Vol. 46 No. 2, July 2022

ISSN 0378-813 X

PKV RESEARCH JOURNAL

Trombay Akola Suruchi

PDKV Lathyrus Dal Mill Plant

Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH

(AGRICULTURAL UNIVERSITY)

AKOLA (Maharashtra), INDIA

www.pdkv.ac.in

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA

PKV RESEARCH JOURNAL (ISSN 0378-813X)

---

1. PKV Research Journal is published twice a year in January and July by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.
2. The contribution of paper is open only to active members and subscribers.
3. Annual membership of Journal subscription (with effect from 1-4-2015)

i) Active member	Rs. 500/- per annum
ii) Students	Rs. 300/- per annum
iii) Libraries/Institutes	Rs. 500/- per annum
iv) Other subscribers	Rs. 1000/- per annum (for overseas)
v) Life members/Donors	Rs. 3000/- (Rs. 5000/- for overseas)
vi) Patrons	Rs. 5000/-
vii) Sustaining Associates	Rs. 10,000/-

4. A limited space will be provided for the advertisement pertaining to various branches of Agriculture and Veterinary Science.
5. **Correspondence :** All correspondence regarding subscription and business matter may please be addressed to the Secretary, PKV Research Journal, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Krishi Nagar, Akola - 444 104 Maharashtra State (India).
Email : editor.pkvrj@gmail.com

This publication is included in the abstracting and indexing coverage of Biosciences Information Service of Biological Abstracts and Field Crop Abstracts.

INDEX

Vol. 46 **No. 2** **July, 2022**

SHORT NOTES

PKV Res. J. Vol. 46(2), July, 2022

Quality of Soybean as Influenced by Integrated Nutrient Management System

P. N. Chirde[1], A. N. Paslawar [2], Nilima K. Darekar [3], V. M. Bhale[4], P. V. Shingrup[5], M. R. Deshmukh[6] and K. J. Kubade[7]

ABSTRACT

The experiment was carried out at Agronomy Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* and *rabi* season of 2016-17 and 2017- 18. The study on soybean quality parameters revealed that significantly highest protein content in soybean seed was recorded by application of RDF (30:75:30 NPK kg ha^{-1}) (37.34 and 37.03%), 50% RDN + 50% RDN through vermicompost (36.00 and 35.69%) and 50% RDN + 50% RDN through compost (35.75 and 35.56%) being at par with one another during individual years. Oil yield of soybean crop influenced significantly due to INM treatments but the oil content in seed of soybean crop did not differ significantly.

Soybean (*Glycine max*. L.) is one of the important oilseed as well as leguminous crop. Soybean is considered as a miracle "Golden bean" of the 21^{st} century mainly due to its high protein (40%) and oil (20%) content. In India, it is mainly grown as 'oilseed crop'. Soybean is also called as 'Gold of soil' for its various qualities such as ease in cultivation, less requirement of fertilizer and labour etc. It builds up the soil fertility by fixing atmospheric nitrogen through nodules. Symbiotically soybean fixes 125-150 kg N ha^{-1} and leaves behind at about 30-40 kg N ha^{-1} for succeeding crop. All these qualities have made it an ideal alternative for crop rotation.

It is gaining importance in India and also in other developing countries for removing malnutrition. Due to its high nutritive value, soybean cultivation has taken great strides during recent years. It contains more essential amino acid and lysine (6.4 %) which is limiting factor in cereals. In addition, soybean is the cheapest source of vegetable protein equivalent to meat, milk product and egg protein. Soybean is unique crop in nutritional value because it contains complete protein, carbohydrates, fats, vitamins and folic acid as well as minerals including calcium and iron required for good nutrition. Soybean occupies an intermediate position between legumes and oilseeds. Indian diets are mostly deficient in protein and calories. Soybean has the tremendous potential to combat the problem of malnutrition in India. Soybean is viewed by most of the agricultural scientists and experts as a weapon to fight against world hunger and protein starvation.

The area covered under soybean in India was 10.32 million ha which produced 10.93 million tonnes with productivity of 1058 kg ha^{-1}, whereas in Maharashtra, the area under cultivation was 3.69 million ha which produced 3.80 million tonnes of soybean grains with productivity of 1030 kg ha^{-1} (Anonymous, 2018).

However, continuous use of chemical fertilizers led to crop yield stagnation and resulted in imbalance of nutrients in the soil which have adverse effects on soil health. Use of organic manures alone or in combination with chemical fertilizers will help to improve physico-chemical properties of the soils, efficient utilization of applied fertilizers for improving seed yield and seed quality. Like other leguminous crops, requirement of nitrogen is subsequently fulfilled from symbiotic nitrogen fixation through Rhizobium. Sharma and Dixit (1987) reported that application of N in general, caused significant increase in growth and uptake of N P K Ca and Mg, protein and oil yield were by the combined use of fertilizer and FYM. Improved soil fertility and yield obtained due to integration of organic manure and fertilizers than fertilizer alone. Balanced supply of nitrogenous fertilizers not only enhances nodulation but also increases produce quality.

MATERIAL AND METHODS

The experiment was carried out in the plot No. 66 at Agronomy Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* and *rabi* season of 2016-17 and 2017- 18. The soil of the experimental plot was clayey in texture dominated by smectite clay minerals which belongs to hyperthermic family of Typic Haplustert having swell shrink property. It was slightly alkaline in reaction (pH 8.6), low in organic

1 and 3. Ph.D. Scholar, 2. Chief Scientist (Agronomy), 4. Former Vice Chancellor, 5. SRA, 6. Assistant Professor and 7. Associate Professor, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

carbon (0.52%), available nitrogen (216.50 kg ha^{-1}), available phosphorus (16.86 kg ha^{-1}) and high in available potassium (367.22 kg ha^{-1}). The treatments consisted of integrated nutrient management viz., S1 - RDF (30:75:30) NPK kg ha^{-1}, S2 - 50 % RDN + 50 % RDN through vermicompost, S3 - 50 % RDN + 50 % RDN through FYM, S4 - 50 % RDN + 50 % RDN through compost and S5 - 50 % RDN + 50 % RDN through soybean straw + *Trichoderma viride* @ 1kg ha^{-1} to soybean in *kharif* season as main plot treatments replicated four times in randomized block design. After harvest of produce protein content and oil content of soybean analysed.

