.05%) + Mancozeb (0.2%).

S_3= First spray of carbendazim (0.05%) + Mancozeb (0.2%) followed by two spray of Mancozeb.

S_4 = No spray.

RESULT AND DISCUSSION

Effect epidemiological factors in management alternaria blight: Table 1 revealed that environmental factors *viz*. minimum and maximum temperature, relative humidity (R.H.) and date of sowing have significantly effects in the disease development. There is a good correlation between, temperature, R.H. and rainfall on the disease incidences. In the year 2002-2003, the disease

Table 1. Epidemiological studies of Alternaria blight in rapeseed and mustards (2002 -2003)

Period	Disease intensity (%) of diff. Date of sowing				Temp. (°C)		Rainfall		Relative humidity
	1st Oct.	15th Oct.	30th Oct.	15th Nov.	Max.	Min.	Amount days	Rainy days	(%)
15.11.02	-	-	-	-	29.20	12.7	1.8	1	65.35
30.11.02	8.0	2.0	3.0	-	27.55	9.25	-	-	59.40
15.12.02	9.1	7.2	5.8	3.0	25.45	6.10	-	-	59.75
30.12.02	15.0	9.4	8.8	7.2	23.60	7.80	0.4	1	66.05
14.01.03	16.2	11.2	9.8	9.2	13.75	3.08	6.5	1	85.96
29.01.03	18.6	12.0	13.6	12.8	16.55	2.79	-	-	81.96
13.02.03	23.6	24.0	17.2	19.3	24.49	8.64	18.5	1	76.97
28.02.03	31.0	24.4	24.8	28.6	26.97	12.63	2.9	1	66.42
15.03.03	34.2	32.9	37.1	37.9	28.16	11.14	-	-	64.61
30.03.03	37.0	40.1	40.8	43.6	30.46	16.14	-	-	53.93
Yield (g/ha)	17.33	16.66	12.66	12.39	-	-	-	-	-

appeared in the field in second fortnight of November when maximum and minimum average temperatures were 27.55°C and 9.25°C respectively with 59.40 per cent relative humidity. The disease incidence increased rapidly up to the second fortnight of December in all the sowing dates. The disease progress up to the IInd fortnight of Dec. 15%, 9.4%, 8.8% and 7.2% respectively for sowing of Ist Oct., 15th Oct., 30th Oct. and 15th November (maximum temperature 23.6°C and minimum 7.8°C with 66.05 per cent R.H.). In the monthly of January the disease developed very slightly because there was very low temp. (Minimum 2.79°C and the maximum 16.55°C). With the increase of temperature the disease also progressed and it reached to its maximum in second fortnight of March for all the sowing dates *ie*. 37%, 40.1%, 40.8% and 43.6% for Ist Oct., 15th Oct., 30thOct., and 15th Nov. sowing. The average minimum and maximum Temperature were 30.46°C & 16.14°C respectively with R.H. 59.93% in this period. Saxena (1998) also reported that crop sown as 15th October gave the maximum yield with lower disease intensity.

Integrated disease management (IDM); Table-2 revealed that all the treatment gave better repose in minimizing the disease intensity and increased the yield over control. Early sowing (18 October) reduced the disease incidence significantly and enhanced the yield during both the year in comparison to late sown crop *ie*. 18th November. The minimum disease intensity 24.92% and 20.62% was recorded during 2001-2002 and 2002-2003 respectively in D_1S_2 combination. The maximum yield (24.83q/ha and 13.49 q/ha) was also observed in the same combination D_1 S_2. The maximum disease incidence 29.36 and 63.12 per cent in both year were found in D_1S_4 combination (without spraying). In this combination minimum yield was also recorded 22.44 q/ha and 9.66 q/ha. during both the years.

The results indicated that the 1st spraying of Ridomil MZ – 72 WP (0.25%) followed by to spraying of carbendazim

Table 2. Integrated disease management 2001-2002

S. No.	Treatment	Disease intensity (%)		Seed yield q/ha		Mean 1000 seed weight	
		2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
1	D_1 S_1	27.67	28.92	23.49	12.24	5.6	3.42
2	D_1 S_2	24.92	20.62	24.83	13.49	5.8	3.50
3	D_1 S_3	25.74	28.80	23.74	12.83	5.8	3.61
4	D_1 S_4	29.36	63.12	22.49	09.66	5.4	3.14
5	D_2 S_1	40.58	28.67	11.94	10.41	5.2	3.37
6	D_2 S_2	38.57	20.85	13.74	11.49	5.8	3.80
7	D_2 S_3	38.86	24.62	12.13	11.41	5.6	3.56
A8	D_2 S_4	41.26	68.07	11.83	08.66	4.9	2.92

(0.05%) + Mancozeb (0.2%) gave the significant response in reducing the disease intensity and also increasing the yield in both dates of sowing during the year 2001-2002 and 2002-2003. In all the treatment combination significantly superior yield was obtained over control in both years, it means spraying of the fungicide and early sowing have significantly superior effect. Sinha et al., (1992) reported from Bihar that the incidence of disease on *B. compestrise* var. *toria* was lowest with consequential increased in yield when the crop was sown early *ie*. between 30th Sept. and 15th Nov.

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EFFECT OF VARIOUS INSECTICIDES ON CONTROL OF TERMITES IN SUGARCANE

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ABSTRACT

A field experiment was conducted during 2011-12 and 2012-13 at farmer field in Burhanpur (MP).Experiment was laid out in RBD with six treatments and four replications. Insecticides viz. chlorpyriphos 50% EC, phorate 10% CG,cartap hydrochloride 4% GR, fipronil 0.3% GR and carbofuran 3% CG were tested to find out their effectiveness for controlling sugarcane termitesas well as growth and yield of sugarcane. Insecticide like phorate 10% CG, cartap hydrochloride 4% GR, fipronil 0.3% GR and carbofuran 3% CG were applied @ 20 kg ha^{-1} at the time of sowing while chlorpyriphos 50% EC was used for cane setts treatment followed by application 30 days after planting @ 1.5 litre ha^{-1}. Sugarcane variety Co – 86032 was planted in first week of Octoberduring both the years at 5×1 fit in 25 cm deep trenches. Least population of termites was found in Fipronil 0.3% GR treated plot and all the insecticides were found significantly superior over control during both the years. Data on yield attributes (tillers&milleablecane)also generated and found maximum number of tillers and milleable cane under fipronil 0.3% GR and all the treatments have higher number of tillers and milleable cane over control. Yield of cane significantly increased over control in all treatments and maximum sugarcane yield was also found in fipronil 0.3% GR (T_5) followed by chlorpyriphos.

Key words: Termites, Insecticides, Sugarcane

INTRODUCTION

Sugarcane is an important cash crop of India. It is cultivating about in 4.1million ha with production of 283 million tonnes and average productivity is 72.6tonha^{-1}. Sugarcane is growing across the country and maximum production in UP while highest productivity in Tamilnadu (134.2 ton ha^{-1}). About 60% of cane in India is in the subtropical zone and 40% in the tropical zone. The productivity varies significantly between these zones; it is 89 and 58 ton ha^{-1} respectively. Burhanpur comes under Nimar region of MP and area under sugarcane is about 5090 ha with average productivity 54.92 ton ha^{-1}.

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Among all the pest of sugarcane,termite (*Odontoterms Spp.*) is major pest. There are so many termite species damaging sugarcane crop in India, but 13 species of termite are reported to cause severe damage to crop. Termite infestation caused 30-60% destruction of buds (Teotia*et al.*, 1963 and Roonwal, 1981). Termites attacking on sugarcane crop from its germination throughshoot emergence and finally it affects the quality of canes. At germination stage, the losses up to 90 - 100 % have been recorded (Salihah*et al.*, 1988). During the experimentation Koto *et al.* (2000) found that termites live in the soil and damages sugarcane by excavating through the cane setts, leading to the death of buds and young shoots. Termite may attack on any part of sugarcane setts, but they prefer to attack the ends, eye buds and root bands (Chaudhary*et al.*, 1986 and mill, 1992).

Termites (Order - Isoptera) feed on a vast range of host and are known as important pests of crops and trees. The damage caused to crops especially sugarcane may be severe (Sands 1977).Termites feed on underground portions of the sugarcane plants resulting in stunted growth of the plant and in severe attacks dessications of leaves and deteriorated cane stalks (Sands 1977, Fewkes and Greathead 1978, Mill 1992). The setts are completely hollowed out and even where the undamaged buds manage to germinate the shoots soon die. Healthy shoot are attacked below soil level and often die as a result of starvation and dessication.

Various control measures have been recommended, the most effective being the use of insecticides (Sands 1977, James *et al.*, 1990, Mill, 1992). Chaudhry*et al.* (1986) reported that application of insecticides to cane setts at the timeof planting was useful in controlling pest, although the duration of effectiveness varied among chemicals.

Keeping in view above facts present investigation was undertaken for the purpose to find out the effectiveness of different insecticides against termites.

MATERIALS AND METHODS

The experiment was conducted in a farmer's field at Burhanpurduring 2011-12 and2012 – 13 cropping seasons. Experiment was laid out in RBD with 6 treatments along with control and four replications with the objective to identify the most effective insecticide against termite control. Insecticides were taken in experimentation*viz*chlorpyriphos 50% EC, phorate 10% CG, cartap hydrochloride 4% GR, fipronil 0.3% GR and carbofuran 3% CG. Sugarcane variety Co – 86032 was planted in first week of October at 5×1 fit distance in 25 cm deep trenches. Two eyed setts were prepared and placed in trenches. Insecticides like phorate 10% CG, cartap hydrochloride 4% GR, fipronil 0.3% GR and carbofuran 3% CG were applied at the time of sowing in soil @ 20 $kgha^{-1}$ while chlorpyriphos 50% EC was used for setts treatment and applied after 30 days of planting @ 1.5 $litreha^{-1}$. Data were collected on termite population three times, initially at 21 DAP when un-germinated cane setts were dugout and examined for termite damage, secondly in the month of February at tillering stage when most of the setts are attacked and then in October at the maturity stage. Data on growth and yield parameter like tillers,milleablecane and yield of sugarcane were also collected. Intercultural operations like weeding, earthing up and irrigations were done as usual. To study the efficacy of applied insecticides data on termite population were taken thrice. Five clumps per plot were uprooted with the help of spade. The uprooted setts /stools were placed on a thick polythene paper, then split with a knife and counted termite population. Statistical analysis was done and treatment means were compared with the control. Percent efficacy of insecticides was also calculated by the following formula.

$$\% \text{ Efficacy} = \frac{Pu - Pt}{Pt} \times 100$$

Where: -Pu = Population of termite in untreated plots.

Pt = Population of termite in treated plots.

Results and Discussion

In first population samplings at 21 days after planting, treatment T_2 and T_5 were found at par while all the treatments significantly superior over control (T_1). Treatment T_5 (15.72) significantly reduces termite population over T_3, T_4 and T_6 and similar trend was observed in case of T_2.Maximum and minimum efficacy were recorded in T_5 (78.56) and T_6 (56.32%) respectively (Table 1). In second sampling i.e.on 15 February similar trend was found as in case of first sampling. Maximum and minimum termites' population were found in T_1 (165) and T_5 (9.36). Highest efficacy was found in T_5 (89.14%) while it was minimum in T_6carbofuran 3% CG (41.23).

In the third sampling collected, more termites, especially in carbofuran 3% CG except control. The insecticides lost their controlling capacity late after application. Fipronil 0.3% GR,chlorpyriphos 50% EC, phorate 10% CG,and cartap hydrochloride 4% GR effectively controlled termite population and resulted 98.37 to 88.10 % efficacy against termite population.Treatment T_5 performed better than other treatment throughout the experimentation followed by treatment T_2, T_3, T_4& T_6. Similar results have also been reported by Ahmed *et al.* (2007), Koto *et al.* (2000) and Alam*et al.* (2001).

It is visualized from the data given in table 2 that, tillers $10^3 ha^{-1}$ varied from 162.75 – 223.78. Maximum numbers of tillers were found in T_5 fallowed by T_2, T_4, $T_3$and T_6. In T_5 37.49 % more tillers were occurred than the control, it may be due to lesser attack of termite in T_5 from germination to harvesting. Another yield attribute of sugarcane has been recorded during experimentation i.e. milleablecane and maximum milleable canes were found in T_5 which was 41.7 ($10^3 ha^{-1}$) more than the control. A noticeable different was found between treated plot and control. Similar results have also been reported by Singh and Singh (2001).

The yield of sugarcane was significantly higher in T_5 over T_3, T_4 and T_6. Data revealed that yield under all

Table 1. Effects of different insecticides on reduction of sugarcane termites populations

Treatment	21 DAP		15 February		15 October	
	Mean POP	Efficacy (%)	Mean POP	Efficacy (%)	Mean POP	Efficacy (%)
Control (T_1)	149.00	-	165.00	-	198.24	-
Chlorpyriphos 50% EC (T_2)	18.46	75.43	11.26	87.54	6.56	97.21
Phorate 10% CG (T_3)	54.28	65.88	45.17	77.00	40.14	88.10
Cartap hydrochloride 4% GR(T_4)	36.66	69.37	29.33	78.85	22.54	92.31
Fipronil 0.3% GR (T_5)	15.72	78.56	9.36	89.14	3.33	98.37
Carbofuran 3% CG (T_6)	72.89	56.32	82.77	41.23	101.66	25.42
CD at 5%	16.14	-	13.21	-	14.57	-

Table 2. Effect of different insecticides on yield and yield contributing characters of sugarcane

Treatments	Tillers (10^3 ha^{-1})	Milleable cane (10^3 ha^{-1})	Yield t ha^{-1}
Control (T_1)	162.75	71.64	65.31
Chlorpyriphos 50% EC (T_2)	219.36	116.21	103.45
Phorate 10% CG (T_3)	177.19	94.26	84.87
Cartap hydrochloride 4% GR(T_4)	213.42	97.42	90.56
Fipronil 0.3% GR (T_5)	223.78	113.34	105.78
Carbofuran 3% CG (T_6)	170.26	88.79	79.37
CD at 5%	-	-	13.85

treated plots were significantly greater than the control. Differences with in the treatments (T_3, T_4, & T_6) were not found significant. These results are in close confirmity with the findings of Alam*et al.* (2008) and Singh *et al.* (2001).

The overall results of experiment indicated that termites'population might be controlled effectively with treatment of insecticides from planting of setts to the harvest of sugarcane.

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KOKUM (*GARCINIA INDICA*) PROCESSING AND MARKETING - AN LIVELIHOOD OPTION IN *KONKAN* REGION OF MAHARASHTRA

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ABSTRACT

Kokum fruits processing is an important activity because raw/ripe fruits need to be processed before their consumption. In this context, *kokum* crop has attained the status of economical importance. The study was intended to make a attempt to identify the problems related to processor as well as various market functionaries involved in marketing of *kokum* products. The study shows that most of the rural household preparing *kokum* product and it is common practice in *kokum* producing area. At household level, products were prepared for home consumption therefore capital requirement is negligible and mostly family labour oriented. Therefore, it provides employment to large number of workers in rural area. Hence at household level, this entrepreneurship provides more opportunities for employment of family labour and income generation to family.

Key words:, *Garcinia indica*, Fruit processing, Marketing, Employment

The value addition to the *kokum* fruits through processing assumes an important activity because raw/ripe fruits need to be processed before their consumption. In this context, *kokum* crop has attained the status of economical importance. The resultant of this activity creates employment opportunities in rural area and on the other hand develops suitable products for earning the foreign exchange through the export of *kokum* derivatives.

Many home scale or small scale processing units are developed in *Konkan* region which utilized large quantity of neglected fruits like *kokum* for processing into different products. The *kokum* fruits are available as a raw material in plenty quantity during the season of processing. It is also observed in the study area that, many farmers were used to process the *kokum* fruits for their home consumption which is not estimated anywhere.

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Further, the study was intended to make a attempt to identify the problems related to processor as well as various market functionaries involved in marketing of *kokum* products. This study is of immense use to planners and policy makers to frame appropriate policies related to the *kokum* processing and marketing.

The specific objectives of the study are as follows.

- To study the economics of processing of *kokum* fruits.
- To study the marketing of value added *kokum* products
- To document the constraints experienced in *kokum* processing, and marketing.

MATERIALS AND METHODS

South *Konkan* region was selected as the cultivation of *kokum* is mainly concentrated in the region. There are

two districts in the region, viz. Ratnagiri and Sindhudurg district, and from each district five tahasils having maximum area under *kokum* were selected purposively.

From the study area the nine household from each of the tahasil were selected randomly. Thus, the final sample consisted of 90 households' *kokum* processors from South *Konkan* region.

The number of *kokum* units in the tahasil were selected by quota sample method. Accordingly, 20 *kokum* processors were randomly selected with quota sample method at the rate of 2 processing units from each tahasil.

Similarly, the list of authorized *kokum* traders was obtained from APMC of respective district. Different market functionaries and market channels were identified and a list of registered trader was prepared. Further from the list, 50 per cent of registered *kokum* traders/ dealers operating in the whole district were selected purposively. However, other intermediaries were selected randomly from respective tahasil of the districts. From each of the market, 6 retailers were chosen and interviewed personally. The information of selected respondents preparing *kokum* product was collected by survey method for the productive year 2011-12.

Analysis of data

The data collected were analyzed by using simple mathematical tools like averages, percentage ratios and frequency distribution; standard cost concepts were used to study cost of production and returns.

Estimation procedure

The final product prepared by the sample households and quantity of raw material (fruits) used were estimated for whole region. The following function was used for estimation of fruits requirement and final product.

Estimation of fruits requirement

$$\Sigma X_1 = \{(P/S) \times Ri \times Qi\}$$

Where,

X_1 = Total quantity of *kokum* fruits used for i^{th} product.

P = Rural population of region.

S = Average size of family in the region

Ri = Ratio of proportion of households preparing i^{th} product.

Qi = Average quantity of *kokum* fruits used by each family for i^{th} product

Estimation of Final product

$$\Sigma Z_1 = \{(P/S) \times Ri \times Ti\}$$

Where,

Z_1 = Total quantity of *kokum* i^{th} processed product.

P = Rural population of region.

S = Average size of family in the region

Ri = Ratio of proportion of households preparing i^{th} product.

Ti = Average quantity of final *kokum*

product prepaid by each household for i^{th} product

RESULTS AND DISCUSSION

Cost of processing of kokum fruits at household level

The cost of processing of *kokum* fruits at household level is presented in Table 1. It is revealed from the table that, per household used quantity of *kokum* fruits for different product i.e. 55.55 kg for preparation of dried *kokum* rind, 21.40 kg for *Amrit kokum* and 16.20 kg for *kokum agal*. Per household, cost of processing of *kokum* fruits into dried rind worked out to Rs. 814.00; out of which maximum cost was incurred on purchase of raw material i.e. *kokum* fruits (Rs. 444.44). However, the cost of labour, interest on working capital and expenditure on salt was Rs. 192.00, Rs. 92.21 and 39.96 respectively.

The final product of dried *kokum* rind obtained was 11.86 kg per household in the south *Konkan* region with total value of Rs. 1162.28, which indicated 1: 0.21 fruit to final product ratio. This is a commonly prepared product by large number of rural households in the south *Konkan* region. The net value added of dried *kokum* rind per household was

Table 1. Cost of processing of *kokum* fruits at household level.

Particular Raw material	Dried kokum rind		Amrit Kokum		Kokum Agal	
	Quantity	Amount (Rs.)	Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
Fruit (kg)	55.55	444.44	21.40	171.20	16.20	129.60
Sugar (kg)	-	—	12.60	403.20	—	—
Salt (kg)	6.66	39.96	0.30	1.80	8.30	49.80
Jira (kg)	—	—	0.10	20	—	—
Packing material (kg/No.)	0.10	18		60.00		48.00
Labour days	2 .27	192	3.41	288	33.41	288
Interest on working capital		97.21		132.16		72.75
Depreciation		22.50		23.80		23.80
Total Cost		814.00		1100.16		611.35
Final product	11.86 kg	1162.28	19.35 lit.	2322.00	9.6 lit.	864.00
Gross added value		717.84 (161.51)		2150.80 (1256.30)		734.40 (566.66)
Net added value		348.28 (78.36)		1221.84 (713.69)		252.65 (194.87)
Benefit cost ratio		1.43		2.11		1.40
Ratio of fruit to final product		0.21		0.91		0.51

(Figures in parentheses indicated percentage)

78.36 per cent (Rs.348.28), whereas, gross value added was 161.51 per cent (Rs. 717.84).

The cost of processing of *kokum* fruits (21.40 kg) into *Amrit kokum* came to Rs. 1100.16 per household. Out of which maximum expenditure was incurred on sugar Rs. 403.20 which was followed by labour wages Rs.288.00, *kokum* fruits Rs. 171.20, interest on working capital Rs. 132.16, and packing material Rs. 60.00. Per household final product of *Amrit kokum* obtained was 19.35 lit. and the total value was Rs. 2322.00 which indicated 1:0.91 fruit to final product ratio. The net value addition in processing into *Amrit kokum* was 713.69 per cent (Rs.1221.84 per household), whereas gross added value per household was 1256.30 per cent (Rs. 2150.80).

The per household, the quantity of *kokum* fruits processed for *kokum agal* was 16.20 kg, and the cost of processing per household of *kokum* fruits into *kokum agal* came to Rs. 611.35. Out of which maximum cost was for labour wages (Rs. 288.00) followed by purchase of fruits (Rs. 129.60), interest on working capital (Rs. 72.75), salt (Rs.49.80) and packing material (Rs.48.00). Per household final product of *kokum agal* obtained was 9.60 lit. with the total value of Rs. 864.00 which indicated 1:0.51 fruit to final product ratio. The net value added due to processing in to *kokum agal* per household was 194.87 per cent (Rs. 252.65), whereas gross value added was 566.66 per cent (Rs. 734.40).

The *kokum agal* and *Amrit kokum* were time consuming and labour intensive products, Hence, maximum fruits were utilized for preparation of dried *kokum* rind during the season, due to shortage of family labour, and pre-monsoon works. The net added value in *Amrit kokum* was higher (713.69%) as compared to *kokum agal* (194.87%) and *kokum* dried rind (78.36%), due to use of additives like sugar and *jira* which were not utilized in *kokum agal* and dried *kokum* rind. The benefit cost ratio was found to be maximum in case of *Amrit kokum* preparation 2.11 which was followed by dried *kokum* rind preparation 1.43 and *kokum agal* preparation 1.40. The data presented in the table also showed that the conversion ratio of raw material (fruits) in to final product was much less in the dried *kokum* rind (1: 0.21) as compared to *Amrit kokum* (1:0.91) and *kokum agal* (1: 0.51), This is because of no additives were added while processing and sun drying method is commonly followed in the process for minimizing moisture content in the final product. However the ratio is higher in *Amrit kokum* due to higher concentration of sugar used for extracting its juice.

Table 2. Disposal of *kokum* products of household processing unit

Disposal	Dried *kokum* rind		*Amrit Kokum*		*Kokum* Agal	
	kg	(%)	lit	(%)	lit	(%)
i) Home consumption	2.74	23.10	6.35	32.82	2.60	27.08
ii) Given to relative and friends	1.26	10.62	4.00	20.67	2.00	20.84
iii) Sold	7.86	66.28	9.00	46.51	5.00	52.08

Disposal of kokum product at household level

It was observed that disposal of *kokum* product in the region has three different ways Viz. a) home consumption, b) distribution between relatives and friends and c) sale. Among the products sale was found to be varying from 46.51 to 66.28 per cent., while gift to friends and relatives varying from 11.00 per cent to 20.00per cent, and rest of product was retained for home level (23.00 % to 33.00%). Therefore it is seen that maximum quantity of household product sold in domestic market or local level to the tourist after meeting their home requirement.

Kokum processing units

Capital investment in kokum processing unit

The capital investment made in the *kokum* processing unit includes fixed capital and working capital which is presented in Table No. 3.

It is observed that, in the study area the total capital investment of Rs.2.13 lakhs was made to undertake the processing of *kokum* fruit in to dried *kokum* rind. In this total capital investment the share of fixed capital investment was 76.68 per cent (Rs.1.63 lakhs) and share of working capital was observed to 23.32 per cent (Rs.0.49 lakhs). In the total working capital, raw material share was highest (Rs. 0.38 lakhs) which was followed by labour wages Rs.6948, packing material Rs.1800, other charges Rs.1228 and chemical and preservatives Rs. 935.

In case of *Amrit kokum* production unit, it was observed that per unit total capital investment made was Rs. 16.63 lakhs. Out of which 52.82 per cent (Rs. 7.72 lakhs) amount was incurred on working capital and 47.18 per cent for fixed capital (Rs.6.90 lakhs). From the total working capital investment, the per unit maximum share of capital Rs. 4.47 lakhs was incurred for additives and preservatives which was followed by raw material (fruits) Rs. 1.75 lakhs, packing

Table 3. Per unit capital investment in *kokum* processing (Rs.)

Item of cost	Dried *kokum* rind	*Amrit Kokum*	*Kokum Agal*
Fixed capital : (A)	163507 (76.68)	690504 (47.18)	475704 (58.78)
Working Capital :(B)			
Raw material	38820	175406	137021
Packing material	1800	77392	74077
Additives & preservatives	935	447356	63847
Labour wages	6948	59435	46293
Other charges	1228	13224	12275
Sub total (B)	49731 (23.32)	772813 (52.82)	333513 (41.22)
Grand total (A+B)	213238 (100)	1463317 (100)	809217 (100)

(Figures in parentheses indicates percentage)

material Rs. 77392, labour wages Rs.59435 and other charges Rs. 13224.

In case of *kokum agal* production, total capital investment was made to Rs. 8.09lakh, out of which 58.78 per cent (Rs. 4.75 lakhs) was incurred on fixed capital and 41.22 per cent was incurred on working capital. The per unit expenditure incurred on raw material in *kokum agal* unit was highest Rs. 1.37 lakhs. Within the working capital categories, this was followed by packing material Rs. 0.74 lakhs, additives and preservatives Rs. 0.63 lakhs , labour wages Rs.0.46 lakhs and other charges Rs 0.12 lakhs.

The overall investment pattern in *kokum* processing unit indicating direct relationship between extent of capital investment and volume of the processed product.

Cost and return of processing unit

In processing unit, item wise cost incurred in the processing of *kokum* fruits into different *kokum* products were analyzed and results are presented in Table No. 4.

Per unit total processing cost incurred in *kokum* fruit processing product was worked out to be Rs. 14.01 lakh. In this the maximum cost of Rs. 9.24 lakh was incurred on *Amrit kokum* followed by *kokum agal* (Rs. 4.08 lakh) and dried *kokum* rind (Rs. 68601) . At an overall level from the total cost, the share of

Table: 4. Per factory Cost and return of different *kokum* products. (Rs.)

Sr. No.	Particular	Dried *kokum* rind	*Amrit Kokum*	*Kokum Agal*	Total
I	Raw material				
i)	Fruits	38820	175406	137021	351247
ii)	Container& Packing material	1800	77392	74077	153269
iii)	Additives preservatives	935	447356	63847	512138
iv)	Labour wages	6948	59435	46293	112676
v)	Other charges	1228	13224	12275	26727
II	Depreciation	2221	15151	12275	29647
III	Interest on				0
a)	Working capital	6962	108193	46691	161846
b)	Fixed capital	9687	28094	15740	53521
IV	Total Cost	68601	924251	408219	1401071
V	Total output	1.30 tonnes	17424 lit	16684 lit	
VI	Gross return	104000	1132560	750780	1987340
VIII	Tax paid	4160	45302	30031	79493
IX	Net return	31239	163007	312530	506776
X	B:C ratio	1.52	1.23	1.83	1.41

additives and preservatives cost was maximum and accounted to Rs. 5.12 lakh. While the share of raw material, containers and packing material and interest on working capital in business accounted to Rs. 3.51 lakh, Rs. 1.53 lakh and Rs. 1.61 lakh respectively.

In different *kokum* processed product, the total processing cost in *Amrit kokum* preparation, the maximum cost Rs. 447356/- was incurred towards additives and preservatives followed by raw material Rs. 175406/-, interest on fixed capital Rs. 108193/-, containers and packing material Rs. 77392/-, labour wages Rs. 59435/-, interest on fixed capital Rs. 28094/-, depreciation Rs. 15151/- and other charges Rs. 13224 respectively.

In case of *kokum agal*, cost of fruits was worked out to be maximum (Rs. 137021/-) followed by containers and packing material (Rs. 74077/-), additives and preservatives (Rs. 63847/-), interest on working capital (Rs. 46691/-), labour wages (Rs. 46293/-), interest on fixed capital (Rs. 15740/-) and depreciation and other charges each having Rs. 12275/- respectively.

Similarly in case of dried *kokum* rind preparation, unit Rs. 38820 expenditure was incurred for purchasing of fruits, which was followed by interest on fixed capital Rs. 9687, interest on working capital Rs. 6987/-, labour wages Rs. 6948/-, depreciation Rs. 2221/-, containers and packing material Rs. 1800/- and additives and preservatives Rs. 935/- respectively.

The per processing unit total gross returns (Rs.1987340/-) obtained from *Amrit kokum* was Rs. 1132560/-, followed by *kokum agal* Rs. 750780/- and dried *kokum* rind Rs. 104000/-. After deducting the total cost and tax paid, the net return amounted to Rs. 163007 in *Amrit kokum*, Rs. 312530/- in *kokum agal* and Rs. 31239/- in dried *kokum* rind. Hence at overall level per unit total net return of Rs. 506776/- were realized by the *kokum* processors.

It was observed from the Table 4. that per season quantity obtained by the *kokum* processing unit was 17424 lit. of *Amrit kokum*, 16684 lit of *kokum agal* and 1.30 tonnes of dried *kokum* rind. Whereas BC ratio at overall level was 1.41, but it was maximum in *kokum agal* unit level 1.83, followed by dried *kokum* rind unit 1.52 and *Amrit kokum* unit 1.23. The main reason for maximum BC ratio in *kokum agal* unit level was due to less use of additives as compared to *Amrit kokum*.

Cost of processing for kokum product

The cost of processing incurred in one quintal of dried *kokum* rind, 100 lit of *Amrit kokum* and 100 lit of *kokum agal* was computed. The per unit profitability and added value of the different processed products is worked out and presented in Table 5.

The cost of processing per quintal of dried *kokum* rind, worked out to Rs. 5595/- out of which maximum cost was incurred on fruits (Rs. 2986/-) The important item of costs were interest on fixed capital (Rs. 745/-), interest on working capital (Rs. 535/-), labour wages (Rs. 334/-), tax paid (Rs. 320/-), container and packing material (Rs. 138/-), other charges (Rs. 95/-). The cost incurred on additives and a preservative used in the processing was Rs. 71/- and depreciation Rs.171/-.

Table 5. Cost of processing of *kokum* products (Rs.)

Sr. No.	Particular	Dried *kokum* rind (per 100 kg)	*Amrit Kokum* (Per 100 lit)	*Kokum Agal* (Per 100 lit)
I	Raw material			
i)	Fruits	2986	1007	821
ii)	Container & Packing material	138	444	444
iii)	Additive Chemical & preservatives	71	2567	383
iv)	Labour wages	534	341	277
v)	Other charges	95	76	74
II	Depreciation	171	87	74
III	Interest on			
i)	Working capital	535	621	280
ii)	Fixed capital	745	161	94
	Tax paid	320	260	180
IV	Total Cost	5595	5564	2627
V	Gross return	8000	6500	4500
VI	Net return	2405	936	1873
VII	Added values			
i)	Gross	167%	545.48%	448.12%
ii)	Net (V-IV)	80.54%	92.94%	228.13%

The cost of processing of *kokum* fruits into per 100 lit *Amrit kokum* worked out to Rs. 5564/-, out of which cost of additives and preservatives was maximum (Rs. 2567/-) followed by cost of fruits(Rs. 1007/-), interest on working capital (Rs. 621/-), container and packing material (Rs. 444/-), labour wages (Rs. 341/-). The cost for tax paid was Rs. 260/-, whereas interest on fixed capital was Rs. 161/-. The expenses incurred on other items were depreciation (Rs. 87/-) and other charges Rs. 76/-.

It is also observed that, the cost of processing of *kokum* per 100 lit of *kokum agal* was worked out to Rs. 2627, out of which maximum cost incurred to fruits (Rs. 821/-) followed by additives and preservatives (Rs. 383), interest on working capital (Rs. 280/-), labour wages (Rs. 277/-). The tax paid was estimated to Rs. 180/- for 100 lit of *kokum agal*. Whereas, cost for interest on fixed capital was estimated to Rs. 94/- and depreciation Rs. 74/-. The cost structure for different product is similar to that at household level.

It is also depicted from Table 5 that the gross returns obtained were Rs. 8000/- per quintal of dried *kokum* rind, Rs. 6500/- and Rs. 4500/- for 100 lit of *Amrit kokum* and *kokum agal* respectively. Due to processing of *kokum*

fruits in to different product the sale value has increased. The gross added value estimated in dried *kokum* rind was 167 per cent, while the gross value added in *Amrit kokum* was 545 per cent and in *kokum agal* it was 448 per cent and net added value was 80.54 per cent, 93 per cent and 228 per cent in the same order.

Estimation of total quantity of processed product from kokum fruits

The large quantity of *kokum* fruits are processed in to different product at household level and registered processing unit level in the South *Konkan* region, but the *kokum* fruit production and quantity of final product were not recorded and published. Hence, an effort is made to estimate the quantity on the basis of this study for south *Konkan*. The quantities of fruit processed and quantities of final product prepared were estimated as par the procedure given in the methodology and estimates are presented in Table 6.

It is observed that the total quantity of *kokum* fruits utilized for different product of *kokum* estimated to 12655.81 MT, out of which maximum *kokum* fruits 10655.70 MT (84.19%) were utilized at rural household level in the south *Konkan* region. Where in, the maximum quantity of *kokum* fruits was utilized for preparation of dried *kokum* rind (5607.25 MT) on the other hand at processing unit level it was maximum for *Amrit kokum* (908.60 MT) followed *kokum* agal (709.77MT). This is because of product like *Amrit kokum* and *kokum agal* are labour and capital intensive and both are available at factory level but at unorganized household level processing is depend only on family labour only. The maximum quantity of *kokum* fruit were processed in to dried *kokum* rind for

Table 6. Estimation of total quantity of processed product from *kokum* fruits (Qty. in MT)

Sr. No.	Product	Household level	Processing unit level	Total Estimate
Kokum fruits				
1	Dried *kokum* rind	5607.25	381.73	5988.98
2	*Amrit Kokum*	3471.63	908.60	4380.23
3	*Kokum Agal*	1576.83	709.77	2286.60
	Total Estimate	10655.71 (84.19)	2000.10 (15.81)	12655.81 (100.00)
Kokum Product				
1	Dried *kokum* rind	1197.15	76.70	1273.85
2	*Amrit Kokum*	3139.07	1027.78	4166.85
3	*Kokum Agal*	934.42	984.12	1918.54
	Total Estimate	5270.64 (71.62)	2088.60 (28.38)	7359.24 (100.00)

(Figures in parentheses indicated percentage)

family consumption at household level due to local availability of fruits and less capital and labour intensive processing.

Similarly from the Table 6, it is observed that total quantity of final processed product was estimated to 7359. 24 MT. of which maximum 71.62 per cent (5270.64 MT) quantity was prepared at rural unorganized household level and remaining 28.38 per cent (2088.60 MT) quantity was prepared at registered processing unit level.

Therefore it is revealed that the major volume of *kokum* fruits were processed at unorganized rural household level which is not recorded in anywhere, and only 15 to 28 per cent of total volume of fruits and final products were processed by registered processing unit level only. The 47.32 per cent of the total fruits were processed for only dried *kokum* rind which having 167 per cent of gross value addition. If all the fruits diverted towards the *Amrit kokum* preparation, there would be significant increment in gross value addition to the *kokum* fruits.

Estimation of annual value addition due to kokum fruit processing

The value addition in *kokum* fruits due to processing was estimated for south *Konkan* region and presented in Table 7.

In south *Konkan* region, most of the *kokum* fruits were processed by unorganized sector i.e. at household level. Therefore, the estimate of value addition in the study area are not documented. Hence, an effort is made to estimate gross value addition and net value addition due to processing at household level and registered processing unit level. It is observed from

Table 7. Estimated annual value addition due to *kokum* fruit processing in South *Konkan* region. (Rs. in lakhs)

Sr. No.	Product	Household level	Processing unit level	Total Estimate
Gross value addition				
1	Dried *kokum* rind	90.56	6.37	96.93
2	*Amrit Kokum*	436.14	49.56	485.70
3	*Kokum Agal*	89.35	31.83	121.18
Total Estimate		616.05 (87.53)	87.76 (12.47)	703.81 (100.00)
Net added value				
1	Dried *kokum* rind	43.93	3.07	47.00
2	*Amrit Kokum*	247.76	8.44	256.20
3	*Kokum Agal*	30.72	16.19	46.91
Total Estimate		322.4 (91.56)	27.70 (8.44)	350.11 (100.00)

(Figures in parentheses indicated percentage)

the Table 7 that the total gross value addition due to processing of *kokum* fruits in the south *Konkan* region was estimated to Rs. 703.82 lakhs, out of which 87.53 per cent was estimated from household level and 12.47 per cent from registered processing unit level. Similarly, the net added value due to *kokum* processing in the study area was estimated to Rs. 352.14 lacks out of which 91.56 percent net added value was estimated from unorganized sector and only 8.44 per cent added value was generated from organized sector of *kokum* processing unit.

Therefore, it is revealed from the Table 7 that the maximum share of net value addition Rs. 322.43 lakhs were generated from unorganized sector of *kokum* processing annually. This is mainly due to localized used of *kokum* fruits and engaging the part of family labour in the processing to earn additional income for the family livelihood during the season and also utilizing their own fruit production for processing.

Price spread for processed kokum product

The sample processors in the study area marketed the processed *kokum* product viz. dried *kokum* rind, *Amrit kokum* and *kokum agal* through different market channels. For these different market channels the price spread was worked out and presented in Table 8.

It was observed from the Table 8 that in marketing dried *kokum* rind, *Amrit kokum* and *kokum agal* resorted to two marketing channels. viz. I) Processors—

Table 8. Producers share in consumer rupee in *kokum* product marketing. (Rs./kg or lit)

Sr. No.	Cost of item	*Kokum* rind		*Amrit kokum*		*Kokum* agal	
		Channel I	Channel II	Channel I	Channel II	Channel I	Channel II
1	Net price received by producer	83.30	80.00	70.00	65.00	50.00	45.00
2	Cost incurred by producer	1.70	—	-	—	-	—
3	Purchase price of dealer	—	80.00	—	65.00	—	45.00
4	Cost incurred by dealer	—	2.30	—	3.40	—	3.40
5	Profit margin of dealer	—	4.00	—	5.00	—	5.00
6	Purchase price by retailer	85.00	86.30	70.00	73.40	50.00	53.40
7	Cost incurred by retailer	3.10	3.10	4.20	4.20	4.20	4.20
8	Profit margin of retailer	36.90	30.60	20.80	17.40	20.80	17.40
9	Consumer purchase price	120.00	120.00	95.00	95.00	75.00	75.00
10	Price spread	36.70	40.00	25.00	30.00	25.00	30.00
11	Producer share in consumer rupee (%)	69.41	66.66	73.63	68.42	66.66	60.00

Retailer——Consumer II) Processors— Dealer— Retailer— Consumer. The producer has realized maximum net price of Rs. 83.30 per kg followed by Rs. 80.00 per kg of dried *kokum* rind marketed through channel -I and channel- II respectively. Hence, producer's share in consumer rupee was observed to be maximum (69.41%) in channel I followed by channel -II (66.66%). For dried *kokum* rind, market margin was worked out to Rs. 36.70 per kg in channel- I and Rs. 40.00 per kg in channel- II. Thus highest market margin was observed in channel- II.

In case of *Amrit kokum* and *kokum agal*, it was observed that the processors had realized maximum net price in channel- I Rs. 70.00 and Rs. 50.00 respectively. The producer's share in consumer rupee was also highest in the same channel- I Rs. 73.63 per cent and Rs. 66.66 per cent. Therefore, the market margin was highest in channel-II for both the products (Rs.30/ lit).

Processing and marketing constraints in kokum

The constraints encounter in the processing and marketing of *kokum* product by the sample processors and marketing intermediaries in the study area were studied and presented in Table 9.

Processing

The major constraints experienced in the processing of *kokum* in study area was no incentives for the processing of *kokum* fruits from state government to popularize the *kokum* product and enhance *kokum* plantation (100%), which was followed by high cost of raw material and inadequate availability of *kokum* fruits (95%), and shortage of labour during peak period of processing (50%).

Marketing

The major constraints expressed by market intermediaries viz. retailers and dealer was delay in payment of sale produce 66.96 per cent, followed by high transport cost (53.57 per cent) and no sufficient quantity of processed product for transporting to distant market (17.85 per cent).

Table 9. Processing constraints experienced by processors

Sr.No.	Particulars	N=20
	Processing constraints	
1	No. incentive from Govt.	20 (100.00)
2	Inadequate availability of fruits	19 (95.00)
3	Labour shortage	10 (50.00)
	Marketing Constraints	N=82
1	Delay in payment of sale proceeds	55 (66.96)
2	High transport cost	44 (53.57)
3	No sufficient load	14 (17.85)

(Figures in parentheses indicated percentage)

CONCLUSIONS

1) Most of the rural household preparing *kokum* product and it is common practice in *kokum* producing area.

2) Among the different *kokum* product dried *kokum* rind was common in household level whereas *Amrit kokum* and *kokum* agal were common at commercial production unit level.

3) At household level, products were prepared for home consumption therefore capital requirement is negligible and mostly family labour oriented. The operation in *kokum* processing is carried out manually, therefore it provides employment to large number of workers in rural area, hence at household level this entrepreneurship provides more opportunities for employment of family labour and income generation to family.

4) The cost of processing was highest in *Amrit kokum* in both at household and commercial processing unit level.

5) The prices of value added product are comparatively much higher than fruits.

6) No incentives form government for popularization of *kokum* product, labour shortage during peak period of processing, high cost and inadequate available of *kokum* fruits, these problems perceived by the processors whereas delay in payment of sale proceeds and high transport cost problem face by the market intermediaries.

Policy Implication

Major *kokum* fruits were processed and marketed by unorganized rural household level, therefore there is need to take initiatives for marketing of *kokum* product through organizational set up and efforts should be taken for establishment of collection centers at local/ village level with brand name through self help group operated in the region.

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STUDY ON INTEGRATED NUTRIENT MANAGEMENT IN MAIZE CROP

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ABSTRACT

The experiment was conducted in Forage Agronomy block of Instructional Dairy Farm, Nagla at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand during 2007-08 and 2008-09 to determine the optimum proportion of organic and inorganic sources of nutrients along with the suitable INM system for enhanced yield and quality of forage for maize crop and to find out the effect of inorganic sources of nnutrients on the residual soil fertility status. In general application of 75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + biofertilizer resulted in higher growth, productivity and quality in maize crop. Whereas the overall better soil health was recorded with the treatment having application of one third dose each of recommended nitrogen through inorganic source + through FYM + through vermicompost alongwith biofertilizer inoculation.

Key words: maize, organic and inorganic sources, growth and development, productivity, fodder quality, soil fertility

The success of livestock industry depends on feeding the animals with sufficient quantity of nutritious forage to meet their requirements for maintenance, growth and production. At present, India has nearly 40 per cent short supply of green forage production. Since, the forages are cheapest source of animal feed (Joshi *et al.,* 2007), the gap between demand and supply can be bridged up with increase in productivity of forage crops.

To maintain good health and potential of animals in term of draft, milk, meat and wool, feeding of quality fodder is more important. The high yielding varieties of forage crops and agronomic techniques may be helpful to achieve this goal. The forage crops are heavy feeder of plant nutrients and also removes large amount of nutrients from the soils. For harvesting full forage quality potential, forage crops requires liberal supplementation of nutrients, addition of external fertilizers and manures to meet the nutritional requirements of crop. Hence, nutrient management of forage crops is most important.

Maize is an important food cum fodder crop of the *kharif* and *rabi* seasons in India. It grows well in summer and rainy season and supplies fodder from April to December. It has high production potential, wide adaptability and multiple uses. This crop has an edge over other cultivated forage crops due to its better palatability and usage in the form of silage. It has 8-9 per cent crude protein content and rich in carbohydrate. Since, it provides essential nutrients to ruminant animals, so maize fodder is one of the excellent quality fodder.

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Maize is very sensitive to nutrient requirement. Nitrogen is most important factor influencing the yield of this crop. Maize is primarily being grown in monsoon season, therefore, the recovery of nitrogen by this crop is as low as 30-35 per cent (Prasad, 1996). Since, fertilizers cost has increased considerably in the recent years, average and marginal farmers cannot afford to purchase them. It is necessary to find out a judicious dose of nitrogen without reduction in yield and quality of fodder. The complimentary use of chemical fertilizers and organic manures help in achieving sustainable forage production in specified time by not only augmenting the efficiency of applied fertilizer, but also through correction of secondary and micronutrient deficiency. Hence, the increasing cost of fertilizers and poor economic condition of farmers make it imperative to adopt integrated nutrient management.

It has been studied that organic manures can supplement the requirement of crop plants (Sharma, 1981). It is therefore, needed to find out alternatives to minimize the dependence on fertilizers without affecting the nutritional requirement of the crop plants. Information on these aspects is lacking. Therefore, the present study was undertaken to determine the optimum proportion of organic and inorganic sources of nutrients along with the suitable INM system for enhanced yield and quality of forage for maize crop and to find out the effect of inorganic sources of nutrients on the residual soil fertility status.

MATERIALS AND METHODS

The experiment was conducted in Forage Agronomy block of Instructional Dairy Farm, Nagla at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. The Instructional Dairy Farm is located in the *Tarai* belt of Shivalik range of Himalayas with humid sub-tropical type of climate at latitude of 29°N and longitude of 79.3°E and situated at an altitude of 243.84 m above the mean sea level. The climate experienced at Pantnagar is humid sub-tropical with extreme of weather conditions such as hot and dry summers and cold winters. Generally south west monsoon commences in third week of June and few showers occur in winter and occasionally during summer also.

Table 1. Chemical composition of the experimental soil

S.No.	Particulars	2007	2008	Methods
1.	pH (1:2 soil : water ratio)	7.26	7.57	Beckman glass electrode pH meter (Jackson, 1973)
2.	Organic carbon (%)	0.76	0.79	Walkley and Black's method (Jackson, 1973)
3.	Available nitrogen (kg N/ha)	281.3	281.7	Alkaline Permanganate method (Subbiah and Asija,1956)
4.	Available phosphorus (kg P/ha)	26.2	26.6	Olsen's method (Jackson, 1973)
5.	Available potassium (kg K/ha)	245.8	248.3	Flame photometry method (Jackson, 1973)

The mean annual rainfall was 1369 mm of which 80 to 90 per cent is received from June to October. The soil of experimental field was slight silty clay loam (Nagla series, Mollisol) in texture, dark grayish brown to dark grey in humus with weak fine to medium granular structure.

The experiment was laid out in a Randomized Block Design consisting total 12 treatments with 4 replications.