RESULTS AND DISCUSSION

During 2016 and 2017, the data pertaining to oil content did not show significant differences among treatments are presented in Table 1. Halvankar *et al.* (1999) also reported that the oil content in soybean was not altered due to fertility levels. Numerically maximum oil content in seed was observed with treatment application of RDF (S_1) (19.88 and 19.40 %) while treatment 50 per cent RDN + 50 per cent RDN through soybean straw + *T. viride* (S_5) (18.75 and 16.95 %) recorded minimum oil content during both the years of investigation. But oil yield was significantly influenced by various treatments due to significant differences among treatments in respect of seed yield. During individual years, application of chemical fertilizer RDF (30:75:30 NPK kg ha^{-1}) (S_1) recorded maximum oil yield (422.29 and 408.18 kg ha^{-1}) as compared to remaining treatments and it was observed statistically on par with treatment 50 per cent RDN + 50 per cent RDN through vermicompost (S_2) (400.65 and 389.45 kg ha^{-1}), however, in second year, the same best treatment RDF (30:75:30 NPK kg ha^{-1}) (S_1) also found statistically identical with treatment 50 per cent RDN + 50 per cent RDN through compost (S_4) (353.61 kgha^{-1}). During both the years, among the different integrated nitrogen management treatments, the treatment of 50 per cent RDN + 50 per cent RDN through vermicompost (S-$_2$) recorded maximum oil yield and remained statistically at par with treatment of application of 50 per cent RDN + 50 per cent RDN through compost (371.66 and 353.61 kg ha^{-1}, respectively). However, in second year, the treatment 50 per cent RDN + 50 per cent RDN through compost (S_4) recorded statistically similar oil yield as that of 50 per cent RDN + 50 per cent RDN through FYM (302.28 kg ha^{-1}). The lowest oil yield (303.05 and 294.13 kg ha^{-1}) was noticed with treatment 50 per cent RDN + 50 per cent RDN through soybean straw + *T. viride* (S_5), however, this treatment was found at par with that of 50 per cent RDN + 50 per cent RDN through FYM (S_3) during both the years. Increases in oil content and oil yield might be attributed to balanced nutrition and supply of organic and inorganic nutrients seems to be involved in an increased conversion of primary fatty acid metabolites to end products of fatty acid which increased the oil content in seeds and resulted in higher oil yield. Similar results were reported by Kumavat *et al.* (2000), Joshi (2003) and Kolpe and Bodake (2017).

(From Table 2) The data on protein content and protein yield of soybean seed as affected by different treatments. During 2016 and 2017, mean protein content in soybean seed was 35.64 and 35.39 per cent and protein yield was 673.21 and 662.92 kg ha^{-1}, respectively. The data pertaining to protein content showed significant differences among treatments. During both years,

Table 1: Oil content and oil yield of soybean as influenced by different treatments during 2016 and 2017

Treatments	2016		2017	
	Oil content (%)	Oil yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
S_1 - RDF (30:75:30 NPK kg ha^{-1})	19.88	422.29	19.40	408.18
S_2 - 50%NU+50%NVC	19.50	400.65	19.08	389.45
S_3 - 50%NU+50%NFYM	18.75	320.65	17.80	302.28
S_4 - 50%NU+50%NCOM	19.50	371.66	18.60	353.61
S_5 - 50%NU+50%NSSt	18.75	303.05	16.95	272.46
SE(m)$\pm$	0.41	12.21	0.59	17.79
CD at 5 %	-	37.61	-	54.81
GM	19.28	363.66	18.37	345.20

Table 2: Protein content and protein yield of soybean as influenced by different treatments during 2016 and 2017

Treatments	2016		2017	
	Protein content (%)	Protein yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
S_1 - RDF (30:75:30 NPK kg ha^{-1})	37.34	792.76	37.03	777.44
S_2 - 50%NU+50%NVC	36.00	741.83	35.69	729.09
S_3 - 50%NU+50%NFYM	35.25	602.89	35.13	595.81
S_4 - 50%NU+50%NCOM	35.75	680.47	35.56	674.43
S_5 - 50%NU+50%NSSt	33.88	548.11	33.56	537.85
SE(m)$\pm$	0.61	23.63	0.50	17.59
CD at 5 %	1.89	72.82	1.54	54.19
GM	35.64	673.21	35.39	662.92

maximum value of protein content in seed was observed with treatment of application of RDF (30:75:30 NPK kg ha^{-1}) (S_1) (37.34 and 37.03 %) and being statistically comparable with 50 per cent RDN + 50 per cent RDN through vermicompost (S_2) (36.00 and 35.69 %) and 50 per cent RDN + 50 % RDN through compost (S_4) (35.75 and 35.56 %). However, treatment 50 per cent RDN + 50 per cent N through soybean straw + *T. viride* (S_5) (33.88 and 33.56 %) recorded minimum value of protein content and remained statistically on par with 50 per cent RDN + 50 per cent N through FYM (S_3) (35.25 and 35.13 %). Protein yield was significantly influenced by various treatments due to significant differences among treatments in respect of seed yield. During both the years of investigation, the treatment where nutrients were supplied directly in the available form (i.e. S_1- chemical fertilizers at treatment RDF alone), recorded significantly higher protein yield (792.76 and 777.44 kg ha^{-1} respectively) as compared to remaining treatments, being statistically on par with 50 per cent RDN + 50 per cent RDN through vermicompost (S_2) (741.83 and 729.09 kg ha^{-1}). Among the organic and inorganic nitrogen substitution treatments, 50 per cent RDN + 50 per cent RDN through vermicompost (S_2) recorded maximum protein yield While in first year it was found comparable with treatment 50 per cent RDN + 50 per cent RDN through compost (S_5) (680.47 kg ha^{-1}) but during second year this treatment i.e. (S_2) was found superior over rest of the nitrogen substitution treatments. During both individual years, minimum protein yields (548.11 and 537.85 kg ha^{-1}) were noticed with treatment 50 per cent RDN + 50 per cent N through soybean straw + *T. viride* (S_5), however, this treatment was found at par with that of 50 per cent RDN + 50 per cent RDN through FYM (S_3) (602.89 and 595.81 kg ha^{-1}). Nitrogen is a basic constituent of protein and with the increase in rate of nitrogen application from organic manures and inorganic fertilizers, the nitrogen availability increased which resulted in enhanced protein content in seeds and protein yield. Similar results were reported by Kumavat *et al.* (2000), Joshi (2003) and Kolpe and Bodake (2017).