Treatment details

Symbol	Treatments
T_1	Control
T_2	Recommended dose of NPK through inorganic source
T_3	75% dose of recommended nitrogen through inorganic source + 25% through FYM
T_4	75% dose of recommended nitrogen through inorganic source + 25% through vermicompost
T_5	50% dose of recommended nitrogen through inorganic source + 50% through FYM
T_6	50% dose of recommended nitrogen through inorganic source + 50% through vermicompost
T_7	75% dose of recommended nitrogen through inorganic source + 25% through FYM + B.F.
T_8	75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + B.F.
T_9	50% dose of recommended nitrogen through inorganic source + 50% through FYM + B.F.
T_{10}	50% dose of recommended nitrogen through inorganic source + 50% through vermicompost + B.F.
T_{11}	$33^{1/3}$% dose of recommended nitrogen through inorganic source+$33^{1/3}$% through FYM+$33^{1/3}$% through vermicompost
T_{12}	$33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$% through vermicompost + B.F.

B.F. = Biofertilizers (*Azotobacter* spp.)

Recommended dose of N,P & K for Maize : 90:60:40 kg NPK/ha

The African Tall variety of maize was used for the experimentation. The required amount of farm yard manure (containing 0.5% N, 0.2% P_2O_5 and 0.5% K_2O) and vermicompost (containing 2.0% N, 1.2% P_2O_5 and 0.8% K_2O) was calculated and applied with respect to treatment. Urea, SSP and MOP were used as inorganic source of nitrogen, phosphorus and potassium, respectively.

The calculated data during experimentation were analysed statistically. The statistical analytical procedure was followed as given by Cochran and Cox, 1966. In case of significant results, critical difference (CD at 5%) was calculated for testing the significance of the difference between two treatments at 5% level of probability.

Results and Discussion

The results on effects of different organic and inorganic sources on growth & development, productivity, fodder quality and soil fertility in maize are described here.

Growth and development

At 60 DAS, during 2007-08, T_8 being at par with T_2 T_3, T_4, T_5, T_6, T_7, T_9, T_{10}, T_{11} and T_{12} recorded significantly more plant height than T_1. Similar to T_8, T_7

Table 2. Growth and development of maize as influenced by various treatments.

Treatments	Plant height at 60 DAS (cm)		Number of leaves/0.5m row length at 60 DAS		Leaf area index at 60 DAS		Leaf dry weight (gm)/0.5m row length at 60 DAS		Stem dry weight (g)/0.5m 0row length at 60 DAS		Total dry matter accumulation g/0.5 m row length at 60 DAS	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T1	161.9	159.2	25.3	24.8	8.10	8.30	34.00	31.75	39.10	37.80	73.10	69.55
T2	266.0	261.5	31.9	32.4	15.81	17.30	45.55	42.32	81.97	90.72	127.53	133.05
T3	268.0	264.5	31.4	33.2	15.21	14.87	45.00	50.85	80.70	82.00	125.70	132.85
T4	271.0	274.2	32.2	31.7	16.23	17.76	46.25	49.97	79.09	90.05	125.35	140.03
T5	267.0	264.5	30.4	31.6	14.29	14.23	40.10	38.90	80.30	84.25	120.40	123.15
T6	265.9	261.5	31.1	32.0	14.33	14.90	44.20	41.50	85.17	88.85	129.38	130.35
T7	270.0	274.2	33.7	32.5	18.12	19.82	47.40	53.37	88.22	97.57	135.63	150.95
T8	278.0	284.5	34.5	36.9	18.40	20.15	49.10	55.10	91.20	100.90	140.30	156.00
T9	269.0	265.2	32.5	32.0	16.92	17.75	46.45	45.95	86.39	94.00	132.85	139.95
T10	272.0	273.0	33.4	33.4	17.61	19.94	47.00	52.97	79.20	88.25	126.20	141.23
T11	269.0	261.5	30.1	30.1	14.15	14.16	41.35	39.42	80.59	78.27	121.95	117.70
T12	267.0	267.5	30.8	31.6	14.25	15.04	42.60	49.32	82.39	89.15	125.00	138.48
S.Em.±	8.6	6.4	1.3	1.5	0.97	1.21	2.01	2.69	4.46	3.66	5.22	4.65
CD (P=0.05)	24.7	18.4	3.8	4.5	2.80	3.50	5.78	7.76	12.86	10.54	15.03	13.38

DAS= days after sowing

T_1-Control, T_{2-} Recommended dose of NPK through inorganic source, T_{3-}75% dose of recommended nitrogen through inorganic source + 25% through FYM, T_{4-}75% dose of recommended nitrogen through inorganic source + 25% through vermicompost, T_{5-}50% dose of recommended nitrogen through inorganic source + 50% through FYM, T_{6-}50% dose of recommended nitrogen through inorganic source + 50% through vermicompost, T_{7-}75% dose of recommended nitrogen through inorganic source + 25% through FYM + B.F., T_{8-}75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + B.F., T_{9-}50% dose of recommended nitrogen through inorganic source + 50% through FYM + B.F., T_{10-}50% dose of recommended nitrogen through inorganic source + 50% through vermicompost + B.F., $T_{11-}33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$ through vermicompost, $T_{12-}33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$% through vermicompost + B.F.

also showed its significant superiority over T_1. However, during 2008-09, T_8 being *at par* with T_4, T_7, T_{10} and T_{12} recorded significantly taller plants than T_1, T_2, T_3, T_5, T_6, T_9 and T_{11}. During both the years, treatments T_7 being at par with all the treatments except T_1, recorded significantly taller plants than T_1. During both the years, T_1 recorded significantly lower plant height than remaining treatments.

At 60 DAS, during 2007-08, T_8 being at par with T_2, T_3, T_4, T_6, T_7, T_9, T_{10} and T_{12} recorded significantly more number of leaves than T_1, T_5 and T_{11}. Treatment T_7 being at par with all the treatments except T_1, recorded significantly more number of leaves than T_1. During 2008-09, treatment T_8 being at par with T_2, T_3, T_7 and T_{10} showed significantly higher number of leaves than T_1, T_4, T_5, T_6, T_9, T_{11} and T_{12}. Treatments T_{10} being at par with all the treatments except T_1 caused significantly more number of leaves than T_1 (control). During both the years, at both the stages, T_1 produced significantly lower number of leaves than remaining treatments.

At 60 DAS during 2007-08, treatment T_8 being at par with T_2, T_4, T_7, T_9 and T_{10} showed significant superiority than T_1, T_3, T_5, T_6, T_{11} and T_{12}. However, T_{10} being at par with T_2, T_3, T_4, T_7, T_8 and T_9 recorded significantly higher LAI than T_1, T_5, T_6, T_{11} and T_{12}.

During 2008-09, T_8 produced significantly higher LAI than T_1, T_3, T_5, T_6, T_{11} and T_{12} but it was at par with T_2, T_4, T_7, T_9 and T_{10}. Similar to treatment T_8, T_7 was at par with T_2, T_4, T_7, T_9 and T_{10} also produced significantly higher LAI than T_1, T_3, T_5, T_6, T_{11} and T_{12}. The lowest LAI was observed in control (T_1) during both the years.

At 60 DAS, T_8 recorded significantly higher leaf dry weight than T_1, T_5, T_{11} and T_{12} during 2007-08 and than T_1, T_2, T_5, T_6, T_9 and T_{11} during 2008-09. Treatment T_7 recorded significantly higher leaf dry weight than T_1, T_5 and T_{11} during 2007-08 and T_2, T_5, T_6 and T_{11} during 2008-09, however, T_7 was statistically at par with rest of the treatments. During both the years, control (T_1) produced significantly less dry weight of leaves than rest of the treatments except T_5 and T_{11} during 2008-09.

At 60 DAS, during 2007-08, treatment T_8 being at par with rest of treatments recorded significantly higher dry matter accumulation in stem than T_1, however during 2008-09, T_8 being at par with T_2, T_7 and T_9 recorded significantly higher dry matter accumulation in stem than remaining treatments. During both the years, T_7 also recorded significantly more dry matter accumulation in stem than T_1 during 2007-08 and T_1, T_3, T_5 and T_{11} during 2008-09 but was statistically at par with rest of the treatments. During both the years, control (T_1) recorded significantly less dry matter accumulation in stem than rest of the treatments.

At 60 DAS, significantly higher total dry matter accumulation was recorded due to T_8 compared to T_1, T_5, T_{11} and T_{12} but it was remained at par with rest of the treatments, however, T_7 being at par with T_2, T_3, T_4, T_6, T_8, T_9, T_{10}, T_{11} and T_{12} significantly increased dry matter accumulation compared to T_1 and T_5 during 2007-08.

During 2008-09, T_8 caused significantly higher dry matter accumulation than rest of the treatments except T_7, while T_7 also being

at par with T_8 recorded significantly higher dry matter accumulation than rest of the treatments. Control (T_1) recorded significantly less dry matter accumulation than rest of the treatment during both the years.

In the present study, the growth parameters of different crops under of cropping system viz. plant height (Tables 3, 17 and 27), number of leaves (Tables 4, 18 and 28), leaf area index (Tables 5, 19 and 29), increased due to application of 75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + biofertilizer treatment. Increase in growth parameters with combined use of organic and inorganic fertilizers might be owing to availability of plant nutrients throughout the growth period as suggested by Arya *et al.* (2000).

Productivity

During both the years, treatment T_8 being at par with T_4, T_7, T_9 and T_{10}

Table 3. Yield parameters of maize as influenced by various treatments.

Treatments	Green fodder yield (q/ha) at harvest		Dry matter yield (q/ha) at harvest		Crude protein yield (q/ha) at harvest		Digestible dry matter yield (q/ha) at harvest	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T1	249.7	242.6	47.4	45.6	3.87	3.61	24.85	22.65
T2	382.5	390.2	87.1	88.7	7.67	7.63	48.12	49.39
T3	383.2	379.7	85.9	85.2	7.75	7.66	47.47	46.81
T4	392.3	401.7	88.6	93.0	7.79	8.22	50.37	53.61
T5	328.2	323.7	70.9	70.1	6.54	6.35	38.47	39.48
T6	365.0	359.2	78.9	78.2	7.23	6.96	43.16	44.62
T7	415.5	420.0	100.6	104.4	9.07	9.13	61.53	66.48
T8	435.7	441.0	106.9	108.9	9.83	9.70	66.35	69.68
T9	402.2	404.8	95.0	95.8	8.63	8.37	54.32	57.57
T10	406.3	411.2	97.6	97.8	9.21	8.47	56.78	58.64
T11	324.2	319.7	70.0	68.9	6.49	6.11	37.41	38.79
T12	338.7	340.7	71.8	73.0	6.84	6.78	38.22	41.00
S.Em.±	15.3	12.7	5.4	5.3	0.5	0.4	4.53	4.41
CD (P=0.05)	44.2	36.6	15.8	15.4	1.4	1.3	13.06	12.70

T_1-Control, T_2- Recommended dose of NPK through inorganic source, T_3-75% dose of recommended nitrogen through inorganic source + 25% through FYM, T_4-75% dose of recommended nitrogen through inorganic source + 25% through vermicompost, T_5-50% dose of recommended nitrogen through inorganic source + 50% through FYM, T_6-50% dose of recommended nitrogen through inorganic source + 50% through vermicompost, T_7-75% dose of recommended nitrogen through inorganic source + 25% through FYM + B.F., T_8-75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + B.F., T_9-50% dose of recommended nitrogen through inorganic source + 50% through FYM + B.F., T_{10}-50% dose of recommended nitrogen through inorganic source + 50% through vermicompost + B.F., T_{11}-$33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$ through vermicompost, T_{12}-$33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$% through vermicompost + B.F.

Table 4. Fodder quality parameters of maize as influenced by various treatments.

Treatments	Dry matter content (%)		Crude protein content (%)		Digestibility (%)		ADF (%)		NDF (%)		Hemicellulose (%)		Cell content (%)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T1	19.20	18.90	8.20	7.91	51.90	49.60	40.10	39.85	51.40	50.37	11.30	10.52	48.60	49.63
T2	22.51	22.55	8.92	8.67	54.20	55.33	42.59	42.65	54.10	53.01	11.50	10.36	45.90	46.98
T3	22.54	22.59	9.04	8.98	54.21	54.61	42.30	41.85	54.00	52.92	11.70	11.07	46.00	47.08
T4	22.58	23.00	8.84	8.78	55.90	56.97	42.80	42.59	56.00	54.88	13.20	12.29	44.00	45.12
T5	21.42	21.59	9.29	9.08	52.89	54.90	41.40	39.75	52.70	51.64	11.30	11.89	47.30	48.35
T6	21.51	21.66	9.12	8.90	53.80	55.84	41.71	41.90	52.90	51.84	11.20	9.94	47.10	48.15
T7	24.11	24.75	9.01	8.80	60.10	62.38	44.70	43.81	57.01	55.86	12.30	12.04	43.00	44.14
T8	24.57	24.86	9.25	8.93	60.91	63.21	45.90	44.85	58.10	56.94	12.20	12.09	41.90	43.06
T9	23.71	23.50	9.11	8.81	56.80	58.95	43.20	44.23	56.10	54.97	12.90	10.74	43.90	45.02
T10	23.91	23.89	9.37	8.70	57.20	59.37	43.09	41.29	56.30	55.17	13.21	13.88	43.70	44.82
T11	21.50	21.50	9.34	8.86	53.23	54.90	41.09	40.75	52.70	51.64	11.60	10.89	47.30	48.35
T12	21.40	21.32	9.51	9.29	52.22	54.25	41.59	41.02	52.80	51.74	11.20	10.72	47.20	48.25
S.Em.±	0.93	1.04	0.3	0.3	2.00	2.16	0.98	0.32	1.82	0.91	1.77	0.81	1.82	0.91
CD (P=0.05)	2.68	3.00	NS	NS	5.78	6.21	2.84	0.93	NS	2.64	NS	NS	NS	2.64

T_1-Control, T_{2-} Recommended dose of NPK through inorganic source, T_{3-}75% dose of recommended nitrogen through inorganic source + 25% through FYM, T_{4-}75% dose of recommended nitrogen through inorganic source + 25% through vermicompost, T_{5-}50% dose of recommended nitrogen through inorganic source + 50% through FYM, T_{6-}50% dose of recommended nitrogen through inorganic source + 50% through vermicompost, T_{7-}75% dose of recommended nitrogen through inorganic source + 25% through FYM + B.F., T_{8-}75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + B.F., T_{9-}50% dose of recommended nitrogen through inorganic source + 50% through FYM + B.F., T_{10-}50% dose of recommended nitrogen through inorganic source + 50% through vermicompost + B.F., $T_{11-}33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$ through vermicompost, $T_{12-}33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$% through vermicompost + B.F.

Table 5. Effect of different treatments on available NPK (kg/ha) after harvest of maize

Treatments	Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T1	262.40	258.00	24.80	23.00	235.10	225.18
T2	276.90	293.23	26.29	26.10	245.00	243.50
T3	282.60	299.27	26.60	26.56	248.50	251.25
T4	281.50	298.10	26.40	26.39	248.40	251.70
T5	284.10	300.86	26.70	26.58	249.90	254.10
T6	283.40	300.12	26.70	26.79	249.70	258.30
T7	283.20	299.91	26.29	26.26	249.50	245.50
T8	282.70	299.38	26.70	26.75	249.10	250.79
T9	285.50	302.34	27.20	26.95	250.00	251.20
T10	283.80	300.54	27.02	27.10	249.80	254.70
T11	286.70	303.61	27.00	26.92	251.80	254.90
T12	287.70	304.25	27.30	27.32	252.30	257.20
S.Em.±	4.22	8.29	1.14	0.87	2.92	1.48
CD (P=0.05)	12.15	23.86	ns	ns	8.40	4.27

T_1-Control, T_2- Recommended dose of NPK through inorganic source, T_3-75% dose of recommended nitrogen through inorganic source + 25% through FYM, T_4-75% dose of recommended nitrogen through inorganic source + 25% through vermicompost, T_5-50% dose of recommended nitrogen through inorganic source + 50% through FYM, T_6-50% dose of recommended nitrogen through inorganic source + 50% through vermicompost, T_7-75% dose of recommended nitrogen through inorganic source + 25% through FYM + B.F., T_8-75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + B.F., T_9-50% dose of recommended nitrogen through inorganic source + 50% through FYM + B.F., T_{10}-50% dose of recommended nitrogen through inorganic source + 50% through vermicompost + B.F., T_{11}-$33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$ through vermicompost, T_{12}-$33^{1/3}$% dose of recommended nitrogen through inorganic source + $33^{1/3}$% through FYM + $33^{1/3}$% through vermicompost + B.F.

produced significantly higher green fodder yield than remaining treatments except during 2008-09 when T_8 was not statistically at par with T_7. During 2007-08, T_7 produced significantly higher green fodder yield than T_1, T_5, T_6, T_{11} and T_{12} but was at par with rest of the treatments, however, during 2008-09, T_7 being at par with T_2, T_4, T_8, T_9 and T_{10} also showed its significant superiority over rest of the treatments. Control (T_1) caused significantly lower green fodder yield than rest of treatments during both the years.

During both the years, treatment T_8 being at par with T_7, T_9 and T_{10} produced significantly higher dry mater yield than rest of the treatments. During 2007-08, T_7 being at par with T_2, T_3, T_4, T_8, T_9 and T_{10} also recorded significantly higher dry matter yield than remaining treatments during 2007-08, whereas, during 2008-09, T_7 being at par with at

par with T_4, T_8, T_9 and T_3 recorded significantly more dry matter yield than remaining treatments. During both the years, control (T_1) recorded significantly low dry matter yield than rest of the treatments.

Higher green forage and dry matter yield has also been reported by Singh (2009) by integration of inorganic and organic sources of nutrition which confirms the findings of the present investigation. Higher yield with integration of inorganic and organic sources was due to positive effect of prolonged and adequate supply of nutrients to yield attributes of various crops of cropping system viz. plant height, LAI, green leaves and leaf and stem dry weight.

During both the years, T_8 being at par with T_7, T_9 and T_{10} produced significantly higher crude protein yield than rest of the treatments. During 2007-08, T_{10} being at par with T_7, T_8 and T_9 also produced significantly higher crude protein yield than rest of the treatments. During 2008-09, T_7 was at par with T_4, T_8, T_9 and T_{10} also produced significantly higher crude protein yield than rest of the treatments. During both the years, significantly lower crude protein yield was recorded in control (T_1). The increase in dry matter yield under integration of nutrients compared to inorganic sources might be the reason for high crude protein yield under the same treatment. Higher crude protein yield under application of 75% dose of recommended nitrogen through inorganic + 25% through vermicompost + biofertilizer might be due to production of higher metabolizable energy (Kalra and Khokhar, 1979 and Krishna *et al.*, 1988).

During both the years, T_8 being at par with T_7, T_9 and T_{10} recorded significantly higher digestible dry matter yield than remaining treatments. During both the years, treatment T_7 produced significantly higher digestible dry matter yield than T_1, T_2, T_3, T_5, T_6, T_{11} and T_{12} but it (T_7) was at par with T_4, T_8, T_9 and T_{10} except during 2008-09 when T_4 was not at par with T_7. Control (T_1) produced significantly less digestible dry matter yield than all the treatments during both the years. More digestibility might be due to nitrogen application which increases the crude protein content and metabolize energy besides improving succulency and palatability of fodder crops.

Fodder quality

During both the years, treatment T_8 being at par with T_2, T_3, T_4, T_7, T_9 and T_{10} recorded significantly higher dry matter content than T_1, T_5, T_6, T_{11} and T_{12}. Treatment T_7 being at par with T_2, T_3, T_4, T_6, T_8, T_9, T_{10} and T_{11} also recorded significantly higher dry matter content than rest of treatments during 2007-08, however, during 2008-09, T_7 being at par with T_2, T_3, T_4, T_8, T_9, and T_{10} also showed its significant superiority over rest of treatments. During both the years, T_1 being at par with T_5, T_6, T_{11} and T_{12} accumulated significantly less dry matter content than all other treatments.

During both the years, crude protein content did not influenced significantly by different treatments, however, highest and lowest crude protein content was recorded in T_{12} and T_1, respectively.

During 2007-08, T_8 being at par with T_4, T_7, T_9 and T_{10} recorded significantly

higher digestibility than T_1, T_2, T_3, T_5, T_6, T_{11} and T_{12}. Treatment T_7 also showed similar trend as T_8. During 2008-09, T_8 being at par with T_7, T_9 and T_{11} showed its significant superiority over T_1, T_2, T_3, T_4, T_5, T_6, T_{11} and T_{12}. In control (T_1) lowest digestibility was recorded but it was at par with all the treatments except T_7 and T_8 during 2007-08. However, in 2008-09, lowest digestibility was observed in same treatment but was at par with t_2, T_3, T_5, T_{11} and T_{12}.

During 20087-08, T_8 being at par with treatment T_7, T_9 and T_{10}, recorded significantly higher ADF content than remaining treatments while during 2008-09, T_8 being at par with T_9 recorded significantly higher ADF content than rest of the treatments. During 2007-08, treatment T_7 also recorded significantly higher ADF content than T_1, T_5, T_{11} and T_{12} but it was at par with rest of treatments. During 2008-09, T_9 being at par with T_7 and T_8 recorded also significantly higher ADF content than remaining treatments. During 2007-08, significantly less ADF content was observed in control than T_7, T_8, T_9 and T_{10} but was par with rest of the treatments, however, during 2008-09, control (T_1) being at par with T_5 and T_{11} recorded significantly less ADF content than rest of the treatments.

During 2007-08, there was no significant difference among treatments in NDF content, however, higher and lower NDF content was noticed in T_8 and T_1, respectively. During 2008-09, T_8 being at par with T_4, T_7, T_9 and T_{10} recorded significantly higher NDF content than remaining treatments, whereas, T_7 being at par with T_4, T_8, T_9 and T_{10} recorded significantly higher NDF content over rest of the treatments. Control (T_1) produced significantly lower NDF content than T_4, T_7, T_8, T_9 and T_{10} but it was at par with remaining treatments.

During both the years, no significant difference among treatments on hemicellulose content was observed. However, higher values of hemicellulose was recorded in T_{10} during both the years. Treatment T_6 and T_{12} during 2007-08 and T_1 during 2008-09 recorded lowest value of hemicellulose.

During 2007-08, there was no significant difference among treatments in terms of cell content, however, highest and lowest value was recorded in T_1 and T_8, respectively. During 2008-09, control (T_1) being at par with T_2, T_3, T_5, T_6, T_{11} and T_{12} recorded significantly higher cell content than remaining treatments. Treatment T_5 and T_{11} being at par with T_1, T_2, T_3, T_6, T_{11} and T_{12} also recorded significantly higher cell content than other treatments. During 2008-09, T_8, being at par with T_4, T_7, T_9 and T_{10} recorded significantly less cell content than remaining treatments.

In general, with the application of combined inorganic and organic sources of nutrition, ADF (%) and NDF (%) increased in maize crop. Increase in ADF (%), NDF (%) content might be due to lower leaf to stem ratio and stem being more fibrous than leaf at higher level of nitrogen. The cell content decreased with increased NDF (%). With increase in NDF (%) and ADF (%), Hemicellulose (%) also increased.

Soil fertility

Data pertaining to available N, P and K are presented in Table 5.

During both the years, T_{12} recorded significant higher available N in soil after

harvest of maize crop than remaining treatments during both the years, T_1 recorded significantly less available N than remaining treatments. During both the years, there was no significant difference among treatments on available soil P, however, T_{12} and T_1 recorded significant higher and low value of available P, respectively.

During 2007-08, T_{12} recorded significant higher available K in soil than T_1 but remained at par with remaining treatments. During 2008-09, T_6 being at par with T_5, T_{10}, T_{11} and T_{12} showed its significant superiority over remaining treatments. During both the years T_1 recorded significantly less available K in soil after harvest of maize than other treatments.

The beneficial effect on soil was more with the application of 33½% per cent dose of recommended nitrogen through inorganic source + 33½% per cent through FYM + 33½% per cent through vermicompost + biofertilizer and it caused higher available nitrogen, potassium and significantly higher available nitrogen and potassium compared to other treatments under maize crop.