LITERATURE CITED

Anonymous, 2018. Ministry of Agriculture and Farmers Welfare, Govt. of India.

Halvankar, G. B., S. P. Taware and V. M. Raut. 1999. Response of some soybean (*Glycine max*) varieties to different fertility levels, Indian J. Agron., 44(3): 605-608.

Joshi, M. N. 2003. Effect of varying levels of irrigation, phosphorus and biofertilizers on summer soybean (*Glycine max*) under South Gujarat condition. M.Sc (Agri.) Thesis (Unpub.), submitted to G.A.U., S.K. Nagar.

Kolpe, B. A. and P. S. Bodake, 2017. Quality, Yield and Economics of Summer Soybean as Influenced by Interaction Effect of Integrated Nutrient Management and Potassium Levels, International J. Applied Res. Technol. 2(2): 153-156.

Kumavat, S. M., L. L. Dhakar and P. L. Maliwal, 2000. Effect of irrigation regime and nitrogen on yield, oil content and nutrient uptake of soybean, Indian J. Agron., 43 (2): 361-366.

Sharma, R. A. and B. K. Dixit, 1987. Effect of nutrient application on rainfed soybean, J. Indian Soc. Soil Sci. 35: 452-55.

* * *

Received on 22 August, 2022 - Accepted on 5 October, 2022

Study of Biomass production Through Legume Green Manuring Crops

V. R. Najan[1], P. U. Raundal[2] and M. J. Mohite[3]

ABSTRACT

An experiment was carried out at Agronomy Farm,Divisionof Agronomy,CollegeofAgriculture, Pune during *kharif,* 2021 with eight treatments replicated four times inRandomized Block Design. Eight treatments were dhaincha, sunhemp, greengram, blackgram, cowpea, french bean, soybean were green manuring crops and control. The fresh biomass, dry matter, fresh weight of roots, dry weight of roots, nodule count, days to 50 per cent flowering found highest in dhaincha which were 40.98 t ha^{-1}, 5.73 t ha^{-1}, 0.48 t ha^{-1}, 0.17 t ha^{-1} and 128.25 $plant^{-1}$respectively. French bean (42.50 days) showed lowest number of days to 50 per cent flowering. Plant analysis in which total nitrogen, total potassium and total carbon, at 50 per cent flowering were found maximum in dhaincha (3.90, 2.10, 57.69 %, respectively). Whereas total phosphorous was found higher in soybean (0.66 %). C:N ratio found minimum in dhaincha (14.63).

Green manure is a component of organic farming. When a plant is still green or just before it starts to blossom, it is ploughed under or covered with earth to enrich the soil.The presence of organic matter in the soil contributes to the beneficial effects of green manures. One of the most crucial components of soil is organic matter, which is known for its actual soil fertility (Najan *et.al.,*2021). The availability of nutrients in the soil is impacted by the breakdown of this organic waste. Crops produced for green manure are categorised as such. For many years, our farmers have been using green manuring. Green manure that is 40–50 days old and up to 80–100 kg may be provided. While half of this N can be used, the crop can cover 50-60 kg of green manure. N ha^{-1} fertiliser (Sharma *et al.*, 1995).

Sannhemp, dhaincha, cowpea, mung, bean, guar, berseem, and other potential green manures include these. During the kharif season, 8–21 tonnes of green and 42–95 kilogrammes of the green manure crops were documented for the cultivation of dhaincha, sannhemp, mung bean, and guar. Similar to the previous season, the rabi can bring with it 12-29 tonnes of green and 67-68 kg N/ha in the form of cow sari, cowpeas, and berseem. (Mishra and Nayak, 2004).

In India, green manuring was widely practised, but in recent years, interest in it has declined due to increased pressure on food production, the presence of various competitive and profitable crops, and the accessibility of both cheap and expensive chemical fertilisers. Green manures have recently regained importance for both organic growers and low-input farms using conventional agronomic methods due to access in soil issues, depletion of soil fertility, and public concern about abuse and energy conservation. (Kumar *et al*. 2014).

MATERIAL AND METHODS

A field experiment was laid out in randomized block design with four replications and eight treatments of green manuring *viz*., *Sesbania rostrata, Crotalaria juncea, Vigna radiata, Vigna mungo, Vigna unguiculata, Phaseolus vulgaris, Glycine max* with control in combinations in *kharif,* 2021. The soil of experimental plot was very low in available nitrogen (100.34 kg ha^{-1}), moderately high in available phosphorous (21.12 kg ha^{-1}) and high in available potassium (335.61 kg ha^{-1}).The gross plot size was 3.60 m × 4.00 m and net plot size was 2.70m × 3.40 m. The experimental plot was not fertilized. The seeds of different crops were sown with 22.5 cm line sowing on final land preparation following recommended seed rate of all the above crops.

Growth study

The observations of one square meter area of the respected block were taken at the time of incorporation.

Fresh biomass

The fresh biomass of one square meter area of

1. P.G. Student 2. Associate Professor, College of Agriculture, Pune (M.S.) and 3. Junior Research Assistant, Regional Sugarcane and Jaggery Research Station, Kolhapur (MPKV Rahuri).

the block was calculated by uprooting the plants and weighing on the weighing balance.

Dry matter accumulation

To determine dry matter of the plants one representative sample from each block was uprooted and observations were recorded after 2-4 days of air drying. After air dry keep it for oven dry at 60±°C until constant weight obtain. After weighing the material, the dry matter of plant was recorded.

Fresh weight of roots

Fresh weight of roots was determined by uprooting the plants and cutting of the roots of respected plot. After weighing the roots, fresh weight can be determined.

Dry weight of roots

Dry of roots can be determined by the air drying of the roots of sample for 2-4 days and oven dry at 60±°C till constant weight obtained. After weighing the roots, dry weight was recorded.

Days to 50 per cent flowering

The number of days to 50 per cent flowering was recorded by observing all plants of the net plot.

Nodule count

Nodule count per plant was calculated by counting the nodules of the respected plant.

Plant analysis

The observational plants collected from each treatment plot at harvesting, used for chemical analysis. The dried samples of plant were ground and were passed through Willey mill (20 mesh) and about 20 g of representative samples from each powdered material was stored in plastic bag, suitably labelled and used for estimation of nitrogen, phosphorous, potassium and micronutrients *viz*., Fe, Zn, Mn and Cu separately. The methods utilized are given in table below.