When compared with initial soil values, the available nitrogen, phosphorus and potassium (Table 16, 26 and 37) were higher under integrated sources of nutrients. All the soil health parameters reduced when 100 per cent recommended dose of N, P and K was applied through inorganic fertilizer. This might be due to more loss of nutrients in absence of organic sources. Higher values of available nitrogen, phosphorus and potassium due to integrated nutrient sources might be a result of buildup in organic carbon, solubilization of simple and available form, acidifying action of FYM/vermicompost on native phosphorus at the time of decomposition making more phosphorus available and reduction of potassium fixation (Syed Ismail *et al.,* 1998).

Conclusion

On the basis of two years experimentation it is concluded that application of 75% dose of recommended nitrogen through inorganic source + 25% through vermicompost + biofertilizer can be used for higher fodder productivity of maize crop. For sustaining overall soil health application of one third dose each of recommended nitrogen through inorganic source + through FYM + through vermicompost alongwith biofertilizer inoculation has been found suitable.

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ORGANIC FARMING PACKAGES ON YIELD AND SOIL CHARACTERS UNDER CHILLIES - BENGAL GRAM - BABY CORN CROPPING SYSTEM

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ABSTRACT

Experiments were conducted to study the performance of organic farming practices in the high value chillies - bengal gram - baby corn cropping system at Tamil Nadu Agricultural University, Coimbatore during the year 2006-07 and 2007-08 and it was laid out in randomised block design with three replications. The results of the experimental study revealed that the application of required N for different crops in the form of 50% organic and 50% inorganic resulted higher net returns and B:C ratio (2.21) compared with different organic farming packages. Among the different organic farming packages, 50% N as EFYM + neem cake + bio compost registered higher net returns with B: C ratio (1.85).

Key words: Organic farming, EFYM, bio fertilizer, neem cake

The advent of high yielding varieties and increased area under assured irrigation led to a major shift from organic based nutrient application to chemical fertilizers. Consequently, there was not only reduction in consumption of organic manures but also excess use of high analysis fertilizers in an unbalanced manner imposed additional problems of soil fertility such as acidity, alkalinity, multiple nutrient deficiency especially micro and secondary nutrients and resulted in total loss of soil health. Continuous use of inorganic fertilizers not only brought about loss vital soil fauna and flora but also resulted in loss of secondary and micronutrients. In view of these facts, supply of all the plant nutrients has been advocated through organic sources only (Tarafdar *et al.*, 2008). Crops grown with organic manures contain better nutritive value than crops grown with inorganic fertilizers. It was also observed that the biological value of food materials increased with the use of natural manures than fertilizer nutrients. The focus of present day farmers is on export oriented agriculture. The export of high value crops like chillies, cowpea and bengal gram has been gaining momentum at present among Indian producers and exporters.

In this context the study of organics as a sole source of nutrients to crops like chillies, cowpea and baby corn will be of much useful to study their impact on the yield and on the fertility status of soil.

MATERIALS AND METHODS

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during the year 2006 - 07 and 2007 - 08. The experiment was laid out in randomised block with three replications. Chillies (PKM 1), Bengal gram (CO 1) and babycorn (COBC 1) were raised in *kharif, rabi* and summer season during the year 2006 – 07 and 2007 – 08 in a sequence. The soil of the experimental site is sandy loam in texture. The soil pH is alkaline and has low to medium soluble salt content and low in available nitrogen, low to medium

in available phosphorus and medium to high in available potassium. The mean annual rainfall is 657 mm distributed over 47 rainy days. The mean maximum and minimum temperatures are 31.5 and 21.4°, C respectively. The treatment combinations were, T_1 – 50% N as inorganics + 50% N as Enriched FYM(EFYM); T_2 – 100% N as Enriched FYM + bio-compost + Neem cake (each 33%); T_3 – T_2 + (Chillies +Onion) – (Bengal gram + Coriander) – (Baby corn + Vegetable cowpea); T_4 – T_2 + Agronomic practices for weed and pest control; T_5 – 50% N as Enriched FYM + *Azospirillum* + Phosphobacteria; T_6 – T_2 + *Azospirillum* + Phosphobacteria; T_7 – 100% NPK + secondary and micronutrients based on STV.

RESULTS AND DISCUSSION

Soil physical properties

The bulk density was lowered because of the application of organic manures. The water holding capacity (WHC) (60.3%) and porosity (35.0%) were higher with 100 % organics. The decrease in bulk density making the soil more pulverised and increase in WHC for retention of soil moisture extended period and increase in porosity for effective aeration are positive factors in organic farming practices (Table 1). The particle density did not change much because of the different organic faming practices.

Yield

The results revealed that application of 100% N as EFYM + Bio-compost + Neem cake recorded significantly higher chillies fruit yield (9771 kg/ha), which was followed by the application of 100 % N as EFYM + Bio compost + Neem cake + intercrop (9408 kg / ha). Application of inorganics alone registered the fruit yield of 7026 kg/ha only. The same result was obtained by Rao and Rao (1999) in soybean, stated that substitution of fertilizer N requirement by FYM similar to those obtained with complete inorganic fertilizer. Bengal gram favourably responded to the application of 100% N as Enriched FYM + bio-compost + Neem cake + agronomic practices for weed and pest control and recorded higher pod yield (1360 kg/ha) compared with 100% inorganics application(1330 kg/ha) and it might be due to the acceleration of respiratory process by cell permeability or by hormone growth action due to organic manurial application as it supplies N, P_2O_5 and sulphur in available forms to the plants through biological decomposition. Application of 100% N as EFYM + Bio-compost + Neem cake registered significantly higher baby corn green cob yield (6315 kg/ha) over application of 100% inorganics recorded only 5855 kg/ha (Table 1). Sharma (2002) noticed that application of FYM @ 10 t ha^{-1} coupled with 50% recommended N recorded maximum values of yield attributes in maize.

Nutrient availability

In *kharif season*, available N and P status of the soil was significantly higher in the treatments that received 100 % N as EFYM + Bio compost + Neem cake + *Azospirillum* + Phosphobacteria followed by 100% inorganics. The same trend was followed in *rabi* and summer seasons also. In case of K, application of 100% N as inorganics recorded higher value in all the three seasons followed by the treatment received 50 % N as inorganics + 50 % N as organics (Table 2). Studies with continuous application of organic manures showed that application of FYM

Table 1. Organic farming packages on physical properties, yield and economics of chillies-bengalgram-babycorn cropping system (pooled data for two years)

Treatments	Bulk density (g cc^{-1})	Particle density (g cc^{-1})	Water holding capacity (%)	Porosity (%)	Green chillies yield (kg/ha)	Bengal gram yield (kg/ha)	Baby corn yield (kg/ha)	B:C ratio
T_1 : 50 % N as inorganics + 50 % N as organics	1.11	2.0	59.2	29.0	8686	1230	6156	2.21
T_2 : 100 % N as FYM + Bio compost + Neem cake	1.00	2.0	59.3	34.0	9771	1350	6315	1.66
T_3 : 100 % N as FYM + Bio compost + Neem cake + intercrop	1.05	2.1	58.2	33.0	9408	1180	6220	1.54
T_4 : T_2 + agronomic practices of weeds and pest control	1.17	2.1	57.7	32.0	9104	1360	6155	1.61
T_5 : 50 % N as FYM + Neem cake + BioCompost	1.13	2.0	59.5	29.3	6936	1130	5145	1.51
T_6 : T_2 + *Azospirillum* + Phosphobacteria	1.15	2.1	58.4	31.0	9296	1210	6140	1.56
T_7 : 100 % NPK as inorganics	1.15	2.1	49.9	28.6	7026	1330	5855	1.98
Initial	1.20	2.1	46.4	24.6	-	-	-	-
CD(P=0.5)	0.11	0.19	4.9	2.8	796	128	459	-

@ 10 t ha^{-1} resulted in increase the availability of N, P_2O_5 and K_2O in soil after harvest in cotton. (Harish kumar, 2003).

Organic carbon status

Continuous application of organic manure will increase the organic carbon content in soil. Organic carbon was higher in the application of 100 % N as EFYM + bio compost + Neem cake with intercrops (0.77, 0.79 and 0.82 in *kharif*, *rabi* and summer seasons, respectively). These findings are similar to those of Santhy *et al.* (1999) reported that different soil amendments including FYM significantly improve the soil physicochemical and biological properties and thereby increase the organic carbon content of the soil. Application of 100% N as inorganics registered lower organic carbon content in all the three seasons.

Economics

Higher net returns could be achieved only in chillies and baby corn (Table 2) both being crops of high commercial value, unlike bengalgram. Based on the net returns obtained from the cropping system, chillies - bengalgram - babycorn

Table 2. Organic farming packages on soil available nutrient status (pooled data for two years)

Treatments	Available N (kg ha^{-1})			Available P (kg ha^{-1})			Available K (kg ha^{-1})		
	Kharif	*Rabi*	Summer	*Kharif*	*Rabi*	Summer	*Kharif*	*Rabi*	Summer
T_1 : 50 % N as inorganics + 50 % N as organics	322	280	264	13.0	15.5	11.5	470	390	490
T_2 : 100 % N as FYM + Bio compost + Neem cake	346	294	210	14.5	13.0	9.0	440	350	450
T_3 : 100 % N as FYM + Bio compost + Neem cake+ intercrop	370	306	270	16.0	14.5	11.0	410	360	460
T_4 : T_2 + agronomic practices of weeds and pest control	360	314	245	15.0	12.5	9.5	430	340	440
T_5 : 50 % N as FYM + Neem cake + BioCompost	284	257	228	12.0	13.0	10.0	440	350	460
T_6 : T_2 + *Azospirillum* + Phosphobacteria	392	350	320	17.0	19.5	15.5	450	380	470
T_7 : 100 % NPK as inorganics	380	325	285	15.0	17.0	13.0	490	410	510
CD(P=0.5)	28	22	25	8	12	9	35	46	30

as a whole, 50 % N as inorganics + 50 % N as organics is found to be superior (B:C ratio - 2.21) followed by 100% NPK (B:C ratio - 1.98) as inorganics. This shows that the higher cost and also the low availability of organic inputs involved in applying 100 % as organics do not commensurate with the returns as compared to the application of either 50% or 100 % as inorganics.

Inference

Application of 100 % N as in the integrated package (50% N as organic + 50% N as inorganic) recorded higher monetary benefits in the chillies - bengal gram - baby corn cropping system. Among the complete organic practices, application of N as enriched farm yard manure (EFYM) + Bio compost + Neem cake (1/3rd each on N equivalent basis) performed better compared with other organic practices.

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YIELD, DRY MATTER, NUTRIENT CONTENT AND UPTAKE BY OKRA AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT IN COASTAL REGION OF MAHARASHTRA

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Abstract

An experiment was conducted during *kharif* season of the year 2007 with Okra cv. Parbhani Kranti on lateritic soil of Konkan region at Central Experiment Station, Wakawali, Dist. Ratnagiri, Maharashtra. The treatments comprised of recommended dose of NPK (100:50:50 kg ha^{-1}), zinc sulphate @ 25 kg ha^{-1}, Borax @ 5 kg ha^{-1}, FYM @ 10 t ha^{-1} and *Azospirillum* @ 25 kg ha^{-1}. There were nine treatment combinations replicated thrice in a randomized block design. The results showed that the yield, dry matter of plant and N, P, K, Ca, Mg, Zn and B in plant increased with integrated use of manure, fertilizers and biofertilizer. Among the various treatments, treatment receiving an integration of manure, fertilizers and biofertilizer viz. RDF+ZnSO4 @ 25 kg ha^{-1} + Borax @ 5 kg ha^{-1} + FYM @10 t ha^{-1} + *Azospirillum* @ 2 kg ha^{-1} produced maximum yield with highest dry matter as well as highest nutrient content and uptake by Okra plant. In the present investigation, the application of manure, fertilizers and biofertilizer in integrated manner have showed their beneficial effect over absolute control and recommended dose of NPK fertilizers alone.

Key words : Lateritic soil, Integrated nutrient management, Okra yield

Okra (*Abelmoschus esculentus L.*) is a nutrient loving plant and responds well to added nutrients in soil. It is one of the most important vegetable crop grown in tropical and subtropical region. In India, it is cultivated in almost all states, throughout the year and consumed by common people. The total area under okra crop in India is about 498 thousand hectares with production of 5784 thousand tones and average productivity of 11.60 metric tones per hectare (Anonymous, 2011). In Maharashtra, it is grown on an area about 19 thousand hectares with annual production of 224 thousand metric tones and productivity of 11.80 metric tones (Anonymous, 2011). Okra is a multiple use crop and is one of the most nutritious vegetables which contains on an average 36 calories energy, 2.4 g protein, 89 per cent moisture, 0.3 g fat, 7.6 g carbohydrates, 92 mg Calcium, 52 mg phosphorus, 1.5 mg iron, 3 mg sodium and 103 mg potassium per 100 g of fresh fruits (Bose et al., 1985). The immature fruits are eaten as cooked vegetable. Dried seeds are nutritious foods. It contains up to 20 per cent protein and the fiber from okra canes is a possible paper pulp source, while the dried canes are a fuel source.

Ever increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production. Use of organic manures to meet the requirement of crop would be an inevitable practice in years to come for sustainable agriculture (Vennila and Jayanthi, 2008). Integrated nutrient management involves the combine use of chemical fertilizers, organic manure and

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biofertilizer which ensures higher crop production, helps to restore and sustain the soil fertility. Though, the lateritic soils are best suited for okra cultivation, the traditional methods of farming and less use of organic manures reduces the magnitude and quality of okra. Therefore, the present investigation was undertaken to study the effect of integrated nutrient management on yield and yield attributing characters, dry matter production and nutrient content and uptake of okra in lateritic soil of Konkan region.

Materials and Methods

An experiment was conducted during *Kharif* season of the year 2007 at Central Experiment Station Wakawali, Dr.Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli with okra variety Parbhani Kranti. The soil was clay loam in texture having organic carbon 21.0 g kg^{-1}, pH 5.17 and EC 0.10 dS m^{-1}. The available N content was 244.60 kg ha^{-1}, available P_2O_5 12.94 kg $ha^{-1}$and available K_2O 314.34 kg ha^{-1}, available Zn 1.21 ppm and available B was 0.07 ppm. The bacterial count in the soil was 0.53 x 10^6 CFU g^{-1}. The experiment was conducted in randomized block design with nine treatments and replicated thrice. The treatments were T_1 - control; T_2 - RDF (recommended dose of fertilizer); T_3 - RDF + $ZnSO_4$ (25 kg ha^{-1}); T_4 - RDF+$ZnSO_4$ (25 kg ha^{-1})+ Borax (5 kg ha^{-1}); T_5 - RDF+FYM (10 t ha^{-1}); T_6 - RDF+FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}); T_7 - RDF + Borax (5 kg ha^{-1})+ *Azospirillum* (2 kg ha^{-1}); T_8 - RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}); T_9 - RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}). The field was thoroughly prepared and the full dose of single super phosphate and muraite of potash were applied at the time of sowing. Nitrogen in the form of urea was applied in three splits i.e. 50 per cent dose at sowing, 25 per cent at 30 DAS and remaining 25 per cent at 60 DAS. Full dose of zinc sulphate and borax was applied at the time of sowing. Farm yard manure @ 10 t ha^{-1} and *Azospirillum* @ 2 kg ha^{-1} were applied as per treatment schedule. The observations regarding the yield attributing characters, fruit yield and dry matter production were recorded from five representative plants from each plot. The okra fruit were harvested at 2-3 days interval. Fresh weight of okra fruits was calculated on the basis of yield per plot and the fruit yield was expressed in quintal ha^{-1}. The freshly harvested five plant samples were randomly selected from each treatment and were dried in an oven at the temperature of $60^0C \pm 5^0C$ and grinded with grinding machine and were used to know the nutrient content in Okra fruit and plant. The total N, P, K content was estimated by microjeldhal method, ammonium-molybdate-vanadate method, and by flame photometric method, respectively and were presented in percentage (Tandon, 1993). The exchangeable Ca and Mg content was estimated by versenate titration method and expressed in mg 100 g^{-1} (Anonymous, 1968). The Zn content was estimated by atomic absorption spectrophotometer method as suggested by Lindsay and Norvell (1978) whereas, boron content was estimated by hot water soluble turbidimetric method and was expressed in ppm (Tandon, 1993).

Results and Discussion

Yield and yield attributing characters

As far as the fruit yield (Table 1) of okra was concerned, it differed

Table 1. Effect of integrated nutrient management on yield, yield attributing characters and dry matter production of okra

Tr. No.	Treatments Details	Fruit yield (q ha^{-1})	Fruit length (cm)	No. of fruits $plant^{-1}$	Fruit weight $plant^{-1}$ (g)	Dry matter production (q ha^{-1})
T_1	Control	63.73	6.28	3.68	23.30	6.15
T_2	RDF (Recommended dose of fertilizer)	69.13	11.42	5.12	58.68	10.49
T_3	RDF + ZnSO4 (25 kg ha^{-1})	73.37	11.86	5.46	65.59	11.76
T_4	RDF + ZnSO4 (25 kg ha^{-1}) + Borax (5 kg ha^{-1})	113.33	12.08	8.13	96.89	15.58
T_5	RDF + FYM (10 t ha^{-1})	83.21	13.32	6.80	78.02	12.95
T_6	RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	96.76	13.72	7.72	84.87	15.13
T_7	RDF + Borax (5 kg ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	78.94	12.48	6.53	67.62	12.43
T_8	RDF + ZnSo4 (25 Kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1})	121.02	14.22	8.57	111.64	16.02
T_9	RDF + ZnSO4 (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	128.61	14.78	9.84	113.94	16.24
	SEm ±	0.32	0.14	0.23	0.09	0.32
	CD at 5%	1.18	0.52	0.84	0.32	1.18

significantly between different treatments and it varied from 23.30 to 113.94 q ha^{-1} with a mean value of 77.84 q ha^{-1}. Among the various treatments, treatment T_9 consisting application of RDF+ $ZnSO_4$ (25 Kg ha^{-1}) + Borax (5 Kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 Kg ha^{-1}) resulted significant improvement in yield (113.94 q ha^{-1}) over all other treatments including RDF alone (T_2). However, it was at par with treatment T_8 consisting RDF+ $ZnSO_4$ (25 Kg ha^{-1}) + Borax (5 Kg ha^{-1}) + FYM (10 t ha^{-1}). These result clearly indicated that only inorganic sources can not maintain instant flow of nutrients in increasing crop yield. There is a need to use organic, chemical fertilizers and biofertilizers in combinations so as to increase crop productivity. The increase in the fruit yield (128.59 q ha^{-1}) due to application of 75 kg N + Biofertilizer + FYM was also reported by Patil et al. (2000). These results are also in conformity with the results obtained by Tripathy and Maithy (2009) and Shinde et al. (2010).

Yield attributing characters differed significantly between the treatments. Application of RDF+ $ZnSO_4$ (25 kg ha^{-1})

+ Borax (5 kg ha^{-1})+ FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) brought significant improvement in yield attributing characters of okra followed by treatment T_8 consisting RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) resulted in higher fruit length (14.78 cm.), number of fruits (9.84) $plant^{-1}$ and fruit weight (128.61 g.) $plant^{-1}$. The lowest fruit length (6.28 cm.), number of fruit (3.68) $plant^{-1}$ and fruit weight (63.73) $plant^{-1}$ was observed in the control treatment. These findings are similar to those of Vennila and Jayanthi (2008) in okra.

Dry matter production

From the persual of data presented in Table 1, it is evident that the dry matter production of okra ranged between 6.15 to 16.24 q ha^{-1} with a mean value of 12.97 q ha^{-1}. Maximum dry matter production was observed with T_9 (16.24 q ha^{-1}) followed by T_8, (16.02 q ha^{-1}), T_4 (15.58 q ha^{-1}) and T_6 (15.13 q ha^{-1}) which were significantly superior over all other treatments. Treatment T_9, T_8, T_4, and T_6 were at par with each others. The increased dry matter production might be due to well established root system in addition to increased plant height and number of branches and leaves. Similar results were also reported by Tripathi *et.al.* (2004) due to combined application of chemical fertilizers and biofertilizer (*Azotobacter* + *Azospirillum*).

The maximum dry matter production of okra crop receiving (19.55 q ha^{-1}) at 105 DAS was also reported by Thorbole (2002) due to application of 75 per cent N of RD + Growmore biofertilizer @ 2 t ha^{-1}. These results are also in conformity with results observed by Kadlug *et al.* (2005).

Nutrient content in okra fruit

The data pertaining to the effect of different treatments of integrated nutrient management on the nutrient content in okra fruit is presented in Table 2. The maximum nitrogen (2.89%), phosphorus (0.68%) and potassium content (3.58%) was recorded with treatment T_9 consisting RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) which was significantly higher over all other treatments. The maximum calcium (94.40 mg^{-100g}) and magnesium content in fruit (67.18 mg^{-100g}) was recorded receiving treatment T_9 viz., RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) which was significantly superior as compared to all other treatments. However, Magnesium content in fruit under treatment T_9 was at par with treatment T_8. Similar results were also reported by Walawalkar (1997).

Nutrient content in okra plant

In respect of the major nutrients presented in Table 2, the maximum nitrogen (1.57%), phosphorus (0.19%) and potassium content (2.38%) were recorded with the treatment T_9 i.e. RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}). The effect of integrated use of manure, fertilizers and biofertilizer on content of secondary and micro nutrient in okra plant indicated that the exchangeable calcium content (2.42%), exchangeable magnesium content (1.21%), zinc content (52.13 ppm) and boron content (3.23 ppm) were significantly higher due to treatment T_9 i.e. RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}). It was

Table 2. Effect of integrated nutrient management on nutrient content of okra fruit and plant

Tr. No.	Treatments	N (%)		P (%)		K (%)		Ca (mg^{-100g})		Mg (mg^{-100g})		Zn (ppm)	B (ppm)
		Fruit	Plant	Fruit	Plant	Fruit	Plant	Fruit	Plant	Fruit	Plant	Plant	Plant
T_1	Control	2.42	0.47	0.52	0.05	3.07	0.88	68.96	1.09	52.09	0.48	40.12	0.71
T_2	RDF (Recommended dose of fertilizer)	2.51	0.61	0.54	0.07	3.13	1.20	71.25	1.28	54.85	0.57	40.34	0.90
T_3	RDF + $ZnSO_4$ (25 kg ha^{-1})	2.53	0.76	0.56	0.09	3.24	1.43	73.75	1.52	58.16	0.62	47.76	1.31
T_4	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1})	2.66	0.90	0.56	0.11	3.19	1.39	77.96	1.76	61.76	0.76	45.24	2.18
T_5	RDF + FYM (10 t ha^{-1})	2.69	1.21	0.62	0.17	3.36	1.79	85.68	2.17	63.53	0.93	45.89	1.78
T_6	RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	2.72	1.34	0.65	0.17	3.51	2.29	90.73	2.25	65.23	1.11	41.92	2.03
T_7	RDF + Borax (5 kg ha^{-1}) + *Azospirillu* (2 kg ha^{-1})	2.58	1.08	0.57	0.12	3.32	1.61	81.34	1.91	63.59	0.82	43.12	2.56
T_8	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1})	2.74	1.46	0.59	0.14	3.44	1.99	92.53	2.36	66.48	1.17	51.87	3.04
T_9	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	2.89	1.57	0.68	0.19	3.58	2.38	94.40	2.42	67.18	1.21	52.13	3.23
	Mean	2.64	1.04	0.59	0.12	3.32	1.66	81.84	1.86	61.46	0.85	45.38	1.97
	SEm ±	0.01	0.03	0.02	0.01	0.05	0.03	0.38	0.02	0.23	0.02	0.62	0.09
	CD at 5%	0.04	0.10	0.08	0.04	0.20	0.11	1.40	0.07	0.85	0.06	2.28	0.34

Table 3. Effect of integrated nutrient management on nutrient uptake in okra plant

Tr. No.	Treatment details	Nutrient uptake in plant (kg ha^{-1})						
		N	P	K	Ca	Mg	Zn	B
T_1	Control	2.90	0.31	5.42	6.71	2.96	253.61	4.36
T_2	RDF (Recommended dose of fertilizer)	6.35	0.73	12.55	13.38	5.95	285.94	9.37
T_3	RDF + $ZnSO_4$ (25 kg ha^{-1})	8.92	1.06	16.80	17.84	7.26	376.06	15.28
T_4	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1})	14.05	1.71	21.67	27.46	11.85	442.46	33.95
T_5	RDF + FYM (10 t ha^{-1})	15.61	2.19	23.14	28.06	12.00	391.01	23.00
T_6	RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	20.28	2.57	34.66	34.05	16.80	398.05	30.72
T_7	RDF + Borax (5 kg ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	13.43	1.49	20.02	23.75	10.20	350.60	31.87
T_8	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1})	23.40	2.25	31.89	37.82	18.75	524.47	48.72
T_9	RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	25.50	3.09	38.67	39.32	19.66	528.13	52.52
Mean		14.49	1.71	22.76	25.38	11.71	394.13	27.76
SEm ±		0.54	0.17	0.74	0.79	0.33	6.19	1.68
CD at 5%		1.99	0.64	2.71	2.9	1.22	22.68	6.17

closely followed by treatment T_8. These results are in close conformity with those results reported by Walawalkar (1997) and Dademal (2000).