Methods used for analysis of NPK from biological material

S.N.	Parameter	Method Used	Reference
1.	Total N (%)	Micro-Kjeldahl method	Bremner & Mulvaney (1982)
2.	Total P (%)	Vanado molybdate yellow colour in nitric acid system	Jackson (1973)
3.	Total K (%)	Flame photometer (H_2SO_4:H_2O_2 extractant)	Chapman and Pratt (1961)
4.	Total carbon (%)	Ignition method	Chopra and kanwar (1980)

RESULTS AND DISCUSSION

Fresh Biomass (t ha^{-1})

Data in respect of fresh biomass of various green manuring crops are presented in table1. The fresh biomass was influenced significantly by various green manure crops. The fresh biomass was maximum in dhaincha (40.98 t ha^{-1}) which was at par with sannhemp (40.40 t ha^{-1}) and significantly superior over rest of the green manuring crops. The second best green manuring crop in respect fresh biomass was sannhemp which was also significantly superior over rest of the crops except dhaincha.

The genetic composition of each species may vary the fresh biomass yield, which is significant in plants with more branches, greater plant heights, and dense vegetation. Highest biomass yield may result from quick and determined growth patterns. Similar findings were also reported by Irin *et al*. (2019) and Pagare (2020).

Dry Biomass (t ha^{-1})

Data in respect of dry biomass of various green manuring crops are presented in table 1. The dry biomass was influenced significantly due to various green manure crops. Maximum dry biomass in dhaincha (5.73 t ha^{-1}) crop which was at par with sannhemp (4.72 t ha^{-1}) and significantly superior over rest of the green manuring crops. The second best green manuring crop in respect dry biomass was sannhemp which was also significantly superior over rest of green manuring crops except dhaincha.

The number of leaves produced by a genotype and the height of the plant may affect biomass production. When compared to other green manuring crops, it seemed that *Sesbania* species, *Crotalaria juncea*, produced greater biomass. Similar findings were also observed by Pooniya *et al*. (2012) and Irin *et al*. (2019).

Fresh and dry weight of roots (t ha^{-1})

Data in respect of mean fresh weight of roots of various green manuring crops are presented in table1. The fresh weight of roots was influenced by various legume green manuring crops. Maximum fresh weight of roots observed in dhaincha (0.48 t ha^{-1}) which was at par with sannhemp (0.43 t ha^{-1}) and soybean (0.42 t ha^{-1}) and significantly superior over rest of the green manuring crops. The second best green manuring crop in respect with fresh weight of roots is sannhemp which was also significantly superior over rest of crops except dhaincha and soybean.Fresh weight of roots might be depending on inherent genetic potential of green manuring crops. Comparable results were observed by Naidu *et al*. (2021).

Data in respect of mean dry weight of roots of various green manuring crops are presented in table1. The dry weight of roots was influenced significantly by various green manure crops. The dry weight of roots was maximum in dhaincha (0.17 t ha^{-1}) crop which was at par with sannhemp (0.16 t ha^{-1}) and significantly superior over the rest of the green manuring crops. Similar results were observed by Naidu *et al*. (2021).

Nodule count (plant^{-1})

Data in respect of nodule counts of various green manuring crops are presented in table 1. The nodule count was influenced significantly by various green manure crops. The nodule count was maximum in dhaincha (128.25 plant^{-1}) crop and significantly superior over the rest of the green manuring crops. The second best green manuring crop in respect nodule count was sannhemp which was also significantly superior over rest of the crops except dhaincha and followed by soybean (40.50 plant^{-1}) and cowpea (39.75 plant^{-1}).

It's possible that variations in the number of nodules per plant are caused by the unique genetic traits of the legume green manure crops, which also contribute to soil fertility improvement through nitrogen fixation. The West African plant Dhaincha, *Sesbania rostrata*, generates nitrogen-fixing nodules on both the stem and the roots. Only one species of *Sesbania*, *Sesbania rostrata*, can develop nodules on stems. The results were almost similar to the findings of Naidu *et al*. (2021) who found the highest number of nodules per plant from *C. juncea* and *S. rostrata*.

Days to 50 per cent flowering

Data in respect to days to 50 per cent flowering are presented in table 1. Days to 50 per cent flowering was influenced significantly by rest of the green manuring treatments. Lower number of days required to 50 per cent flowering in french bean (42.50 days) which was followed by blackgram (44.00). higher number of days required to 50 per cent flowering in dhaincha 57.25 days which was followed by sannhemp (55 days). The ideal time to incorporate legume green manuring crops are at 50 per cent flowering since it produces the most green matter and is the most succulent stage. The results were almost close to the findings of Alam *et al*. (2022).

Plant Analysis

Data in respect of the total N, P , K ,C, C:N and C: P ratio of various green manuring crops are presented in table 2.

Total Nitrogen

The total nitrogen was influenced significantly by various green manure crops. The total nitrogen was maximum in dhaincha (3.90 %) and significantly superior over the rest of the green manuring crops. The second best green manuring crop with respect to total nitrogen was sannhemp (2.95%) which was also significantly superior over the rest of the crops except dhaincha and followed by greengram (2.88 %) and soybean (2.85%).

The stem nodulation of green manure crops may cause a difference in total nitrogen, contributing to increased soil fertility by nitrogen fixation. The West African plant Dhaincha, *Sesbania rostrata*, generates nitrogen-fixing nodules on both the stem and the roots. Only one species of *Sesbania*, *Sesbania rostrata*, can develop nodules on stems. The results were close in agreement with to the findings of Hundal and Biswas (1987), Mansoer *et al.* (1997), and Vijaykumar *et al.* (2021).

Total Phosphorous

The total phosphorous of various green manuring was 0.32 per cent. The total phosphorous was influenced significantly by various green manure crops. The total phosphorous was maximum in the soybean (0.44 %) crop and significantly superior over the rest of the green manuring crops. Soybean is at par with dhaincha (0.43%) and sannhemp (0.42%). The second-best green manuring crop with respect to total phosphorous was dhaincha (0.43%). The results in close confirmation of these findings were also reported by Mansoer *et al.* (1997) and Vijaykumar *et al.* (2021).