Nutrient uptake in okra plant

The higher uptake of NPK, Ca, Mg, Zn and B in okra plant was observed in treatment T_9 i.e. RDF + ZnSO4 (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) as compared to rest of the treatments. The maximum N uptake (25.50 kg ha^{-1} was recorded with treatment T_9. The result on nitrogen uptake by okra crop revealed that nitrogen uptake is governed by its concentration in plants and dry matter production resulting into synonymous trend in nitrogen uptake to that of dry matter, production by okra crop. These results corroborates with results reported by Subbiah *et.al.* (1984), Subbiah and Sundarajan (1993) and Dedemal (2000).

The P and K uptake by okra crop was also maximum with treatment T_9 as compared to other treatments. The treatment T_9 has proved its superiority of application of inorganic fertilizer in conjunction with organic manure over the inorganic alone indicating the need of organic source of nutrients along with inorganic source. These finding are in confirmation with the results reported by Subbiah *et.al.* (1984), Subbiah and Sundararajan (1993) and Dademal (2000). Maximum Ca and Mg uptake was recorded with the treatment T_9, which was significantly superior over rest of the treatments except treatment T_8. Thorbole (2002) reported that the maximum calcium and magnesium uptake by okra crop was observed due to application of 75 per cent N of RD + Growmore Biofertilizer @ 2 t ha^{-1}. The Zn and Bo uptake by okra crop was significantly superior over control but was at par with treatment T_8. Application of manure, fertilizers and biofertilizer in integrated manner have showed their beneficial effect over absolute control and recommended dose of fertilizer alone.

On the basis of the result obtained during present investigation, it can be concluded that integrated use of RDF + ZnSO4 (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) is essential for improving yield, dry matter, nutrient content and uptake of okra plant grown in lateritic soils of coastal region of Maharashtra.

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RESPONSE OF INDIAN MUSTARD (*BRASSICA JUNCEA L.*) AS INFLUENCED BY DIFFERENT DOSES AND SOURCES OF SULPHUR

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ABSTRACT

The experiment was carried out during Rabi season of 2012-13 at campus research farm of Rajiv Gandhi South Campus, Department of Soil and Water Conservation, Institute of Agricultural sciences, B.H.U. The study comprised three doses and sources of sulphur (fertility levels-15,30,45) (Elemental sulphur, Gypsum, Single superphosphate). Under the design of simple Randomized block Design. Results showed that the most of the yield attributes were significantly influenced by different doses of sulphur. These all attributes were estimated in whole experiment from sowing to maturity and to at harvest. The yield and yield contributing characters were increased with the increasing levels of sulphur fertilizer up to 45kg sulphur per hectare. All yield components, such as number of siliquae per plant, seeds per siliqua, 1000-seed weight and seed yield per plant were found maximum from the treatment with 45kg sulphur per hectare. Similarly increase sulphur dose up to 45kg per hectare significantly improved seed and stover yield of mustard. Sulphur application enhanced seed oil content and oil yield up to 45kg sulphur per hectare. Application of sulphur brought about significant increase in sulphur contents and their uptake by seed, Stover as well as biological yield.

Keywords: Mustard, sulphur, yield parameters.

INTRODUCTION

Oilseeds constitute the second largest agricultural commodity in India after cereals accounting for nearly 5 per cent of gross national product and 10 per cent of the value of all agricultural products. Despite the fact that India is one of the leading oilseed producing countries in the world, it is not able to meet the edible oil requirement for its vast population. Among the oilseeds, rapeseed-mustard group of crops occupies prominent position in the country during winter season contributing nearly 21.6% and 23.1% to the total oilseed cropped area and production, respectively (Anonymous, 2007).

Mustard is an important oilseed crop of India and stands next only to groundnut in terms of both area and production. However, its productivity is low due to poor soil conditions and i8nadequate use of fertilizers. The major nutrients sulphur plays an important role in Indian mustard, which are insufficient in most of Indian soil. According to Tandon (1991) widespread sulphur deficiency has been observed in crops and soils in 120 districts of India irrespective of soil texture and cropping pattern, including Varanasi and Mirzapur districts of eastern Uttar Pradesh. Sulphur is the fourth most important nutrient after nitrogen, phosphorus and zinc for Indian agriculture [1]. Sulphur is best known for its role in the synthesis of proteins, oils, vitamins and flavouring compounds in plants. Three amino acids viz. Methionine (21%S), Cysteine (26%S), and Cystine (27%S) contain S which are the

building blocks of proteins. About 90% of sulphur is present in these amino acids.

Coarse textured soils which have low sulphur retentive capacity, application of 20-50 kg S ha^{-1} is recommended (Tandon, 1990). Sulphur fertilization in deficient soils is known to increase seed yield of irrigated mustard by 12 to 48 percent (Aulakh and Pasricha, 1988). The substantial increase in mustard yield due to sulphur application (Sharma, 1994; Chauhan, 1996; Joggi , 1998 and Singh *et al.*, 2000). Hence the present investigation was undertaken to fined out the "Response of Indian mustard [*Brassica juncea* (L.) Czern. and Cosson] as influenced by different doses and sources of sulphur" on growth attributes.

Materials and Methods

The present experiment was conducted at Agricultural farm of Rajiv Gandhi South Campus, Department of Soil and Water Conservation, Institute of Agricultural Sciences, B.H.U. during Rabi season of 2012-13 which is situated in *Vindhyan* region of district Mirzapur (25º 10' latitude, 82º 37' longitude and altitude of 427 meters above mean sea level) occupying over an area of more than 1000 ha where variety of crops like agricultural, horticultural, medicinal and aromatic plants are grown. *Vindhyan* soil comes under rainfed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). This experiment was conducted by mustard variety Parasmani 8 It was released for cultivation from Hariyana University. Plants are longer and bushy in nature. It matures in 90 - 95 days. The variety is recommended for both rain fed and irrigated conditions in which it gives average seed yield of 10-12 q ha^{-1} and 15-20 q ha^{-1}, respectively. The average oil content is 38-41%. The grains are larger in their size. The field experiment was laid out during Rabi season of 2012-2013 in open field in which crop was sown at 24 October 2012. The experiment was conducted in randomized block design having different treatment with three replication. The treatment comprised three level of elemental sulphur, three level of Gypsum, and three level of single superphosphate i.e. 15,30, 45 used as sources of sulphur in experiment. There was one control plot in each replication.

Full dose of P_2O_5 in the form of diammonium phosphate and single super phosphate and full dose of K_2O through murate of potash @45 kg ha^{-1} with full dose of sulphur (50% through SSP and 50% through elemental sulphur) were applied as per treatment as basal application(before sowing). Few doses of gypsum also applied in the field according to the treatments. Half of the amount of Nitrogen (as per treatment) was applied through diammonium phosphate and urea. The half dose of nitrogen was top dressed after first irrigation.

The crop was sown by keeping the seed rate of 5kg/ha with sowing the seed 2-3cm deep in furrows keeping 45cm row to row distance. The plant to plant distance was kept 15 cm by thinning out the extra plants after 22 days of sowing. One spray of 100 gram Detergent + 50 ml carosin oil which were dissolved in 15 litres of water .The spray was done in each plots at the time of Aphid infestation which occurred at the last stage of experimentation during crop growth period. The characters like growth attributes were recorded Plant height(cm),No of leaf/plant, No of branches/plant, and Dry matter accumulation/plant(g).

RESULT AND DISCUSSION

The growth and growth attributing characters are presented in table 1, 2, 3, and 4. It is clearly indicated that Plant height, No of leaves No of branches and Dry matter accumulation of plant increased with increasing the fertilizer levels.

Data pertaining to plant height as affected by sulphur rates and sources at different crop growth stages have been presented in Table 1. In general, the plant height increased significantly with increasing levels of sulphur up to 45 kg ha^{-1} at all the growth stages. It is evident from the data; among the sulphur sources gypsum caused significant improvement in the plant height over others at all the growth stages. The highest plant height was observed at 45 kg sulphur per hectare due to gypsum. Similarly, 30 kg sulphur per hectare proved their superiority over 15 kg sulphur per hectares and control and so on 15 kg S ha^{-1} over control. It has been observed in the paragraph that height of mustard plant increased due to sulphur application up to 45 kg per hectare. This phenomenon was quite natural because of greater availability of sulphur in the soil and its stimulating effect on the growth of plant. Steffenson (1954) observed that shoot height was affected by the stimulation due to sulphur that may be attributed to its essentiality in cell division. He all so suggested that sulphur is important in the activity of meristematic tissues and development of shoot. Importance of sulphur in cell division, cell elongation and setting of cell structure was also stated by Hearth and Ormarod (1971).

Table 1. Effect of Sulphur doses and sources on plant height

S.No.	Treatments	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
1.	T1(control)	15.40	75.00	117.33	124.39
2.	T2(Es-15)	16.49	84.07	123.22	131.02
3.	T3(Es-30)	20.29	103.48	151.66	162.13
4.	T4(Es-45)	22.88	116.66	170.98	187.01
5.	T5(GY-15)	17.67	94.62	138.67	150.42
6.	T6(GY-30)	22.49	117.67	172.46	182.38
7.	*T7(GY-45)	24.17	123.24	186.62	200.37
8.	T8(SSP-15)	17.35	89.99	131.88	144.25
9.	T9(SSP-30)	20.53	112.18	174.23	190.57
10.	*T10(SSP-45)	23.31	118.88	175.21	191.63
SEm (±)	-	1.025	5.238	7.697	8.320
CD (p=0.05)	-	3.046	15.563	22.870	24.721

T_7–Gypsum-45, *T_{10} –SSP-45.

It is apparent from the data (Table 2) that different levels and sources of sulphur caused significant variation in number of green leaves per plant. Due to the treatments of elemental sulphur, T_2, T_3 and T_4 were at par among themselves but T_3 and T_4 was significantly superior over control at 30 DAS. Similar results were also observed by the application of single superphosphate. However, 30 kg S ha^{-1} produced significantly higher number of green leaves from 15.0 kg S ha^{-1} and control but was at par with 45.0 kg S ha^{-1} at 60, 90 DAS and at harvest. The maximum number of green leaves was obtained at 30.0 kg sulphur per hectares with the application of gypsum and was significantly superior over 15.0 kg S ha^{-1} and control but was at par with T_7 at all the growth states.

Data on numbers of branches (primary and secondary) given in Table 3 clearly revealed that increasing level of sulphur sources brought about significant increase in number of branches up to the application of 30.0 kg ha^{-1}at all the growth stages. However, difference between 30.0 and 45.0 kg S ha^{-1} applied through all the sources showed at par with each at each growth stages. Whereas, the application of 45.0 kg S ha^{-1} showed significant superiority over 15 kg S ha^{-1} and control at all the growth stages. The maximum numbers of leaves were recorded with the application of 30 kg S ha^{-1} through gypsum, followed by 45.0, 15.0 kg S ha^{-1} and control at all the growth stages, respectively.

The data obtained in relation to dry matter accumulation by mustard crop influenced by different levels and sources of sulphur presented in the Table 4. Dry

Table 2. Effect of sulphur doses and sources on green leaves per plant of mustard

S.No.	Treatments	Green leaves (nos.)			
		30 DAS	60 DAS	90 DAS	At harvest
1.	T1(control)	3.50	23.47	37.72	35.52
2.	T2(Es-15)	4.10	27.50	44.20	40.47
3.	T3(Es-30)	4.24	33.40	56.67	49.91
4.	T4(Es-45)	4.53	30.52	48.45	45.89
5.	T5(GY-15)	4.76	33.60	52.50	48.44
6.	T6(GY-30)	4.76	34.95	56.16	49.44
7.	*T7(GY-45)	4.98	36.08	59.20	50.69
8.	T8(SSP-15)	4.24	33.40	56.67	49.91
9.	T9(SSP-30)	4.87	32.66	44.03	41.28
10.	*T10(SSP-45)	4.64	33.93	51.74	49.93
SEm (±)		1.025	5.238	7.697	8.320
CD (p=0.05)		3.046	15.563	22.870	24.721

*T_7–Gypsum-45, *T_{10} –SSP-45

Table 3. Effect of Sulphur doses and sources on branches (nos.) per plant

S.No.	Treatments	Branches per plant (Primary + secondary)			
		30 DAS	60 DAS	90 DAS	At harvest
1.	T1(control)	1.23	6.51	11.23	11.46
2.	T2(Es-15)	1.45	8.11	14.27	14.43
3.	T3(Es-30)	1.68	9.99	17.45	18.13
4.	T4(Es-45)	1.72	8.88	16.52	16.16
5.	T5(GY-15)	1.70	9.44	16.58	17.14
6.	*T6(GY-30)	2.10	11.33	19.30	20.05
7.	*T7(GY-45)	2.24	11.42	19.7 4	20.73
8.	T8(SSP-15)	1.69	8.94	15.92	16.23
9.	T9(SSP-30)	1.98	10.90	18.04	19.18
10.	*T10(SSP-45)	2.06	11.36	19.5 4	19.92
SEm (±)		0.086	0.478	0.839	0.865
CD (p=0.05)		0.255	1.419	2.494	2.571

*T_7–Gypsum-45, *T_{10} –SSP-45

Table 4. Effect of doses and sources of sulphur on dry matter production at different growth stages of mustard

S.No.	Treatments	Dry matter production (g per plant)			
		30 DAS	60 DAS	90 DAS	At harvest
1.	T1(control)	3.24	15.20	26.46	22.56
2.	T2(Es-15)	4.11	19.43	33.56	29.48
3.	T3(Es-30)	4.71	22.91	38.46	32.89
4.	T4(Es-45)	6.02	27.81	49.16	42.67
5.	T5(GY-15)	6.11	28.79	49.90	42.56
6.	*T6(GY-30)	6.24	31.35	50.96	44.69
7.	*T7(GY-45)	6.67	32.74	54.47	46.45
8.	T8(SSP-15)	5.89	29.64	48.10	38.01
9.	T9(SSP-30)	6.15	26.91	50.22	45.14
10.	*T10(SSP-45)	6.43	31.75	52.51	46.68
SEm (±)	SEm (±)	0.168	1.189	2.340	2.030
CD (p=0.05)	CD (p = 0.05)	0.500	3.532	6.953	6.031

*T_7–Gypsum-45, *T_{10} –SSP-45

matter production of mustard crop was significantly influenced due to different treatments of sulphur at all the growth stages of crop. Due to the application of elemental sulphur significantly increased the dry matter accumulation of mustard up to 30.0 kg S ha^{-1} at all the growth stages. Further increase in the amount of applied sulphur (45.0 kg ha^{-1}) significantly reduced the dry matter accumulation at all the growth stages but exhibited significant superiority over 15.0 kg S ha^{-1} and control. The variation due to effect of applied sulphur through gypsum does not reach up to the level of significance and all the treatments concurrently increased up to 30.0 kg S ha^{-1} and further increase the level of applied sulphur decreases dry matter accumulation. It was also noticed that all the treatment remained at par with each other except the difference between T_5 and T_6 at 30 and 60 DAS. However, applied sulphur was significantly improved the dry matter accumulation between T5 and T6 at 30 and at harvest and remaining treatment was at par with each other. The maximum dry matter accumulation was noticed by application of 30.0 kg ha^{-1} sulphur through gypsum.

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METHODOLOGY OF CONTROLLING TEMPERATURE OF GAS SENSOR

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ABSTRACT

This paper presents a proposed method for temperature Control of a microhotplate based gas sensor. The on-chip microhotplate provide very high temperatures(between 200ºC and 400ºC), which are necessary for the normal operation of metal oxide sensing layers Temperature of gas sensor is controlled by stabilizing the current of sensor.

Key words: gas sensor layers;temperature control ;noise of gas sensor.

INTRODUCTION

Nowadays gas sensors are widely used for a variety of applications such as in industries, air quality control, home automation, in military for security purposes. Various types of gas sensors are available in market. Gas sensors available now are of high cost and large power consumption. To overcome these shortcomings cmos technology is used, for small size and less power consumption [1].

Basically three types of gas sensors are there:

(1) Polymer Gas Sensor

(2) Oxide Gas Sensor

(3) Electro chemical Gas Sensor

Gas Sensor which is described in this paper is Oxide Gas Sensor. It has three layers: Heater, PRT, Sensing material. On Gas sensor chip six pads are available, two pads(1,6) for heater, two pads(3,4) for PRT, two pads(2,5) for sensing material(film). Resistance of heater is 746Ω and PRT resistance is 3.946KΩ.

During gas sensing either oxidation or reduction process occurred on sensor surface. Detection of gas depends on temperature and physical state of the material. If we use the material directly then the temperature goes up to 150°C but if some SOI techniques are used then temperature can goes up to 300°C.

Mainly oxide resistive gas sensors use metal oxides for the sensing material like zinc oxide, tin oxide. These metal oxides react with different gases at different temperature.

In this paper we describe Oxide resistive gas sensor having sensing material is either tin oxide or zinc oxide. It acts as a low temperature gas sensor if sensing material is undopped zinc oxide and it will detect CO_2 gas [2].

Gas sensor testing is done for identification of layers of gas sensor. ADC and DAC testing is done for observing behavior of these components practically.

As we know that there is noise present in every component either system noise or external noise. So, Noise analysis is done for observation of noise

impact on circuit performance. Now we have to observe that what amount of noise is present in the entire system, what are the reasons for these noises, on which parameters noise is dependent and how can we reduce these noises?

After noise analysis, interfacing circuit of gas sensor output is given to ADC. Digital output of ADC is given to controller circuit.

TESTING OF GAS SENSOR

Gas sensor has three layers: (1) Heater (2) PRT (3) Sensing material (film).In this paper we only use heater and PRT for observing the behavior of sensor. Resistance of heater is 760&! and resistance of PRT is 3.946K&! physically. In order to identify individual layer out of three layers we had done testing. After testing we know about layers like (heater having resistance is 750&! and PRT having resistance is 3.874K&!) practically.

Gas sensor's Heater is connected to current source from the input and at output PRT is connected to Digital multimeter (DMM) as shown in figure 1. Digital multimeter is used for taking PRT's resistance up to 3 decimal points. Heater and PRT are isolated to each other but they are thermally connected. From current source supply is given to heater, with increase in current heater resistance is also increased because temperature of heater is increased. There is isolation between heater and PRT but due to thermal connection resistance of PRT is also increased. Output of PRT is taken through DMM with increasing current. We believe linear relationship between current and resistance because with increase in current resistance also increase. But relation is not purely linear, resistance increases with current but not in same proportion as shown in table 1.1.

Table 1.1

Current (mA)	Resistance (KΩ) (unequal pulse width)	Resistance(K) (equal pulse width)
0.5	3.8916	3.8732
1.0	3.9525	3.9386
1.5	3.9978	3.9746
2.0	4.0627	4.0421
2.5	4.1626	4.1413
3.0	4.3041	4.2594
3.5	4.4792	4.4374
4.0	4.6502	4.6199
4.5	4.8193	4.7651
5.0	5.0348	4.9794
5.5	5.1724	5.1562
6.0	5.2916	5.3073
6.5	5.4231	5.4021
7.0	5.5957	5.4070
7.5	5.6555	5.5179
8.0	5.6586	5.6002
8.5	5.7066	5.6916
9.0	5.7671	5.8822
9.5	5.7749	5.9838
10	5.9152	5.9838

In this table two observations are taken with equal and unequal pulse width. Change in Resistance is affected by pulse width. Sensor placement also has significant effect on resistance; there is different behavior when sensor is placed in chamber. This is shown with graph as shown in figure 1.2.

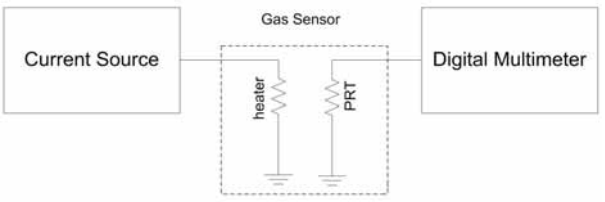

Fig. 1.1. Basic Block Diagram for Gas Sensor Implementation

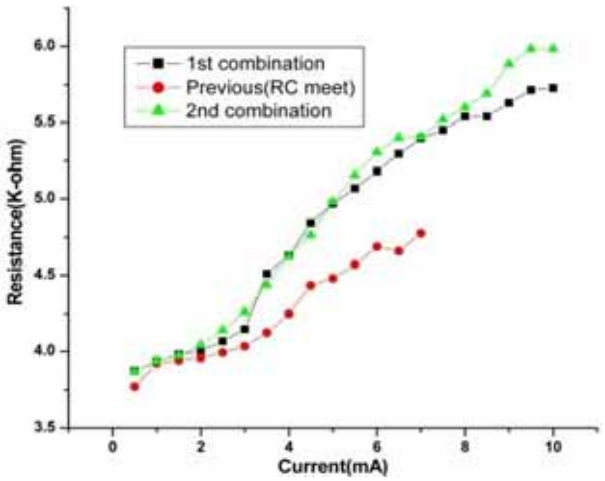

Fig. 2. Current vs. PRT resistance plot

This graph shows that resistance is increased with current but not linearly. So, our requirement is to get linear relationship but why this non linearity occur? What are the factors which affect it?

In order to find answer of these questions we have to do some more test for components of whole circuit.

Output of gas sensor is resistance and DMM is connected to ADC. Input to ADC is either voltage or current. So, replace DMM with an amplifier and a filter then output of filter goes to ADC.

Digital output of ADC is given to controller circuit. Controller circuit consists of an up counter and one down counter. If output of ADC is less than the desired output then controller circuit

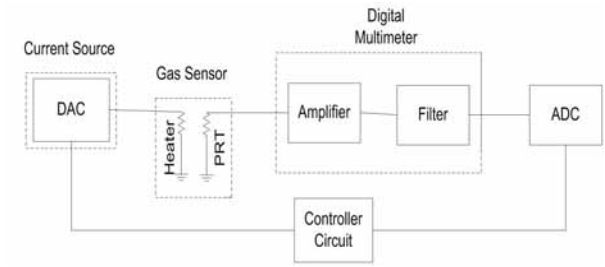

Fig. 1.2. Temperature controller circuit

demands for more input current to Heater. If output is higher than desired then controller circuit demands for reducing input current to heater. Output of ADC is of desired value then controller circuit demands for same input.