Total Potassium

The total potassium was influenced significantly by various green manure crops. Total potassium was

Table 1. Fresh biomass, dry biomass, fresh and dry weight of roots, nodule count and days to 50 % flowering as influenced by different treatments

Tr. No.	Treatment	Fresh biomass (t ha^{-1})	Dry biomass (t ha^{-1})	Fresh weight of root (t ha^{-1})	Dry weight of roots(t ha^{-1})	Nodule count ($plant^{-1}$)	Days to 50% flowering (days)
T_1	Dhaincha	40.98	5.73	0.48	0.17	128.25	57.25
T_2	Sannhemp	40.40	4.72	0.43	0.16	42.75	55.00
T_3	Greengram	20.74	2.28	0.38	0.08	23.75	45.25
T_4	Blackgram	21.48	2.04	0.32	0.10	23.75	44.00
T_5	Cowpea	23.73	2.46	0.27	0.08	39.75	45.50
T_6	French bean	20.50	1.69	0.17	0.04	20.50	42.50
T_7	Soybean	31.63	2.64	0.42	0.15	40.50	47.25
	S. Em ±	0.67	0.48	0.02	0.01	0.89	0.56
	C.D.at 5%	2.01	1.46	0.076	0.03	2.69	1.66
	General mean	28.49	3.08	0.35	0.10	45.60	48.10

Table 2. Nutrient content (N, P, K), total carbon, C:N ratio, C:P ratio in plant as influenced by different treatments

Tr. No.	Treatments	Major nutrients (%)			Total C(%)	C:N ratio	C:P ratio
		N	P	K			
T_1	Dhaincha	3.90	0.43	2.10	57.69	14.63	135.47
T_2	Sannhemp	2.95	0.42	1.79	50.93	17.44	122.87
T_3	Greengram	2.88	0.40	1.92	44.91	15.60	115.21
T_4	Blackgram	2.83	0.32	1.39	52.70	18.66	165.28
T_5	Cowpea	2.03	0.32	1.45	50.50	24.91	159.47
T_6	French bean	2.09	0.27	1.34	42.55	22.68	173.85
T_7	Soybean	2.85	0.44	1.69	53.65	18.84	122.26
	S.E. m±	0.06	0.01	0.03	1.33	0.62	5.66
	C.D. at 5%	0.20	0.03	0.09	3.95	1.82	16.65
	General mean	2.44	0.325	1.45	44.11	16.59	124.30

maximum in dhaincha (2.10%). The second best green manuring crop with respect to total potassium was greengram (1.92%), which was also significantly superior to the rest of the crops except dhaincha. This was also supported by the findings reported by Dubey *et al*. (2015), Mansoer *et al*. (1997), and Vijaykumar *et al*. (2021).

Total Carbon

The mean total carbon of various green manuring crops at 50 per cent flowering was 44.11 per cent. Various green manuring crops influenced the total carbon. Maximum total carbon observed in dhaincha (57.69 %) followed by soybean (53.65%) and which was at par with blackgram (52.70 %), sannhemp (50.93 %), cowpea (50.50 %) and significantly superior over rest of the green manuring crops. The above findings are in close agreement with Mansoer *et al.* (1997).

C: N ratio

A significantly lower ratio was recorded in dhaincha (14.63), followed by greengram (15.60) and dhaincha (17.44). Legume residues with such a lower C: N ratio (below 20) are more likely to break down quickly, which in turn causes quick C and N mineralization and the opposite. Because green manuring crops contained less nitrogen, crop residues had a more comprehensive C: N ratio. Singh and Kumar (1996) and Hundal and Biswas (1987) reported findings that have been highly tied to these results.

C:P Ratio

Various green manuring crops influenced the C:P ratio. Maximum C:P ratio was observed in French bean (173.85), which was at par with blackgram (165.28) and cowpea (159.47). Soybean (122.26), however, indicated a lower C:P ratio. For phosphorus to be mineralized, crop residues with a C:P ratio less than 200:1 are ideal. Essential markers for estimating the mineralization and fixing of soil nutrients during crop growth are the C: N and C:P ratios. The results are revealed by Pagare *et al*. (2020).

CONCLUSION

The findings showed that *Sesbania rostrata* and *Crotalaria juncea* had the highest biomass output, weight of yield, and nodule count, respectively, while french bean had the lowest. Dhaincha and sannhemp were therefore shown to be more effective for boosting soil fertility through in situ assimilation. The highest concentrations of total N, P, and K were found in the dhaincha (3.90 %), soybean (0.44 %), and dhaincha (2.10 %). Dhaincha has the highest total C content (57.69 %). The ratios of C:N and C:P showed variation. The C:N ratio was lowest in dhaincha (14.63) and the C:P ratio was highest in french beans (173.85). Different green manuring crops vary in their micronutrient concentrations.

LITERATURE CITED

Alam, M. S., J. M. Patel, R. K. Pachauri, S. Singh and H. Tiwari, 2022. Green manuring,Sun Agri., 2(6): 4-6.

Bremner, J. M. and C.S. Mulvaney, 1982. A procedure for estimation of total nitrogen, In : Methods of soil analysis, part-2.

Chapman, H. D. and P. F. Pratt, 1961. Methods of Analysis of Soil, Plant and Water, Division of Agricultural Science, California University, USA.: 309.

Chopra, M. and Kanwar, S. 1980. Analytical Agricultural Chemistry : 21-23.

Dubey, L., Dubey, M. and Jain, P. 2015. Role of green manuring in organic farming, Plant Archives. 15(1) : 23–26.

Hundal, H. S., C. R. Biswas and A. C.Vig, 1987. The utilization by rice of P from different P labelled green manures, Biological Wastes, 22 : 97-105.

Irin, I. J., P. K. Biswas, M. J. Ullah, T. S. Roy and M. A. Khan, 2019. Influence of green manuring on dry matter production and soil health improvement, Bangladesh Agron. J., 22 (1) : 39-45.

Jackson, M. L., 1973. Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi.

Mansoer, Z., D. W. Reeves and C. W. Wood, 1997. Suitability of sannhemp as an alternative late-summer legume cover crop, Soil Sci. Soc. Am. J.,61: 246-253.

Mishra, B. B. and K. C. Nayak, 2004. Organic Farming for Sustainable Agriculture, Orissa Review : 42-45.

Naidu, C. A., G. M. Bindu, M. M. Reddy and Uma Devi. 2021. Effect of fertilization on the biomass production of green manure crops during rabi in southern Telangana Zone, The Pharma Innovation J., 10 (2) : 67-74.

Najan, V.R., P.U. Raundale, C.T. Kumbhar and M.J. Mohite, 2021. Effect of legume green manuring crops on population of beneficial microorganisms in soil, PKV Res. J., 45 (2) : 83-88.

Pagare, S. G., 2020. Carbon and nitrogen mineralization and soil enzyme activities as influenced by green manuring crops in inceptisols, M. Sc. Thesis (Unpub.), Mahatma Phule Krishi Vidyapeeth, Rahuri.

Pooniya, V., Y. S. Shivay,A. Rana,L. Nain, and R. Prasanna, 2012. Enhancing soil nutrient dynamics and productivity of basmati rice through residue incorporation and zinc fertilization, Europe. J. Agronomy, 41:28-37.

Sharma S. N., R. Prasad and S. Singh, 1995. The role of mungbean residues and *Sesbania aculeata* greenmanure in the nitrogen economy of rice-wheat cropping system, Plant and Soil, 172:123–129.

Vijaykumar, R., B. Mehera, N. Khare and P. Kishore, 2021. Role of green manures in organic farming, J. Emerging Technol, Innovative Res.8 : 117-123.

* * *

Received on 22 August, 2022 - Accepted on 5 October, 2022

PKV Res. J. Vol. 46(2), July, 2022

Enhancement in Productivity Dynamics of Turmeric Under Organic Sources

N. K. Darekar[1] and A. N. Paslawar[2]

ABSTRACT

A field experiment was undertaken on certified organic field during 2021-22 at Centre for Organic Agriculture Research and Training, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment was laid out in a randomized block design with nine treatments and three replications. The turmeric variety for experiment was PDKV Waigaon. The application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers shows significantly higher growth attributes such as plant height, number of leaves, leaf area and number of tillers at 120 DAP. Similarly, significantly higher yield and yield attributes were recorded by application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers such as number of mother rhizomes, number of primary rhizomes and fresh yield of rhizomes. The application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers resulted in significantly higher productivity of turmeric under organic farming in Vidarbha Region of Maharashtra.

Chemical fertilizer, herbicide and pesticide used in agriculture for increasing yield and controlling weeds and crop pests can contaminate the water, air and food, decrease soil fertility, inhibit growth of soil microorganisms and cause hazard to human health (Parr *et al.*, 1991). This negative effect of agricultural practices could be reversed by the correct utilization of manures and / or crop residues within cropping system either alone or in combination with organic fertilizer (Mandal *et al.,* 2007). Beside these, utilization of organic manure in agriculture is recommended for retaining productivity of problem soils, reducing the usages of chemical fertilizer, improving economy in agriculture and minimizing environmental problems. Organic farming assumes significance globally towards sustainable production and quality up gradation of turmeric (Sadaanadan, 1998). The adverse effects of continuous use of high dose of chemical fertilizers on soil health and environment are long realized; hence, the farmers are also showing considerable inclination towards traditional farming with least usage of fertilizers. The role of organic manures in improving soil structure and fertility is well understood. Organic manures have positive influence on soil texture and structure, better water holding capacity and drainage which in turn help for better growth and development of rhizomatous crop like turmeric (Kale *et al.,* 1991). Considering the economic importance of turmeric and environmental problems caused by chemicals application, it is important to cultivate turmeric using organic fertilizer. Different organic manures influence differently in terms of yield and quality of turmeric.

Turmeric (*Curcuma longa* L.) is a herbaceous perennial plant belonging to the family, Zingiberaceae. It is an ancient, most valuable, sacred spice of India that contains appreciable quantities of proteins (6.3 %), lipids (5.1 %), carbohydrates (69.4 %) and fiber (2.6%). Turmeric is rich in minerals like phosphorus, calcium, iron and vitamin A. Turmeric is widely consumed, especially in Middle Eastern diets, and has a broader range of pharmacological application. It acts as anti-inflammatory agent. Turmeric has demonstrated antimutagenic and anti-carcinogenic properties. Curcumin has also been shown to potentiate the beneficial effects of drugs and vitamins. Turmeric originated in South-East Asia.

Turmeric is being a long duration (8-9 months) and exhaustive crop and requires heavy nutrition for getting higher yield and quality (Govind *et al.*, 2005; Jagadeeswaran *et al.*, 2007). The adverse effects of continuous use of high dose of chemical fertilizers on soil health and environment were realized (Kamal and Yousuf, 2012). Organic manures and biofertilizers offer an alternative to chemical fertilizers and increasingly used in spice crop production including turmeric (Srinivasan *et al.*, 2000). Organic source of nutrients are recommended for retaining productivity of soil, reducing usage of

1. Ph.D .Scholar and 2. Chief Scientist (Centre for Organic Agriculture Research and Training) and Head, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

chemical fertilizers, improving soil health and minimize environmental pollution (Hossain and Ishimine, 2007). Application of organic manures also quickly increases soil microbial biomass and their activity (Dinesh *et al.,* 2010). Soil microorganisms and their activities play important roles in transformation of plant nutrients from unavailable to available forms and also helpful for improvement of soil fertility (Yamawaki *et al.,* 2013). Application of biofertilizers like Azospirillium is helpful for fixation of substantial amount of atmospheric nitrogen and supplies to the crop and increases soil fertility. Use of organic manure and bio-fertilizer combination is suitable for sustainable production (Sreekala, 2015).

There are many different reasons for low productivity of organic turmeric in India and also in Maharashtra viz. nutrient supply, insect- pest infestation etc. Hence, efforts are to be made to boost up the yield per hectare of organic turmeric by using appropriate organic materials through adoptation of modern irrigation. The appropriate organic sources contribute towards establishment of the crop stand, growth of the plant and ultimately the final quality yield of crop. Though the different organic materials have been given due importance, the perfect combinations of organic materials yet to be quantified in Vidharbha region.