INTERFACING CIRCUIT NOISE ANALYSIS

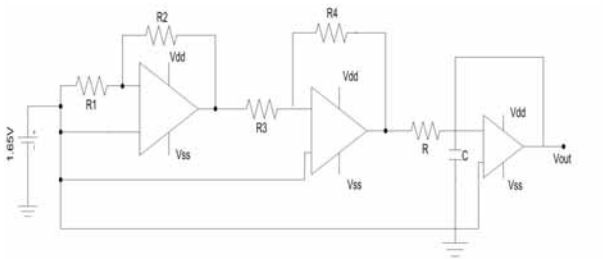

Fig. 1.3. Gas sensor's interfacing circuit

LTC 1050CN8 amplifier and LPF are used in this interfacing circuit to amplify the output of sensor and to match output of interfacing circuit with ADC input range. So, at the output of interfacing circuit along with desired signal noise signal is also presented. Due to noise signal, we can't get accurate working range of ADC. So, we reduce noise of interfacing circuit by stabilizing gain of amplifiers by settling values of Rin and Rf.

Amplifier's Noise Observation

Every component, every circuit generates noise like thermal noise, flicker noise. LTC 1050CN8 amplifier amplifies the signal, but along with

desired signal noise signal is also amplified. It means that we have to use an amplifier in such a way that it amplifies the signal without amplifying noise. In order to reduce noise we have to use two amplifiers 1st amplifier is of small gain and 2nd amplifier is of large gain. In this way we get desired signal with small noise. Test amplifiers in order to see impact of noise on circuit performance with large and small gain of amplifiers. Test amplifiers for equal gain of both amplifiers. Again test amplifiers for large gain (>100) and small gain (>1). Testing results shows that noise is high for large gain as compared to small gain amplifier. Set gain of 1st amplifier Gain of amplifier 5 and 2nd amplifier 100.Gain of amplifier depends on resistances connected in feedback and input. If feedback resistance is small then gain is also small, so noise impact is also small.

Again test is also done by connecting PRT either at input or at feedback.

(i) When PRT is connected at input then noise impact is high as shown in figure 1.4.

Fig. 1.4. Output noise of amplifiers when PRT at input

As shown in above figure, when PRT is connected at input noise magnitude is 231.88mV.

(ii) When PRT is connected in feedback then noise impact is small as compared to (i) as shown in figure 1.5.

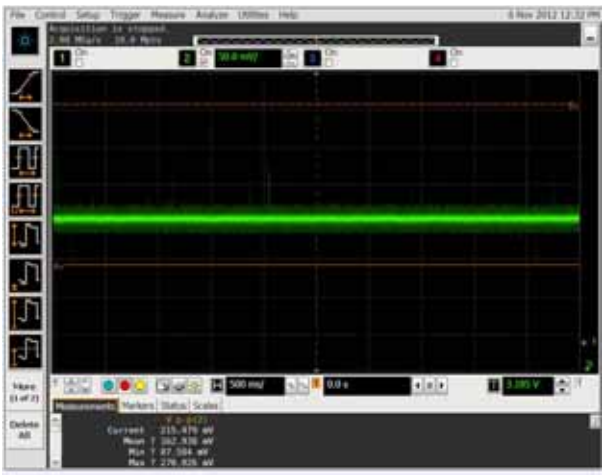

Fig. 1.5. Output noise of amplifiers when PRT in feedback

As shown in above figure noise at output of amplifiers is 162.398mV when PRT is connected in feedback.

So, noise performance is better when connected gas sensor's PRT in feedback.

Filter's Noise Observation

A low pass filter is used for given cut off frequency of 1MHz. We have to select the RC component in such a way that we can get the desired output signal. So, we choose R= 5&!, C=1uf. Output noise of filter is shown in figure 1.6.

Output noise voltage of LPF is 50.871mV as shown in above figure.

Filter circuit is used to get good SNR ratio. A buffer amplifier is connected for impedance matching at output of filter.

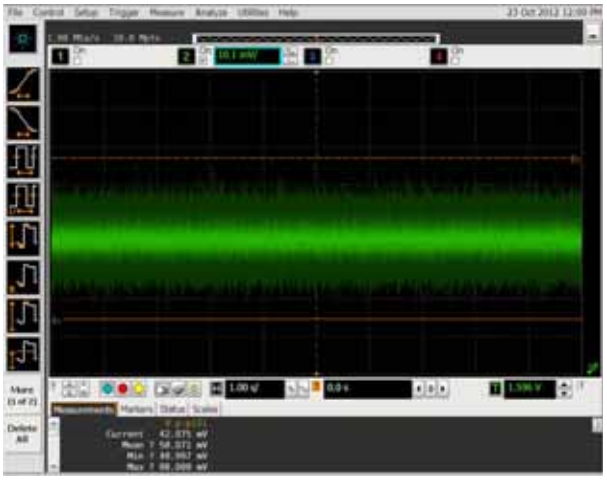

Fig. 1.6. Output noise of LPF with fc=1MHz

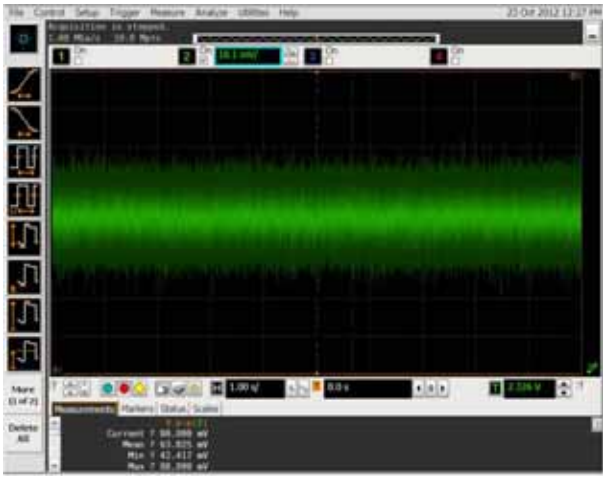

Fig. 1.7. Output noise of interfacing circuit

Make connection between amplifiers, filter and buffer amplifier and observe output noise of circuit. Output noise of circuit is shown in figure 1.7.

2 Noise analysis of amplifier

Feedback is applied to an amplifier in order to reduce noise of amplifier. We know that practically feedback circuit reduce noise of amplifier. Is it really occurring? To prove it mathematically noise analysis is done. So, noise analysis is done for amplifier as well as for feedback circuit. So noise analysis is done by using asymptotic gain method [3]. This method has various advantages:

1) It is exact method.

2) It is a very simple method because in this ohm's law, voltage and current division, source conversions are used to find out feedback terms [4], [5].

Equivalent circuit of feedback amplifier is shown in above figure. This circuit is used for noise analysis of feedback amplifier.

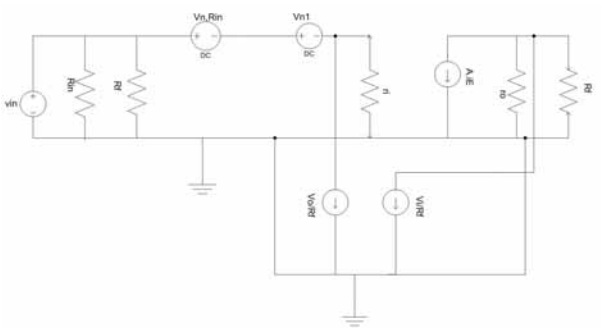

Fig. 1.8. Equivalent circuit of feedback amplifier

The basic formula for asymptotic gain is:

$$G = ((G0+KT)/1+T)$$

Where,

G is closed loop gain

K is asymptotic term

G0 is direct transmission gain

T is loop gain or return ratio

Where, T = a.f

a is open loop gain

F is feedback factor

G0 = (ro/Rin)..... (i)

T = a.f

a = ro/(ro+Rf)*(-A.ro/roQ%Rf)*(1/(riQ%(Rf+Rin))

f = - ((RfQ%ro)/Rf).....(ii)

T = (ro/(ro+Rf))*(A.ro/Rf)*(1/riQ%(Rf+Rin)).(iii)

K= - (ro/Rin-A.ro/(roQ%Rf)).....(iv)

Asymptotic noise gain is given as:

Combine (i), (ii), (iii) and (iv)

G = - (ro.Rf/(1+ro/Rf))

This shows that mathematical value of noise is same as that of practical value of noise.

CONCLUSION

In this paper we describe testing result that we had observed for identification of Gas Sensor's layers. For gas sensor plot graph between PRT resistance and current for random pulse width that shows the resistance change for given range of current (0-10mA).Range of resistance is up to 5K&! for given current range. Also graph between PRT resistance and current for equal pulse width for determining maximum value of PRT resistance with range of current. Graph between temperature and PRT resistance is plotted in order to know the temperature range for PRT resistance range. From graph, resistance of PRT is 5.7285K&! for 10mA at temperature range of 150ºC - 160 ºC .So by this we observe that at every time we get different value of resistance for same value of current with different placement of the gas sensor. Heater that is heart of sensor is compatible with mA range of current source. By above observations we can conclude that there is regular positive change in resistance with increase in current but not as linear function of current.

Various experiments are done for obtaining the stable output of the gas sensor for constant current in this paper. According to noise performance of amplifier PRT is connected in feedback of amplifier or at input .Noise effect is less when connected in feedback instead of input. LPF Filter noise is observed for given cutoff frequency by adjusting RC components. Buffer amplifier noise is observed for same gain as that of amplifier. Assemble all these circuit components and determine noise of whole circuit on oscilloscope.

It concludes that if current is stabilized then resistance of PRT and temperature is also stabilized.

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PERFORMANCE OF PADDY GENOTYPES TRANSPLANTED AT DIFFERENT AGE OF SEEDLINGS AND SPACING UNDER SYSTEMS OF RICE INTENSIFICATION (SRI) IN WESTERN PLAIN ZONE OF UTTAR PRADESH

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ABSTRACT

A field experiment was carried out at Farm of *Krishi Vigyan Kendra, Hastinapur (UP)* during *kharif* seasons of 2008 to 2011. The soil of the experimental field was sandy loam having pH 7.8 with low in organic carbon (0.35 %), medium in available phosphorus (17 kg/ha) and potash (152 kg/ha). The experiment had 8 treatments combinations including 2 varieties (Pusa Basmati-1 & Pusa Sugandha- 4), 2 age of seedlings (10 & 12 days old) and 2 spacings (25 cm x 25 cm & 30 cm x 30 cm) replicated 3 times in a factorial randomized block design. The crop was fertilized with 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 25 kg $ZnSO_4$/ha. The results indicated that the variety Pusa Sugnadha-4 produced significantly higher number of spikes/hill (25.4), grain (37.7 q/h), straw (45.5 q/ha) and biological (83.2 q/ha) yields as well as gross return (Rs. 60267/ha), net return (Rs. 31254/ha) and B: C ratio (2.08) as compared to Pusa Basmati-1. In case of age of seedlings slightly higher values of yield attributes, yields and economics of paddy were recorded when 10 days old seedlings were transplanted as compared to 12 days old seedlings but could not reach up to significant difference. Further, in SRI method there was no significant difference in growth and yield attributes due to change in spacing of transplanting, however, transplanting at 25 x 25 cm spacing gave 5.25, 5.31 and 5.28 per cent higher grain, straw and biological yields as well as more gross return of (Rs. 2853/ha), net return (Rs. 2666/ha) and B: C ratio (0.09) as compared to wider spacing (30x30 cm).

Key words: System of Rice Intensification, Genotypes, Spacings, Seedlings, Transplanting, Yield.

Rice forms staple food for more than half of the world's population and the word demand for rice will grow continuously. Though, India has the largest area under rice in the world, but its productivity level of 3.1tonnes/ha (Economic Survey, 2012) is far below the neighboring country like China greater than (6.0 tonnes/ha) and the world average (4.0 tonnes/ha). To overcome low yields, system of rice intensification has been projected as a potential method of rice cultivation. Husain *et al.* (2004) reported 30 % yield advantages from SRI in Bangladesh and Namara *et al.* (2003) showed an even larger benefit (44 %) in Sri Lanka.

Rice is the largest consumer of irrigation water. In the Indo-gangetic plains of India, total water requirement of rice varies from 1566 mm in clay loam to 2262 mm in sandy loam soils (Tripathi, 1990) about 50-80 % of total water input

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percolates deep in soil profile and only 30-40 % is utilized consumptively (Koga, 1992). The SRI method which envisages alternate wetting and drying may help reduce water losses and improve productivity. Under any method of cultivation, optimum water supply is the important factor governing availability and uptake of essential nutrients, growth, yield and quality of the rice. However, optimum ground space available to each plant is also important for exploitation of available resources. In SRI a wider spacing is recommended, which leads to vigorous root growth and profuse tillering, however, it may be variety dependent and location specific. The square geometry at wider spacing facilitates the movement of mechanical weeder, which is one of the other essential components of SRI techniques. Crop geometry and irrigation may influence the growth and yield of different genotypes to varying degree. A variety with shy tillering and short stature requires to be planted closer, while a tall and profusely tillering one may require wider spacing to produce desire number of healthy and productive shoots per unit area. Likewise, different varieties may respond differently to moisture stress. Thus, the effect of key production components like genotype, irrigation regime and crop geometry on productivity of rice need to be investigated for making any policy on the cultivation of rice with SRI method, especially in the water scares areas.

A System of Rice Intensification (SRI) has attracted attentions because of its apparent success in increasing rice yields with less water use (Uphoff *et al.*, 2008). SRI management involves many departures from the methods conventionally recommended for rice cultivation. SRI proposes the use of single young seedlings, drastically reduced plant densities, keeping fields unflooded, use of a mechanical weeder which also aerates the soil and enhanced soil organic matter. These practices have the aim of providing optimal growth conditions for the plant to get better yield and resource productivity (Stoop *et al.*, 2002). SRI practices are reported to increase the yields of irrigated rice by 20-50 % or even more (Thakur *et al.*, 2010) while reducing water requirements (Satyanarayana *et al.*, 2007). Keeping this in view, a field experiment was planned to evaluation the performance of paddy genotypes transplanted at different age of seedlings and spacing under Systems of Rice Intensification (SRI) in Western Plain Zone of Uttar Pradesh.

Materials and Methods

The field experiment was carried out at the Farm of Krishi Vigyan Kendra, Hastinapur (UP) during *kharif* seasons of 2008 to 2011. Hastinapur is situated at $29^0$01'N, $77^0$45'E and 237 m above mean sea level in Western Plain Zone of Utter Pradesh. The climate the area is semi arid, with an annual average rainfall of 805 mm (75-80% of which is received during July to September), minimum temperature of 0 to 4^0C in January and maximum temperature of 41 to 45^0C in June along with 67 to 83% relative humidity throughout the year. The soil of the experimental field was sandy loam having pH 7.8 with low in organic carbon (0.35 %), available nitrogen (170 kg/ha), medium in available phosphorus (17 kg/

ha) and potash (152 kg/ha). The experiment consisted 8 treatments combinations including 2 varieties (Pusa Basmati- 1 & Pusa Sugandha- 4), 2 age of seedling (10 & 12 days old) and 2 spacings (25 cm x 25 cm & 30 cm x 30 cm) replicated 3 times. The treatments were arranged in a factorial randomized block design. The experiment had 24 plots of size 9 m x 6 m each. The rice seedlings were raised on a raised bed of size 1.25 m x 8 m with wet bed method.

For nursery establishment germinated seeds were broadcasted in first fortnight of July during all the years of experimentation. The nursery was adjacent to the main field so that transplanting could be performed quickly to minimize injury. Ten and Twelve day old seedlings were transplanted on 20th and 22nd July, respectively in all the years of study in the SRI plots within half an hour after removal from the nursery. With both varieties, organic manure was applied at the rate of 5 tonnes per hectare along with chemical fertilizers. The crop was fertilized with 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 25 kg $ZnSO_4$/ha. One third of nitrogen and full dose of phosphorus, potash and zinc sulphate through fertilizers (urea & diammonium phosphate for N & P, muriate of potash for K and zinc sulphate hepta hydrate for Zn) were applied as basal before transplanting. The remaining dose of nitrogen was top dressed equally in 3 splits at 20 days after transplanting, grand tillering stage (40-45 DAT) and panicle initiation (60-65 DAT).

First irrigation was applied 5 days after transplanting to moisten the field without ponding. The second irrigation was given on the evening of 9th day of transplanting at a ponding depth of 2-5 cm, and in the next morning a weeding was performed by a cono-weeder. Thereafter, the alternate wetting and drying method of irrigation was followed and irrigation water was applied 3 days after the disappearance of ponded water. After panicle initiation, all the plots were kept flooded with a thin layer (2-3 cm) of water and all were drained at 15 days before harvest. To control weeds, cono-weeder was run manually in the rows of rice crop twice, in both the directions, at 10, 20 and 30 days after transplanting (DAT) during all the years of investigation.

Data on plant height was recorded before harvesting of crop from all the plots. Average tiller number and panicle number were determined from the crop harvested from a square metre area from each plot. Panicle length, number of grains per panicle and 1000 grain weight were measured from the samples harvested from a square metre area from each replication. The data on grain yield, straw yield and biological yield were recorded at crop maturity from the samples of crop harvested from three square metre areas from each plot. The economic-parameters (gross return, net return and B: C ratio) were worked out on the basis of prevailing market prices of inputs and outputs.

All the data were statistically analyzed using analysis of variance (ANOVA) technique as applicable to factorial RBD as per the procedures described by Rangaswamy (2006). The significance of the treatment effect was

determined using F-test and to determine the significance of the difference between two treatments means, least significant difference (LSD) was estimated at 5% probability level.

Results and Discussion

Growth and yield attributes of paddy

The growth and yield attributes of rice were not influenced significantly due to variation in genotypes, age of seedlings and spacing grown under system of rice intensification (SRI) method except number of spikes/hill (Table-1). Significantly higher numbers of spikes per hill (25.4) were recorded in the genotype Pusa Sugandha-4 as compared to Pusa Basmati-1 (19.1). However, higher values of growth and yield attributes of rice were found in Pusa Sugandha-4 as compared to Pusa Basmati-1.

In case of age of seedlings slightly higher values of growth and yield attributes were recorded when 10 days old seedlings were transplanted as compared to 12 days old seedlings. Similar results were also reported by Patra and Haque (2011).

Further, there was no significant difference in growth and yield attributes due to change in spacing of transplanting, however, slightly higher values of plant height (116.8 cm), number of tillers/hill (37.2), number of spikes/hill (23.1), spike length (20.2 cm), grains/spike (200) and test weight (33.1g) were recorded when transplanting was done at wider spacing (30 x 30 cm) as compared to closer spacing (25 x 25 cm),

Table 1. Effect of genotypes, age of seedling and spacing on growth parameters and yield attributes of paddy under SRI method (Average of 04 years)

Treatments	Plant height (cm)	Tillers/ hill (No.)	Spikes/ hill (No.)	Spike length (cm)	Grain/ spike (No.)	Test weight (g)
Genotypes						
Pusa Basmati- 1	114.4	32.8	19.1	20.0	195	32.0
Pusa Sugandha- 4	117.9	38.6	25.4	19.8	201	33.4
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87
Age of seedlings (Days)						
10	117.5	38.7	23.0	20.0	198	34.0
12	114.8	32.8	21.5	19.8	197	31.4
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87
Spacings (cm)						
25 cm x 25 cm	115.5	34.3	21.4	19.5	195	32.3
30 cm x 30 cm	116.8	37.2	23.1	20.2	200	33.1
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87

but could not reach up to significant difference. This might be due to faster and more development of roots on individual plants transplanting in wider spacing due to more space and less completion for nutrients, water and solar radiation resulted in higher value of growth and yield attributes characters. Thakur *et al.* (2010) and Dass and Chandra (2012) also reported that performance of individual hills was significantly improved with wider spacing compared to closer spaced hills in terms of root growth and xylem exudation rates, leaf number and leaf sizes, canopy angle, tiller and panicle number, panicle length and grain number per panicle, grain filling and 1000-grain weight and straw weight in SRI practice.

Paddy productivity

The productivity of paddy influenced significantly due to variation in genotypes and spacing of transplanting under system of rice intensification, but age of seedlings had no significant effect on grain, straw and biological yields of paddy (Table 2). The two genotypes, Pusa Basmati-1 and Pusa Sugandha- 4 grown under SRI method, exhibited sharp difference in grain, straw and biological yields. Pusa Sugnadha-4 produced significantly higher grain (37.7 q/h), straw (45.5 q/ha) and biological (83.2 q/ha) yields, which were 14.9, 15.2 and 15.07 per cent more as compared to Pusa Basmati-1. This could likely be due to higher values of growth and yield attributes in Pusa Sugandha- 4. Shekhar *et al.* (2009) also reported that higher yields under SRI method.

Table 2. Effect of genotypes, age of seedling and spacing on yield and economics of paddy under SRI method (Average of 04 years)

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Genotypes							
Pusa Basmati- 1	32.8	39.5	72.3	45.3	52427	24252	1.86
Pusa Sugandha- 4	37.7	45.5	83.2	45.3	60267	31254	2.08
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03
Age of seedlings (Days)							
10	35.7	43.4	79.1	45.1	57066	28328	1.98
12	34.8	41.6	76.4	45.5	55628	27178	1.95
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03
Spacings (cm)							
25 cm x 25 cm	36.1	43.6	75.7	45.3	57773	29086	2.01
30 cm x 30 cm	34.3	41.4	79.7	45.3	54920	26420	1.92
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03

Transplanting of different age seedlings had no significant effect of grain, straw and biological yields as well as harvest index on paddy grown under SRI method. However, slightly higher grain (0.9 q/ha), straw (1.8 q/ha) and biological (2.7 q/ha) yields were obtained when transplanting was done at 10 days age of seedlings as compared to 12 days old seedlings. This might be due to early establishment of seedlings in the main field resulted in better root and shoot development ultimately produced more yield. Similar results were also reported by Patra and Haque (2011).

Yield of paddy influenced significantly due to transplanting at different spacings. Transplanting at wider spacing (30 x 30 cm) produced significantly less grain (34.3 q/ha), straw (41.4 q/ha) and biological (75.7 q/ha) yield as compared to transplanting at slightly narrow spacing (25 x 25 cm). In SRI method, transplanting of seedlings at 25 x 25 cm spacing gave 5.25, 5.31 and 5.28 per cent higher grain, straw and biological yields as compared to wider spacing (30 cm x 30 cm). The low yield was recorded at 30x30 cm spacing under SRI practice, as a result of less plant population (11 hills/m^2), despite improved hill performance. Menete *et al.* (2008) and Thakur *et al.* (2010) also reported that wider spacing in SRI method to be disadvantageous, however, wider spacing in SRI improve the productivity of individual hill, but not sufficiently to compensate for the higher yield in area basis as achieved with the lower spacing.

Paddy economics

The economics of paddy cultivation also influenced significantly due to different genotypes and transplanting at different spacings but transplanting of different age seedlings had no significant effect on economics of paddy (Table 2). Significantly higher gross return of Rs. 60267/ha and net return of Rs. 31254/ha as well as B: C ratio (2.08) were obtained with the cultivation of variety Pusa Sugandha-4 under SRI method as compared to variety Pusa Basmati-1 (Rs. 52427/ha, Rs. 24252/ha and 1.86, respectively). This might be due to higher yield of Pusa Sugandha-4 as compared to variety Pusa Basmati-1. Similar results were also reported by Shekhar *et al.* (2009) and Dass and Chandra (2012).

Age of seedling had no significant effect on economics of paddy (Table-2). However, slightly more values of gross return of (Rs. 1438/ha), net return (Rs. 1150/ha) and B:C ratio (0.03) were obtained when paddy seedlings were planted at the age of 10 days as compared to 12 days old seedlings under SRI method. These higher values may be due to higher yields of paddy at 10 days seedlings.

Transplanting of paddy at different spacings also influenced the economics of paddy cultivation under SRI method (Table-2). Paddy transplanting at 25x25 cm spacing gave significantly higher gross return of (Rs. 57773/ha), net return (Rs. 29086/ha) and B:C ratio (2.01) as compared to wider spacing (30x30 cm). The difference in increased values was Rs. 2853 in gross return, Rs. 2666/ha in net return and 0.09 in B: C ratio over transplanting at 30x30 cm spacing. The results are in close conformity with those of Dass and Chandra (2012).

In conclusion, paddy varieties respond differently when grown under SRI conditions but transplanting at slightly different age of seedling had no significant effect on paddy performance. Wider spacing beyond optimum plant density, however, does not give higher grain yield on an area basis but performance of individual hills improves with increase in spacing, therefore, for achieving this; a combination of improved hills with optimum plant population must be worked out for SRI according to location specific conditions.

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EFFECT OF NUTRIENT SOURCES, APPLICATION OF GYPSUM AND GROWTH REGULATOR ON GROWTH, YIELD AND QUALITY OF INDIAN MUSTARD [*BRASSICA JUNCEA* (L.) CZERN AND CROSS] UNDER SUB-HUMID REGION OF UTTARANCHAL

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ABSTRACT

Mustard *(Brassica juncea* (L.) Czern and Cross) is the most important oil seed cropafter groundnut inIndia.The mustard oil is edible and usedfor inductionpurposes.It has peculiar pungency which issuitable for condiments and preparation of pickles, curries and vegetables. Sulphur is important nutrient for mustard crop which influence theseedproductivity and quality. Sulphur is a constituent of protein and playvital role in oil synthesis. Gypsum is the cheapest and best source of sulphur. Besides, this organic fertilization through locally available sources such as FYM and poultry manure are having its own importance in mustard crop production and soil productivity on a sustainable basis. Integrated approach for plant nutrition is being advocated. Since single nutrient approach often reduces fertilizer use efficiency. Thus, combination of organic manures and chemical fertilizers may helps in enhancing and maintaining stability in production system with least degradation in chemical and physical properties of the soil (Piri and Sharma, 2006). In recent years, a new technology has been developed for increasing the crop yield through use of agrochemicals as growth regulators, stimulants and promoting substances to modify various metabolic activities inside the plant. In the present study field experiment was conducted to study effect of organic and inorganic nutrient sources along with soil amendment and growth promoters use for mustard crop under sub-humid climatic condition of Uttaranchal.

Based on complete information of M.Sc thesis of first author submitted to DCAST, Selaqui, Dehradun, Uttarakhand during 2012.

A field experiment was conducted during winter (*rabi*) season of 2012 at research farm of Doon College of Agriculture Science and Technology, Selaqui, Dehradun, Uttaranchal. The soil type was clay loam, slightly alkaline (pH 8.1) and calcareous in nature. It had low organic carbon content (0.55 %) and medium in available NPK (284.2 kg/ha, 20.4 kg/ha and 292.8kg/ha). The maize crop was grown in the experimental field during preceding *kharif* season of 2011 and during summer field was kept fallow. Three treatments of nutrient source (inorganic, FYM+inorganic, PM+ inorganic), three treatments of gypsum application(without gypsum, full dose at sowing and 50% at during sowing + 50% at 30 DAS) and two treatments of plant growth regulators (control and thiourea spray) were chosen. Well rotten farm yard manure(10tonnes/ha) and poultry manure(5 tonnes/ha) were used as organic nutrient source. The farmyard manure wascontains 0.45 % nitrogen and

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0.25% phosphorus while poultry manure 1.2% nitrogen and 0.75% phosphorus on dry weight basis. Which is not sufficient as per the recommendedfertilizers dosesfor mustard crop (60 kg N/ha + 40 kg P_2O_5/ha). The remaining quantity of nutrientswas adjusted through inorganic fertilizers like urea and diammonium phosphate.Half dose of nitrogen and full dose of phosphorus was given at the time of sowing and the remaining dose of nitrogen was applied astop dressed after 30 days of sowing and followed by irrigation. Fine grounded gypsum was broadcasted and well mixed with plough. Foliar spray of thiourea was applied at pre flowering of mustard. Before sowing, the seed was treated with *Bavistin* fungicide @ 2g /kg. The sowing was done manually with a seed rate of 5kg/ha and depth of 2-3cm. The inter row spacing and plant to plant spacing was kept 30cm and 10cm respectively. The mustard variety 'Pusa Jai Kisan' (Bio902) was sown. The agronomical package of practices was adopted as and when required. The crop was harvested after 125 days. The seed and stover were separated by manual winnowing and finally yield was recorded in kg/plot and converted into kg/ha. The leaf area was calculatedby using a formula given by Watson (1947). Oil content in mustard seeds was estimated by Soxhlets and Ether Extraction Method (AOAC, 1995).

All the growth attributes of mustard were influenced significantly with different sources of nutrients (Table 1). However, RGR (g/g/day) was not increased significantly. But the application of inorganic sources of nutrients @ 60 kg N + 40 kg P_2O_5/ha was resulted inmaximum increase ingrowth indices of mustard *viz* plant height at harvest (cm), dry matter accumulation (g/plant), primary and secondary branches/plant, LAI at 60 days after sowing, CGR (g/m^2/day) at 60-90 days after sowing and RGR (g/g/day) at60-90days after sowing. The next best treatment observedwaspoultry manure (5tonnes/ha) + inorganic sources.While, growth attributes were recorded minimum under farm yard manure + inorganic sources of nutrients supplied. This might be due to farm yard manure has low content in nutrients and gradually releasednutrient content as compared to poultry manure and inorganic sources of nutrients (Bairwa *et al* 2009). Besides, farm yard manure is takenmore time in mineralization so nutrients availability will be at later stage for crop. Therefore, full advantage of crop could not betaken during thestudy. Similar results have also been observed by (Dhaka and Kumar 2003).

Yield attributes of mustard were observed significantly higher with different sources of nutrients management (Table 2). However, harvest index was not seemssignificant. Although, the highest yield attributes were measured with inorganic sources of nutrients in mustardcrop,thereafter with poultry manure followed by farm yard manure. It is agreement with previous reported study (Hegde 2004). Yield and quality parameters of mustard were influenced significantly by different sources of nutrients (Table 3). Whereas, seed yield, stover and biological yields were recorded maximum with application of inorganic nutrient sourcethan that of other nutrientsources. The differences between farm yard manure and poultry

Table 1. Effect of sources of nutrients, gypsum application and thiourea on growth attributes of mustard

Treatment	Plant height at harvest (cm)	Dry matter accumulation at harvest (g/plant)	Number of primary branches/ plant	Number of secondary branches/ plant ant	LAI 60 DAS	CGR (g/m^2/ day) 60-90 DAS	RGR (g/g/day) 60-90 DAS
Sources of nutrients							
Inorganic sources	141.01	56.17	8.16	19.76	2.90	20.19	0.0200
FYM@10tonnes/ha+ inorganic source	129.03	52.21	7.40	17.70	2.68	18.44	0.0193
Poultry manure@5tonnes/ha+ inorganic source	132.07	52.69	7.76	18.26	2.65	17.98	0.0192
CD (*P*=0.05)	5.21	3.08	0.44	1.00	0.17	1.58	NS
Gypsum application (250kg/ha)							
Without gypsum	124.60	48.88	7.02	17.00	2.46	17.76	0.0193
Full dose at sowing	137.13	54.44	7.86	18.71	2.79	18.73	0.0195
50% at sowing+50% at 35 DAS	142.12	57.74	8.43	20.00	2.98	20.12	0.0197
CD (*P*=0.05)	6.21	3.08	0.44	1.00	0.17	1.58	NS
Plant growth regulator							
Control(water supply)	131.22	50.52	7.21	17.51	2.56	17.02	0.0192
Thiourea spray @ 1000ppm	138.13	56.85	8.33	19.64	2.93	19.05	0.0198
CD (*P*=0.05)	5.14	2.51	0.36	0.82	0.14	1.29	NS

FYM, Farmyard manure

manure + inorganic source were found statistically at par with each other for seed and biological yields.The seed yield, stover production and biological yield were the maximum with inorganic nutrient sources as compared to other nutrient sources *viz*. combination of FYM + inorganic source and poultry manure + inorganic source. The quality traits of mustard seed like, oil content, oil yield and protein content were influenced significantly with differentnutrient sources. The total N, P and S content in stover and grain of mustard were increased significantly due to different fertility sources (Table 4). The maximum uptake of N, P and S nutrients were exhibited with the application of recommended doses of inorganic fertilizers (60 kg N + 40 kg P_2O_5/ha) followed by poultry manure @ 5 tonnes/ ha+inorganicsources implanted at the

Table 2. Effect of sources of nutrients, gypsum application and thiourea on yield attributes of mustard

Treatment	Number of siliqua/plant	Number of seeds/siliqua	Weight of 1000 seed (g)	Harvest index (%)
Sources of nutrients				
Inorganic sources	271.67	14.85	4.40	29.78
FYM@10tonnes/ha+ inorganic source	248.83	13.42	4.00	29.71
Poultry manure@5tonnes/ha+ inorganic source	262.83	13.52	4.18	29.20
CD (*P*=0.05)	14.27	0.78	0.25	NS
Gypsum application (250kg/ha)				
Without gypsum	227.33	12.46	3.77	29.05
Full dose at sowing	262.00	14.06	4.21	29.81
50% at sowing+50% at 35 DAS	293.33 20.12	15.27 0.0197	4.59	29.82
CD (*P*=0.05)	14.27	0.77	0.25	NS
Plant growth regulator				
Control(water supply)	239.78	13.05	3.90	29.14
Thiourea @ 1000pp	282.00	14.05	4.48	29.99
CD (*P*=0.05)	11.65	0.63	0.20	NS

time of sowing. However, uptake of phosphorus was at par between FYM @ 10 tonnes/ha and poultry manure @ 5 tonnes/ha + inorganic treatments supplied as the sources of nutrients. The lower accumulation of N, P and S nutrients were recorded under FYM @ 10 tonnes/ha. Whereas,the higher uptake of nutrients (N, P and S) was recorded underinorganic sources by 22.59, 22.67 and 7.99% over FYM @ 10 tonnes/ha treatment. This might be due to higher concentration of nutrients in stover and grainwhich have reflected directly upon in total uptakes of nutrients. Similar, results have also observed by Pir *et al* 2005. The net economic gain was the highest (₹ 29160/ha) under inorganic sources, which were significantly higher over FYM @ 10tonnes /ha and poultry manure @ 5tonnes/ha + inorganic sources of nutrient. The benefit: cost ratio was determined higher and almost as compared to inorganic sources of nutrient. This might be due to higher costof both organic sources of nutrients (farm yard manure and poultry manure) as compared to that of inorganic source of nutrients.

The growth parameters *viz* like plant height at harvest, dry matter

Table 3. Effect of sources of nutrients, gypsum application and thiourea on yield and quality traits of mustard

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)	Protein content in seed (%)
Sources of nutrients						
Inorganic sources	2020	4751	6771	38.00	774.04	21.60
FYM@10tonnes/ha+ inorganic source	1864	4418	6281	37.81	708.76	19.06
Poultry manure@5tonnes/ ha+ inorganic source	1848	4487	6335	39.08	726.62	20.20
CD (*P*=0.05)	100	252	270	1.73	55.24	0.71
Gypsum application (250kg/ha)						
Without gypsum	1719	4200	5919	36.03	619.99	18.41
Full dose at sowing	1941	4584	6526	38.56	750.39	20.57
50% at sowing+50% at 35 DAS	2072	4870	6942	40.29	839.06	21.89
CD (*P*=0.05)	100	252	270	1.73	55.24	0.71
Plant growth regulator						
Control(water supply)	1781	4336	6117	36.62	653.33	19.14
Thiourea spray @ 1000ppm	2040	4767	6807	39.97	819.62	21.44
CD (*P*=0.05)	82	205	220	1.41	45.10	0.57

accumulation (g/plant), number of primary and secondary branches/plant, leaf area index (LAI) and CGR (g/m^2/ day) at 60-90 days after sowing were increased significantly due to application of gypsum (Table1). However, Relative growth rate (RGR) (g/g/day) at 60-90 days after sowing does not significantly influenced with and without application of gypsum (250 kg/ha). The differences between full dose of gypsum was applied at the time of sowing and 50% at sowing and 50% at 35 DAS treatments was found statistically at par with each otherfor plant height and CGR. Applicationfull doseof gypsum at sowing and 50 % at sowing and 50% at 35DAS were found better over control (without gypsum application).

Yield attributes like number of siliqua/plant, number of seeds/ siliqua and1000 seeds weight (g) were increased maximum with gypsum applied as 50% at sowing (125 kg/ha) and remaining 50% at 35 days after sowing (125 kg/ha) as compared to other techniques of gypsum application in to the soil. The harvest index was not influenced significantly (Table 2).

Table 4. Effect of sources of nutrients, gypsum application and thiourea on total uptake of nitrogen, phosphorus, sulphur and economic return from Indian mustard

Treatment	Total nitrogen uptake (kg/ha)	Total uptake phosphorus (kg/ha)	Total uptake sulphur (kg/ha)	Net returns (/ha)	Benefit: cost ratio
Sources of nutrients					
Inorganic sources	94.47	23.59	21.48	29160	4.36
FYM@10onnest/ha+ inorganic source	77.06	19.23	19.89	22328	2.07
Poultry manure@5tonnes/ ha+ inorganic source	81.44	19.74	20.08	23437	2.49
CD (*P*=0.05)	4.19	0.832	0.853	1724	0.205
Gypsum application (250kg/ha)					
Without gypsum	68.90	17.10	15.95	21764	2.65
Full dose at sowing	86.10	21.03	21.22	25428	3.00
50% at sowing+50% at 35 DAS	97.75	24.42	24.28	27733	3.28
CD (*P*=0.05)	4.19	0.832	0.853	1724	0.205
Plant growth regulator					
Control(water supply)	74.29	18.55	18.41	22999	2.85
Thiourea spray @ 1000ppm	94.35	23.14	22.55	26952	3.09
CD (*P*=0.05)	3.42	0.679	0.697	1408	0.17

The mustard seed, stover and biological yield wasimproved significantly and found maximumwhengypsum applied as 50%at sowing time and remaining 50% at 35DAS. Similar trends were also observed in case of quality traits *viz*. oil content, oil yield and protein content in seeds of mustard.Both the treatments i.e. without gypsum(control) and full dose(250kg/ha) applied at sowing time were found inferior as compared to gypsum applied as50 % atsowing and 50% at 35 DAS. Similar results have also observed by the Rao and Shaktawat (2005) ingroundnut from Udaipur (Rajasthan). Gypsum application caused significant improvement in total N, P and S uptake. The corresponding values of uptake were increased by 24.96 and 41.87% in N, 22.98 and 42.80% in P and 33.04 and 52.22% in S when gypsum was applied full dose at sowing and50% at sowing + 50% at 35 DAS respectively over to control treatment. Application of full doseof gypsum at sowing and 50 % at sowing + 50% at 35 DAS significantly increased net monetary returns and representing increase of 3666 and 5969/ ha over control (21764/ha). While highest benefit cost ratio (3.28) was realized under gypsum application as 50% at sowing and 50% at 35 DAS.

Application of thiourea @ 1000 ppm/ ha had positive effecton all growth parameters of mustard crop (Table 1). The percent increased in plant height, dry matter accumulation/plant (g), primary and secondary branches/plant, LAI and CGR were increased by 5.26, 12.52, 15.57, 12.16, 14.45, 11.92 and 3.12 respectively over water supply treatment in mustard crop. Application of thiourea @1000 ppm/ha caused significant improvement in number of siliqua/plant by 17.60%, whereas, it was increased by 7.66 % over water spray when comparison was made with thiourea spray over the mustard crop. Application of thiourea had recorded significantly higher 1000 seeds weight and increased by 14.87% higher over water spray. The seed and stover yields were also increased significantly with spray of thiourea @ 1000 ppm/ha in the tune of 14.54 and 9.94% higher than water spray treatment. Similarly biological yield of mustard was increased by 11.28% greater over water spray. The oil content in mustard seeds was increased due to spray of thiourea @ 1000 ppm/ha than spray of water (control) and improvement in seed oil content by 9.14% higher than water spray treatment. Similarly, the oil yield was also increased due to spray of thiourea in the extent of 25.45% higher overwater spray. Application of thiourea @1000 ppm had also increased protein content in seeds by 12.01 % than control treatment. It is evident from the results that total uptake of N, P and S was increased by 27.00, 24.74 and 22.48% respectively when spray of thiourea @ 1000 ppm/ha as compared to water spray. The thiourea application @ 1000 ppm significantly improved net income by 22998 and higher benefit:cost ratio (3.09) over water spray (2.85). Thus, additional monetary advantage through thiourea spray was estimated around 3953/ha.

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CORRELATION COEFFICIENT AND PATH ANALYSIS IN *VALAN KAKRI* (*CUCUMIS SATIVUS* VAR. *UTILISMUS* L.)

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ABSTRACT

The correlation and path analysis for yield and yield contributing characters namely vine length (m), number of primary branches per vine, days to anthesis of first male flower, days to anthesis of first female flower, number of male flowers per vine, number of female flowers per vine, number of fruits per vine, total yield per vine (kg), weight of fruit (g), diameter of fruit (cm), length of fruit (cm), pulp thickness (mm), rind thickness (mm), number of seeds per fruit, total soluble solids (ºBrix) and acidity of fruit (%) of 16 *Valan Kakri* genotypes were studied. Significant variations were observed for all the characters in all the genotypes used in the experiment. Total yield per vine was found to be positively and significantly correlated with number of fruits per vine, weight of fruit, diameter of fruit, length of fruit and pulp thickness. Path coefficient analysis revealed that total soluble solids, number of fruits per vine, weight of fruit, number of male flowers per vine and number of seeds per fruit showed positive direct effects on total yield per vine.

Key words: *Valan Kakri*, direct and indirect effects, genotypes, correlation, path analysis.

INTRODUCTION

Cucurbits form an important and big group of vegetable crops in which cucumber (*Cucumis sativus* L.) is the most important salad crop of the family Cucurbitaceae grown commercially throughout the country. Cucumber cultivation goes back to at least 3000 years in India and 2000 years in china (Robinson and Decker-Walters, 1997). Cucumber is native to northern India (Whitaker and Davis, 1962 & Pursglove, 1969). The fruits are mainly consumed as salad, preparation of cosmetic item soap and cream and in many other ways (Dhiman and Chander Parkash, 2005) and it also prevent constipation, checks jaundice and indigestion (Nandkarni, 1927). It is used by native peoples of Northern India as a laxative (Deakin *et a*l 1971). Cucumber contains more than 90% water. The nutritive value of cucumber per 100g of edible portion are minerals (0.3g), vitamins A (45 IU), carbohydrates (2.5g), phosphorus (25mg), fat (0.2g), calcium (12mg) and protein (0.8g) (Rana, 2008).

Valan Kakri (*Cucumis sativus* var. *utilismus* L.) belongs to similar genus and species of cucumber but in respect to size of fruit, length of fruit and keeping quality are different from cucumber which is little bit higher than cucumber. It is also known as the name “Balam Khira”. The use of *Valan Kakri* just similar to cucumber likewise used as salad and cooking vegetable which is easily digestible and increase appetite when consumed.

It is widely grown as a summer and rainy season vegetable in India especially in northern states. It is an annual climber and monoeciaus vegetable, but different sex form like hermaphrodite, staminate, pistillate etc., are commonly

found in nature. The flower of *Valan Kakri* is yellow and anthesis takes place in morning. The skin of *Valan Kakri* is smooth and green. The seed are creamish white with smooth surface. Within the species, wide variation with respect to fruit bearing habits, maturity, yield, shape, size, color, spines and vine habit of the crop has been observed in India (Robinson and Decker-Walters, 1997).

Valan Kakri is a cross pollinated vegetable, thus, its natural population has tremendous variability for fruit shape, colour and taste etc. Being an important crop of arid climate, the research work on *Valan Kakri* is very scanty. Evaluation of genotypes to assess the existing variability is considered as preliminary step in any crop improvement programme. In order to pursue an effective breeding programme, the present investigation was carried out to gather information on correlation and path analysis for different characteristics in *Valan Kakri.*

Materials and Methods

Location of experiment

The genotypes were sown using randomized block design with three replications at Hi-tech horticulture farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur, Rajasthan (India) during July to October 2012. Each entry was planted in a single row of 2.5 m long maintaining row to row 1.0 m and plant to plant 0.50 m.

Plant material and Source

The present investigation comprised 16 genotypes of *Valan Kakri* collected from various parts of Rajasthan state. The details of germplasm are sown in Table 1.

Genotype	Place	Genotype	Place
PVK-1	Kolyari	PVK-9	Phalasiya
PVK-2	Oguna	PVK-10	Dewla
PVK-3	Jhadol	PVK-11	Iswal
PVK-4	Gogunda	PVK-12	Pipala
PVK-5	Vallabhnagar	PVK-13	Maghwas
PVK-6	Gorana	PVK-14	Khakhad
PVK-7	Jaswantgarh	PVK-15	Gogia
PVK-8	Atadiya	PVK-16	Kumbhalgarh

Observations

Observations on five randomly selected plants from each replication were recorded for vine length (m), number of primary branches per vine, days to anthesis of first male flower, days to anthesis of first female flower, number of male flowers per vine, number of female flowers per vine, number of fruits per vine, total yield per vine (kg), weight of fruit (g), diameter of fruit (cm), length of fruit (cm), pulp thickness (mm), rind thickness (mm), number of seeds per fruit, total soluble solids (°Brix) and acidity of fruit (%).