MATERIAL AND METHODS

A field experiment was undertaken on certified organic field during 2020-21 at Centre for Organic Agriculture Research and Training, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment was laid out in a randomized block design with nine treatments and three replications. The average maximum and minimum temperature during growing season ranged between 36.8 ºC to 10.6 ºC and the average annual rainfall was 820.6mm during the crop growing period. Soil was clay loam in texture, alkaline in pH (8.10 ± 0.10) and electrical conductivity was normal (0.31 ± 0.05 dSm^{-1}), medium in organic carbon ($0.49\pm0.05\%$); low in available N (214.5 ± 10 kg ha^{-1}), medium in available P ($18.3 +4$ kg ha^{-1}), high in available K (432.7 ± 15 kg ha^{-1}).

The experiment was laid out in Randomized Block Design replicated three times with nine treatments. The turmeric variety for experiment was PDKV Waigaon. The planting carried out on broad bed furrow with paired row system of planting in which the distance kept between two bed 60cm and two plant row was 30cm and in two plant 30cm. The plot size was 5.4m X 6m. The irrigation provided by sprinkler irrigation at 50 per cent depletion of available moisture in the experimental plots.

As per Recommended Fertilizer Dose of turmeric was 200 : 100 : 100 Kg NPK ha^{-1} for equivalent conversion of nutrients through biomanures as shown in table 1. The equal split doses management of biomanures at 30, 60 & 90 days after planting. For Green Manure Sunhemp used. The Biofertilizers used were *Azotobacter + PSB + KSM*. The Remaining dose of P manage through PROM (Phosphorous Rich Organic Manure). The rhizome Treatment done with *Bijamrut* and *Trichoderma Viridi* at planting time. The different growth and yield attributes were recorded and statistically analyzed for Analysis of Variance (ANOVA) (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The data pertaining to various growth attributes such as plant height(cm), number of leaves, leaf area (cm^2) and number of tillers at 120 days after planting (Table 2) revealed that the treatment T7 with application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers recorded significantly maximum values over the treatment T1 (Absolute control). Among the various treatments, the superior plant height of 105.42 cm recorded with application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers (T7) and significantly superior over the treatment T1 and comparable with treatment T8 (50% Vermicompost + 50 % FYM + Biofertilizers). Balakrishnamurthy (2007) reported that FYM with narrow C:N ratio may produce more humic acid and humic substances contained in it form chelates with phosphorus. The chelated phosphorous has been reported to be more soluble in water, which could make it easily available to crop. This might have lead to increased plant height in turmeric. In the presented data observed that the number of leaves recorded with higher values(16.17) in the treatment T7 with application of 50 per centVermicompost + 50 per cent Neemcake + Biofertilizers and found significantly better with treatment T1 (Absolute control)

Table 1: Treatments and expected addition of nutrients through organic sources to Turmeric:

S.N.	Sym-bol	Treatments	Nutrient Addition (Kg ha^{-1})		
			N	P	K
1.	T_1	Absolute control	Absolute Control		
2.	T_2	25% Neemcake + 25% Cowdung slurry + Biofertilizers	150	74.5	81.5
3.	T_3	25% Vermicompost + 25% Biogas slurry + Green manure at 60 DAS	150	77.96	98.55
4.	T_4	25% Vermicompost + 25% *Jeevamrut* + Biofertilizers + Green manure at 60 DAS	200	58.40	101.11
5.	T_5	25% Vermicompost + 25% Neemcake + 25% Biogas slurry	150	66.16	84.15
6.	T_6	25% Vermicompost + 25% Neemcake + 25% *Jeevamrut*	150	31.6	61.71
7.	T_7	50% Vermicompost + 50% Neemcake + Biofertilizers	250	76.32	130.31
8.	T_8	50% Vermicompost + 50% FYM + Biofertilizers	250	92.24	174.94
9.	T_9	100% Vermicompost	200	66.65	110.63

and parallel with the treatment T8 (50 % Vermicompost + 50% FYM + Biofertilizers). With regards to leaf area (cm^2), the treatment T7 with application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers recorded maximum number (5636.53) and resulted into significantly superior over other treatments. In case of number of tillers per plant, the treatment with T7 application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers recorded significantly maximum number(4.23) over the treatment T1 (Absolute control) and found at par with the treatment T8 (50 % Vermicompost + 50% FYM + Biofertilizers)and T9 (100 % Vermicompost). Kumar *et al.* (2018) reported that the vegetative growth in turmeric was obtained and it may be due to an increase in the activity of enzymes like chitinases and proteases which break down the organic-rich compounds. The activities of microflora and microfauna population in the soil is increased which increases the availability of macro and micronutrients especially by application of vermicompost, FYM, organic manures. Poapst *et al.* (1970) reported that earthworm's cast shows hormone-like activity and stimulates plant nutrient uptake and metabolism resulted in an increase in plant growth. Dudhat *et al.* (1997) revealed that the vegetative growth of the turmeric as influenced by the use of various organic manures (FYM and Vermicompost) revealed an increase in crop yield as well as improvement in the physical, chemical and biological properties of soils. The better performance of plants with neem cake was probably because it acted as natural fertilizer with pesticidal properties which protects plant roots from nematodes, soil grubs & white ants and performs as a nitrification inhibitor and prolongs the availability of nitrogen to short duration as well as long duration crops. Beside these, it improves the soil condition considerably and protects the soil during the droughts. The manure provided nutrients to the plants and may improved edaphic factors, which resulted in higher vegetative growth parameters. These results are in good agreement with the findings of several researchers which revealed that organic manuring increased the vegetative growth and biomass production effectively Roy *et al.* (2010), Dinesh *et al.* (2010), Mohapatra & Das (2009).

The data connecting to yield and various yield attributes (Table 3) such as fresh yield of rhizome (t ha^{-1}), number of mother rhizomes and number of primary rhizomes at harvest exposed that the treatment T7 with application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers recorded significantly maximum values over the treatment T1 (Absolute control). Among the various treatments, the data related to number of mother rhizomes and number of primary rhizomes revealed that also with application of 50 per cent Vermicompost + 50 per cent Neemcake + Biofertilizers recorded significantly maximum values over the treatment T1 (Absolute control) and found comparable with the treatments T8 (50% Vermicompost + 50 % FYM + Biofertilizers) and T9 (100% Vermicompost). With regard to data of fresh rhizome yield (t ha^{-1}) and depicted in