Number of days from sowing to opening of first male flower on a vine was recorded as the number of days required for anthesis of first male flower. Number of days from sowing to opening of first female flower on a vine was recorded as the number of days required for anthesis of first female flower. Five vines were selected randomly and from each vine total number of male and female flowers were counted and then average was calculated. Total number of primary branches of individual plant was counted at the time of final harvest. Fruit were harvested at horticulture maturity stage. Number of marketable fruits was counted at each picking and summed all the picking for each plot. Number of fruits per vine was calculated after dividing

Table 1. Genotypic and phenotypic correlation coefficients between yield attributes and yield per vine

Character		Vine length (m)	No. of primary branches per vine	Days to anthesis of first male flower	Days to anthesis of first female flower	No. of male flowers per vine	No. of female flowers per vine	No. of fruits per vine	Total yield per vine (kg)	Weight of fruit (g)	Diameter of fruit (cm)	Length of fruit (cm)	Pulp thickness (mm)	Rind thickness (mm)	No. of seeds per fruit	T.S.S. (°Brix)	Acidity of fruit (%)
Vine length (m)	G	1	0.80**	-0.55*	-0.40	0.57*	0.56*	0.30	0.31	0.25	0.42	0.35	0.40	0.78**	0.48	0.82**	0.59*
	P	1	0.62**	-0.48	-0.36	0.51*	0.55*	0.28	0.29	0.24	0.39	0.30	0.36	0.71**	0.39	0.75**	0.56*
No. of primary branches per vine	G		1	-0.56	-0.45	0.70**	0.67**	0.20	0.25	0.03	0.40	0.44	0.35	0.60*	0.43	0.81**	0.55*
	P		1	-0.45	-0.36	0.50*	0.52*	0.18	0.21	0.04	0.34	0.37	0.27	0.42	0.33	0.63**	0.39
Days to anthesis of first male flower	G			1	0.90**	-0.73**	-0.90**	-0.32	-0.23	-0.31	-0.41	-0.29	-0.22	-0.25	-0.60*	-0.48	-0.50*
	P			1	0.84**	-0.64**	-0.75**	-0.30	-0.23	-0.31	-0.37	-0.28	-0.19	-0.23	-0.50*	-0.44	-0.43
Days to fnthesis of first female flower	G				1	-0.69**	-0.79**	-0.41	-0.28	-0.32	-0.41	-0.36	-0.32	-0.20	-0.49	-0.46	-0.56*
	P				1	-0.61*	-0.70**	-0.39	-0.28	-0.31	-0.38	-0.32	-0.28	-0.18	-0.37	-0.44	-0.52*
No. of male flowers per vine	G					1	1.00	0.23	0.13	-0.00	0.30	0.29	0.23	0.28	0.19	0.53*	0.61*
	P					1	0.84**	0.21	0.11	-0.01	0.27	0.23	0.23	0.24	0.10	0.44	0.54*
No. of female flowers per vine	G					1	0.29	0.16	0.13	0.41	0.32	0.20	0.27	0.31	0.50	0.56*	
	P						1	0.27	0.17	0.12	0.38	0.24	0.16	0.29	0.28	0.45	0.48
No. of fruits per vine	G							1	0.97**	0.81**	0.86**	0.78**	0.89**	0.30	0.39	0.52*	0.66**
	P							1	0.92**	0.75**	0.79**	0.71**	0.82**	0.27	0.29	0.52*	0.57*
Total yield per vine (kg)	G								1	0.86**	0.86**	0.79**	0.96**	0.30	0.36	0.57*	0.64**
	P								1	0.78**	0.80**	0.71**	0.88**	0.28	0.28	0.52*	0.57*
Weight of fruit (g)	G									1	0.73**	0.73**	0.75**	0.35	0.54*	0.40	0.39
	P									1	0.69**	0.65**	0.68**	0.30	0.41	0.39	0.36
Diameter of fruit (cm)	G										1	0.83**	0.80**	0.43	0.49	0.67**	0.65**
	P										1	0.74**	0.70**	0.38	0.39	0.61*	0.59*
Length of fruit (cm)	G											1	0.81**	0.42	0.36	0.68**	0.62*
	P											1	0.76**	0.40	0.32	0.61*	0.53*
Pulp thickness (mm)	G												1	0.43	0.27	0.69**	0.78**
	P												1	0.42	0.19	0.63**	0.69**
Rind thickness (mm)	G													1	0.52*	0.82**	0.58*
	P													1	0.43	0.74**	0.49
No. of seeds per fruit	G														1	0.44	0.29
	P														1	0.34	0.24
T.S.S (°Brix)	G															1	0.84**
	P															1	0.77**
Acidity of fruit (%)	G																1
	P																1

*, ** - Significant at 5% and 1% levels, respectively

total number of fruits by five. Five marketable fruits were randomly selected from each plot of a replication during the picking and length of each fruit was measured in centimeter from head and up to blossom scar with the help of vernier calipers. Total fruit weight of plot was divided by total number of fruits of the plot to get the average weight of fruit. The same fruit which were used taking observation for average length of fruit was also used for this character. Diameter was recorded from the centre position of fruit by vernier calipers. Five fruits were left for maturity on each genotype for recording number of seeds per fruit. At maturity, all seeds from these fruits were extracted and counted. Finally, it was divided by five to get the average number of seeds per fruit. The vine length was measured in meter from the ground level to the tip of the main vine at the time of final harvest. Total fruit yield over all the pickings were recorded for each plot and yield per vine was obtained after dividing total yield by number of plants of a plot. The pulp thickness was measured from inner side to seed cavity by scale and expressed in millimeter. The rind thickness was measured by scale and expressed in millimeter. Total soluble solids of the fruit were determined by using a hand refractometer of 0 to 30% range. One drop of fruit juice was put on the prism of the refractometer and percent total soluble solids (TSS) was recorded directly. The value were corrected at 20^0 c and expressed as percent TSS of the fruit (AOAC, 1995). The acidity of fruit was determined by titration method (AOAC, 1995). Five gram fruit pulp was taken and then crushed it and then added 45 ml distill water. From this solution pick up 10 ml by pipette in conical flask and then add 1-2 drops of phenopthlin indicator. Than it titrate against N/10 NaOH when till not appeared pink colour. Than percent acidity of fruit were calculated by multiplying from correction factor to titration reading.

Statistical Analysis

Correlation (genotypic and phenotypic) and path coefficient were computed by the methods suggested by Al-Jibouri *et al.* (1958) and Dewey and Lu (1959).

Result and Discussion

The estimates of genotypic correlation were slighter higher than their corresponding phenotypic correlation for all the characters (Table 3). Genotypic correlation coefficient were higher than corresponding phenotypic correlation coefficient for most of the characters were also reported by Singh *et al.* (2002), Parihar *et al.* (2007) in cucumber. Total yield per vine exhibited significant and positive correlation with number of fruit per vine, weight of fruit, diameter of fruit, length of fruit, pulp thickness, total soluble solids and acidity of fruit both at genotypic and phenotypic levels (Table-3) indicating that any increase in these seven characters should bring about an enhancement in the yield. Similar results exhibiting significant positive association between total yield per vine and other traits were reported by Kumaresan *et al.* (2006) for number of fruits per vine and fruit weight and Narayanankutty *et al.* (2006) for fruit diameter, fruit length, fruit weight, fruits per vine in snake gourd and Parihar *et al.* (2007) for number of fruits per vine, fruit weight, fruit length in cucumber and Kumar *et al.* (2013) for number of fruits per vine, average weight of fruit in sponge gourd. Further, average weight of fruit was significantly and positively correlated with number of fruits per vine,

Table 2. Direct (diagonal) and indirect effects of different correlated characters towards total yield per vine

Character	Vine length (m)	No. of primary branches per vine	Days to anthesis of first male flower	Days to anthesis of first female flower	No. of male flowers per vine	No. of female flowers per vine	No. of fruits per vine	Weight of fruit (g)	Diameter of fruit (cm)	Length of fruit (cm)	Pulp thickness (mm)	Rind thickness (mm)	No. of seeds per fruit	T.S.S. (°Brix)	Acidity of fruit (%)	r
Vine length (m)	-0.38	-0.31	-0.28	-0.15	0.47	-0.11	0.27	0.22	-0.11	-0.28	-0.10	-0.94	0.19	2.16	-0.34	0.31
No. of primary branches per vine	-0.30	-0.39	-0.29	-0.17	0.58	-0.13	0.18	0.03	-0.11	-0.34	-0.09	-0.72	0.17	2.15	-0.32	0.25
Days to anthesis of first male flower	0.21	0.22	0.51	0.35	-0.60	0.18	-0.28	-0.28	0.11	0.22	0.06	0.30	-0.24	-1.26	0.29	-0.23
Days to anthesis of first female flower	0.15	0.17	0.45	0.39	-0.57	0.15	-0.37	-0.28	0.11	0.28	0.08	0.24	-0.19	-1.22	0.32	-0.28
No. of male flowers per vine	-0.21	-0.28	-0.37	-0.27	0.82	-0.20	0.21	-0.00	-0.08	-0.23	-0.06	-0.33	0.08	1.40	-0.35	0.13
No. of female flowers per vine	-0.21	-0.26	-0.45	-0.30	0.82	-0.20	0.26	0.12	-0.11	-0.25	-0.05	-0.32	0.12	1.31	-0.32	0.16
No. of fruits per vine	-0.11	-0.08	-0.16	-0.16	0.19	-0.06	0.90	0.72	-0.23	-0.61	-0.23	-0.35	0.15	1.38	-0.38	0.97**
Weight of fruit (g)	-0.09	-0.01	-0.16	-0.12	-0.00	-0.03	0.73	0.89	-0.20	-0.57	-0.20	-0.42	0.21	1.05	-0.23	0.86**
Diameter of fruit (cm)	-0.16	-0.16	-0.21	-0.16	0.25	-0.08	0.78	0.65	-0.27	-0.65	-0.21	-0.52	0.19	1.76	-0.37	0.86**
Length of fruit (cm)	-0.13	-0.17	-0.15	-0.14	0.24	-0.06	0.71	0.65	-0.22	-0.78	-0.21	-0.51	0.14	1.79	-0.35	0.79**
Pulp thickness (mm)	-0.15	-0.14	-0.11	-0.12	0.19	-0.04	0.80	0.67	-0.21	-0.63	-0.26	-0.51	0.11	1.82	-0.45	0.96**
Rind thickness (mm)	-0.29	-0.23	-0.12	-0.08	0.23	-0.05	0.27	0.31	-0.12	-0.33	-0.11	-1.20	0.20	2.17	-0.34	0.30
No. of seeds per fruit	-0.18	-0.17	-0.30	-0.19	0.16	-0.06	0.35	0.48	-0.13	-0.28	-0.07	-0.62	0.39	1.16	-0.17	0.36
T.S.S (^{o} Brix)	-0.31	-0.32	-0.24	-0.18	0.44	-0.10	0.47	0.35	-0.18	-0.53	-0.18	-0.98	0.17	2.64	-0.49	0.57*
Acidity of fruit (%)	-0.22	-0.22	-0.25	-0.21	0.51	-0.11	0.59	0.35	-0.17	-0.48	-0.20	-0.70	0.11	2.23	-0.58	0.64**

Residual effect-1.10

total yield per vine, diameter of fruit, length of fruit and pulp thickness suggesting thereby, the increase in either of one will ensure the increase in fruit weight. It was in confirmation with the finding of Mehdi and Khan (2009) who observed significant and positive correlation for average fruit weight with fruit length in cucumber.

Path analysis revealed that among 16 traits, few traits namely, total soluble solids, number of fruits per vine, weight of fruit, number of male flowers per vine, days to anthesis of first male and female flower and number of seeds per fruit exhibited positive direct effects on total yield per vine. Vine length, number of primary branches, number of female flowers per vine, diameter of fruit, length of fruit, pulp thickness, rind thickness and acidity of fruit were found to be negative direct effect on total yield per vine but in desirable direction because negative values of these traits are beneficial and contribute positively to the yield per vine (Table 4). It was in confirmation with the finding of Saikia *et al.* (1995), Meng *et al.* (1999), Hanchinamani and Patil (2008), Kumar *et al.* (2011) in cucumber, Rao *et al.* (2000) and Karruppiah *et al.* (2005) in ridge gourd and Kumar *et al.* (2013) in sponge gourd.

Conclusion

On the basis of this study, it can be concluded that selection would be rewarding for acidity of fruit, total yield per vine, weight of fruit, number of fruits per vine and total soluble solids and diameter of fruit in bringing out the improvement in the *Valan Kakri* because Further, correlation study suggested that for improvement in yield, selection for such a plant having more number of fruits, greater weight of fruit, more length of fruit and more diameter of fruit would be beneficial. Number of fruit and weight of fruit were found to be the important characters for increasing the yield potential in *Valan Kakri.* Among the genotypes, PVK-15, PVK-8, PVK-6 and PVK-3 were found to be higher in total yield per vine, which could be gainfully utilized in further breeding/improvement programme.

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ECONOMY OF WHEAT PRODUCTION THROUGH WEED CONTROL IN RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

A field experiment was conducted at the Farm of *Krishi Vigyan Kendra, Budaun* during three consecutive *Rabi* seasons of 2008-09 to 2010-11. The experiment was conducted in Randomized Block Design with 4 weed control treatments *viz.*, Weedy check,Isoproturon (1.0 kg ha^{-1}), Sulfosulfuron (0.034 kg ha^{-1}) and Clodinofop propargyl (0.400 kg ha^{-1}) replicated five times. The soil of the experimental field was sandy loam in texture, with pH 7.8 and was low in organic carbon (0.23%) and medium in available phosphorus (34 kgP_2O_5 ha^{-1}) and low in available potassium (124kg ha^{-1}). A uniform dose 60 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied at the time of sowing and remaining 60 kg N was top dressed in two splits after first irrigation and maximum tillering stage. Wheat variety PBW 550 was sown in the second week of November during all the years using the seed rate of 100 kg ha^{-1}. All the post-emergence herbicides were applied at 30 days after sowing by flat fan nozzle hand sprayer with spray volume 500 litres of waterha^{-1}. The results showed that all herbicidal treatments significantly reduced density and dry matter weight of weeds at 90 DAS compared to unweeded control with maximum reduction by clodinofop propargyl followed by sulfosulfuron and isoproturon along with 79.01, 77.73 and 66.23 per cent weed control efficiency, respectively. Clodinofop propargyl being at par with sulfosulfuron, isoproturon produced highest and significantly more ears/m^2 (357), grain (43.21 q ha^{-1}) and straw (55.02 qha^{-1}) yields as compared to weedy control (298 ears/m^2, 37.46 and 45.56 q ha^{-1} grain and straw yields, respectively).Maximum net returns (Rs. 41744 ha^{-1}) and benefit cost ratio (3.35) was recorded with the application of clodinofop propargyl followed by sulfosulfuron (39118 and 3.24) and isoproturon (36320 and 3.15) with lowest under unweeded control (32368 and 2.84), respectively.

Key words: Clodin of oppropargyl, Isoproturon, Productivity, Profitability, Sulfosulfuron, Weed control efficiency, Weedy check, Weeds, Wheat.

Wheat belongs to family “Graminae” and genus “Triticum”. Among the food crops, wheat is one of the most important cereals of the world and it is grown extensively throughout the world. In India, itis most important winter cereal, contributing approximately 30-35 per cent to total food grain production. It occupies 29.9 million hectare area with production of 93.9 million tonnes (Economic Survey, 2012). It plays an important role in the food economy and food security system of the country. The requirement of wheat will be around 109 million tonnes for feeding the deeming 1.25 billion populations by 2020 AD (Singh, 2010). Thus, wheat production has to increase by another 15 million tonnes. There is no scope for area expansion, additional production has to come by increasing the per hectare productivity (Nagarajan, 1997).Its cultivation is economical and it gives good yields of grain with excellent storage

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properties. It contains 11-13% protein and is a staple food in India. India's per capita production is 67kg against per capita consumption of 73kg, which is also on upswing. The productivity of wheat is 31.40 quintal per hectare in the year 2011-12 which is low as compared to many countries and there is need to increase the productivity to feed the growing population.

There are several constraints for low productivity of wheat in India, out of these, weeds have been recognized as an important one.Weeds are some of the major concerns inthe rice–wheat system and these factors cause significantannual regional productivity losses in wheat (Harrington *etal.*, 1992). Monocot weeds especially little seedcanary grass is highlycompetitive weeds and can cause drastic yield reductionunder heavy infestation. The yield reduction by weeds inwheat may be up to 80% depending upon weed type,density, timing of emergence, wheat density, wheat cultivarand soil and environmental factors (Chhokar and Malik, 2002). Besides reduction in yield andquality of wheat, heavy little seedcanary grass populations thus causing crop lodging.

Wheat is generally infested by both grassy as well asbroad-leaved weeds, but in this region grassy weeds like*Phalaris minor Retz.*, (little seed can arygrass, Gullidanda, Mandusi, Bandriya, Gaihonka mama); *Avenafatua*L. (Jangli Jai); *Cynodondactylon*L. *Pers*. (Doob grass, Chibhar) are predominant weeds. Among broadleaf weeds *Convolvulus arvensis*L. (Hirankhuri); *Cirsium arvense* (L.) *Scop.; Chenopodium album* L. (Bathuwa, Bathu, Jhil); *Argemone maxicana* (Satyanasi, Katili); *Amaranthus viridis* L.(Chaulai, Mariro); *Chenopodiummurale* L. (Khartuwa, Kurand, Janglibathwa); *Melilotus alba* (Sanjani) weeds are common in this region.

Therefore, the control of weeds from the cropfields is essential for obtaining maximum returns.The various methods for control of weeds include mechanical, cultural, chemical and biological methods. Out of these methods chemical weed control method is chief and easy for weed control in wheat in Indian conditions. Chemical method of weed control includes use of suitable chemicals called herbicides to kill the weeds without adversely affecting the crop. Chemical weed control is a preferred practice inwheat due to scarce and costly labour as well as lesserfeasibility of manual weeding in broadcast sown wheat.

Several reports had found that *Phalaris minor* isnot control effectively with is oproturon in northern Indian plains (Chhokar and Malik, 2002), therefore two other herbicides namely sulfosulfuron and clodinaf oppropargyl have been foundeffective (Chhokar *et al.* 2008). Among these, clodinafop only control the grassweeds but sulfosulfuron controls many broad-leavedweeds also (Chhokar and Malik 2002; Chhokar *et al.*, 2006). For sustaining wheat productivity, its control is essential.

Keeping these facts into consideration the present investigation entitled "Effect of herbicidal weed management practices on weeds, wheat productivity and profitability in rice-wheat cropping system in Mid Western Plain Zone of Uttar Pradesh" was proposed.

Materials and Methods

The field experiments were conducted at the Farm of *Krishi Vigyan Kendra, Budaun* (Sardar Vallabhbhai Patel University of Agricultural & Technology, Meerut) during three consecutive *Rabi* seasons of 2008-09 to 2010-11. The experiment was conducted in Randomized Block Design with 4 weed control treatments *viz.*,weedy check (unweeded control),isoproturon (1.0 kg ha^{-1}), sulfosulfuron (0.034 kg ha^{-1}) and clodinofop propargyl (0.400 kg ha^{-1}) replicated five times.

The soil of the experimental field was sandy loam in texture, with slightly alkaline in reaction (pH 7.8) and was low in organic carbon (0.23%) and medium in available phosphorus (34 kgP_2O_5 ha^{-1}) and low in available potassium (124kg ha^{-1}). A uniform dose 60 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied at the time of sowing and remaining 60 kg N was top dressed in two splits after first irrigation and maximum tillering stage. Wheat variety PBW 550 was sown in the second week of November during all the years using the seed rate of 100 kg ha^{-1}. The preceding crop was paddy in all the years of investigation and in this region the rice-wheat is the pre-dominant cropping system. All the post-emergence herbicides were applied at 30 days after sowing. The quantity of spray volume was calculated by test run and the herbicides were applied with flat fan nozzle hand sprayer. Herbicide spray volume was 500 litres water ha^{-1}. The crop was irrigated six times at 20, 40, 60, 80, 100 and 120 days after sowing during all the years.

Data on density and dry matter weight were recorded at 90 days after sowing (DAS) from each plot in two quadrates, each of 1 x 1m area. Weeds were counted as monocots and dicots and then removed them for obtaining their dry weight. Weed samples were first sun dried and then over dried until constant weight obtained. Data on weed density were subjected to square root transformation $\sqrt{X+0.5}$to normalize their distribution before statistical analysis. Weed control efficiency was calculated with the formula suggested by as Kumar *et al.* (2012). Crop was harvested manually in third week of April during all the years of investigation. Data on yield attributes and yield were recorded using standard techniques and subjected for statistical analysis.

Results and Discussion

Effect on weeds

Among the total weed flora as observed from the unweeded control plots consisted of72.25 and 27.75 per cent monocot and dicot weeds, respectively. Data (Table 1) showed that all the herbicidal treatments significantly reduced density and dry matter of weeds compared to unweeded control. Maximum reduction in density and dry matter of total weeds was recorded with the spray of clodinofop propargyl followed by sulfosulfuron and isoproturon in all the years of experimentation. Application of clodinofop propargyl being at par with sulfosulfuron but significantly reduced the density and dry matter of monocot weeds at 90 DAS of crop as compares to unweeded control and isoproturon, unable to reduce the density and dry matter of dicot weeds up to significant level. However, clodinofop significantly reduced the density ($6.85/m^2$) and dry matter ($28.53g/m^2$) of total weeds as compared to unweeded control ($13.24/m^2$ and $135.9g/m^2$, respectively).Further,

Table 1. Effect of different herbicidal weed management practices on density and dry matter of weeds, weed control efficiency, weed index and herbicide efficiency index in wheat at 90 DAS (Average of 03 years)

Treatment	Dose (kg/ha)	Weed density (No./m²)			Dry weight of weeds (g/m²)			Weed control efficiency (%)
		Monocots	Dicots	Total	Monocots	Dicots	Total	
Unweeded check	-	11.26 (126.3)	7.00 (48.5)	13.24 (174.8)	103.30	32.60	135.90	-
Isoproturon	1.000	5.85 (33.7)	5.63 (31.2)	8.09 (64.9)	26.50	19.40	45.90	66.23
Sulfosulfuron	0.034	4.66 (21.2)	5.17 (26.2)	6.92 (47.4)	12.97	17.30	30.27	77.73
Clodinofop propargyl	0.400	1.84 (2.9)	6.63 (43.5)	6.85 (46.4)	2.13	26.45	28.53	79.01
CD (P=0.05)	-	2.96	1.81	2.32	14.07	8.98	16.39	

*Figures in parentheses are original values, Data were square root transformed before analysis through = $\sqrt{X+0.5}$

sulfosulfuron spray also reduced significantly the density and dry matter of all categories of weeds at 90 DAS as compares to unweeded control. Similarly, isoproturon also reduced the density and dry matter of weeds at 90 DAS as compares to unweeded control except density of dicot weeds. The average weed control efficiency (WCE) was 79.01, 77.73 and 66.23 per cent with the application of clodinofop propargyl, sulfosulfuron and isoproturon, respectively. This was mainly due to effective control of weeds during early growth stage of the crop especially monocot weeds, although dicot weeds also controlled by sulfosulfuron and isoproturon. These results are in conformity of Chhokar*et al.* (2007), Kumar and Jat(2008) and Raman Jeet Singh (2012) and Bharat *et al.* (2012)

Effect on wheat yield attributes

The results (Table 2) showed that the yield attributes of wheat were significantly influenced due to application of different herbicides viz, clodinofoppropargyl, sulfosulfuron and isoproturon as compared to unweeded control. All the herbicides produced significantly higher number of effective ears/m² as compared to unweeded control, however all the herbicides remained at par with each other. Though higher values of grains/ear and 1000 grain weight were also recorded with the application of herbicides but could not reach up to significant level over unweeded control. Maximum values of yield attributes i.e. effective ears/m² (357), grains/ear (42.84) and 1000 grain weight (44.86g) were recorded with the application of clodinofop propargyl followed by sulfosulfuron and isoproturon with minimum in unweeded plotsduring all the years of experimentation. This is due to minimum crop weed competition with these herbicidal treatments enabled the crop plant to make maximum use of available dry matter for the formation and development of yield attributes. These

Table 2. Effect of different herbicidal weed management practices on yield attributes, yield and economics of wheat Average of 03 years)

Treatment	Dose (kg/ha)	Effective Ears/m^2	Grains/ ear	1000 grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Net return (Rs ha^{-1})	B:C Ratio
Unweeded check	-	298	40.20	41.96	37.46	45.56	32368	2.84
Isoproturon	1.000	332	41.60	43.61	40.98	51.25	36320	3.15
Sulfosulfuron	0.034	349	42.03	44.27	42.84	53.67	39118	3.24
Clodinofop propargyl	0.400	357	42.84	44.86	43.21	55.02	41744	3.35
CD (P=0.05)	-	26.2	NS	NS	2.97	3.89	-	-

facts are consistent with the findings of Kumar and Jat(2008), Punia and Yadav (2009).

Effect on wheat productivity

The data in the Table 2 indicatedthat grain and straw yields of wheat were influenced significantlydue to application of different herbicides. Application of clodinofop propargyl being at par with sulfosulfuron and isoproturon but produced maximum and significantly higher grain (43.21 q ha^{-1}) and straw (55.02 qha^{-1}) yields as compared to unweeded control (37.46 and 45.56 q ha^{-1} grain and straw yields, respectively). Further, sulfosulfuron and isoproturon also produced significantly higher grain (42.84 and 40.98 q ha^{-1}) and straw (53.67 and 51.25 qha^{-1}) yields as compared to weedy control. The increment in yield is mainly due to better control of weeds under the herbicidal weed control treatments which provided better environment for growth and development of the crop and ultimately resulted in improved yield of the crop. Similar findings were also reported by Chhokar*et al.* (2007), Kumar and Jat (2008) and Bharat *et al.* (2012).

Effect on wheat profitability

The data (Table 2) showed that application of herbicides resulted in marked economic advantage over unweeded control. Maximum net returns (Rs. 41744 ha^{-1}) and benefit cost ratio (3.35) was recorded with the application of clodinofop propargyl followed by sulfosulfuron (39118 and 3.24) and isoproturon (36320 and 3.15) with lowest under unweeded control (32368 and 2.84), respectively. The higher and equal benefit cost ratios under herbicidal weed management was owing to more grain yield. These results are in conformity with the study of Kumar and Jat(2008).

On the basis of three years study it can be concluded that weed control by new herbicides is the easy and economical method of weed control in the early growth stage of wheat for crop growth and development of crop resulted in higher productive and profitability.

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