Table 2: Growth attributes of turmeric as influenced by organic sources

Treatments		Plant Height (cm)	Number of leaves	Leaf Area (cm^2)	Number of tillers
T_1 -	Absolute control	64.73	8.00	1864.13	1.67
T_2 -	25% Neemcake + 25% Cowdung slurry + Biofertilizers	93.72	12.63	3777.87	2.90
T_3 -	25% Vermicompost + 25% Biogas slurry + Green manure at 60 DAS	93.28	13.67	4482.94	3.17
T_4 -	25% Vermicompost + 25% Jeevamrut + Biofertilizers + Green manure at 60DAS	98.32	14.40	4858.99	3.60
T_5 -	25% Vermicompost + 25% Neemcake + 25% Biogas slurry	96.28	13.73	3936.47	3.30
T_6 -	25% Vermicompost + 25% Neemcake + 25% Jeevamrut	95.98	13.40	4074.11	3.27
T_7 -	50% Vermicompost + 50% Neemcake + Biofertilizers	105.42	16.17	5636.53	4.23
T_8 -	50% Vermicompost + 50% FYM + Biofertilizers	101.82	15.30	5518.35	3.73
T_9 -	100% Vermicompost	100.58	14.53	5350.29	3.63
	S.E.(m)$\pm$	3.42	0.37	117.63	0.16
	CD at 5%	10.25	1.10	352.65	0.47
	GM	94.46	13.54	4388.85	3.28

Table 3: Yield attributes of turmeric as influenced by organic sources

Treatments		RDF level compensate through biomanuring treatment	Number of mother rhizomes	Number of primary rhizomes
T_1 -	Absolute control	—	1.07	6.33
T_2 -	25% Neemcake + 25% Cowdung slurry + Biofertilizers	50%	1.73	7.93
T_3 -	25% Vermicompost + 25% Biogas slurry + Green manure at 60 DAS	50%	1.73	8.03
T_4 -	25% Vermicompost + 25% Jeevamrut + Biofertilizers + Green manure at 60DAS	50%	2.00	9.17
T_5 -	25% Vermicompost + 25% Neemcake + 25% Biogas slurry	75%	1.67	8.17
T_6 -	25% Vermicompost + 25% Neemcake + 25% Jeevamrut	75%	1.67	8.83
T_7 -	50% Vermicompost + 50% Neemcake + Biofertilizers	100%	2.40	9.70
T_8 -	50% Vermicompost + 50% FYM + Biofertilizers	100%	2.27	9.50
T_9 -	100% Vermicompost	100%	2.20	9.40
	S.E.(m)$\pm$	0.12	0.19	
	CD at 5%	0.35	0.56	
	GM	1.86	8.56	

fig. 1, revealed that with application of 50 per centVermicompost + 50 per cent Neemcake + Biofertilizers recorded significantly maximum values(16.40) over the treatment T1 (Absolute control). However, effect on recovery percentage was non- significant. Neem cake provided the best option for production of turmeric being an exhaustive crop because neem cake acts as usual fertilizer with pesticidal properties and enhances the organic carbon content of soil. Beside these, neem cake is an effective nitrogen inhibitor which helps of extends the availability of nitrogen for such high exhaustive crop; hence, the productivity of turmeric was probably increased. The organic fertilizer improved soil productivity and fertility, which improved yield and quality of such long duration crop like turmeric. These results are in good agreement with the findings of several researchers which revealed that organic manuring increased the yield attributes and yield of turmeric Hossain and Ishimine (2007), Velmurugan *et al.* (2007), Mohapatra and Das (2009), Roy *et al.* (2010), Dinesh *et al.* (2010). Moreover, Manhas & Gill (2010) found that application of FYM increased the yield of turmeric. Kumar *et al.* (2016) reported that organic manures are significantly beneficial for the yield of rhizomes in comparison to inorganic sources of nutrients. The dry recovery of turmeric is a varietal character however it is also influenced by several other factors like soil moisture, duration of crop, manures and fertilizers applied and soil health. Bondre *et al.* (2019) revealed that application of neem cake @ 4 t ha^{-1} + Azatobacter (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (65 kg ha^{-1}) found to be superior over other treatments and observed that, increase in yield levels were attained over the years which can increase with continuous application of organic nutrient sources and biofertilizers as well as the higher nutrient content in neem cake coupled with their easy and extended availability and better uptake brought about by enhanced microbial action with the combination of biofertilizers viz. Azatobacter, PSB and VAM resulting in higher finger yield. The results are in agreement with Kumar *et al.* (2013) and Sarma *et al.* (2015). Kadam and kamble (2020) revealed that the application of vermicompost (11.36 t ha^{-1}) along with phosphate solubilizing bacteria and Azospirillium @ 5 kg ha^{-1} and other manures at the time of planting to turmeric was found superior with respect to yield and growth. Veeral and Kalaimathi (2021) revealed that the scope of utilization of agro industrial wastes (bagasse ash, pressmud and distillery spentwash), organic sources (crop residues and FYM) and biofertilizer (Rhizobia) in agriculture. The combination of Pressmud @ 12.5 t ha^{-1} + Rhizobia @ 2 kg ha^{-1} + 50 per cent RDF recorded increased the growth and yield attributes of groundnut in Rabi, 2016 and Summer, 2017.

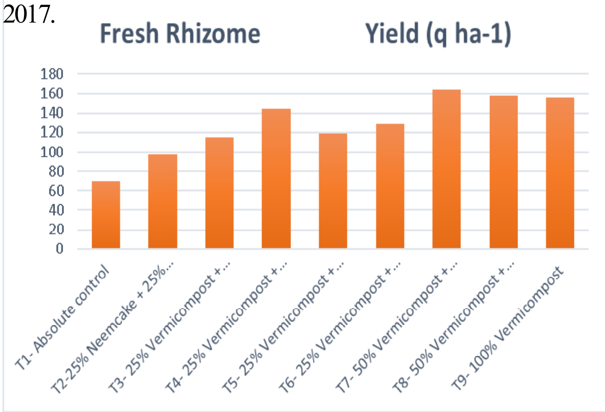


Fig.1 : Fresh Rhizome yield (q ha^{-1}) of turmeric as influenced by organic sources

CONCLUSION

From the results the turmeric with application of 50 % Vermicompost + 50 % Neemcake + Biofertilizers found to be superior in productivity than other organic sources. Also, the treatment with application of 50 % Vermicompost + 50 % FYM + Biofertilizers and 100 % Vermicompost found beneficial than other organic sources. Hence, the combined application of manures is most beneficial to organic turmeric growers.

LITERATURE CITED

Balakrishnamurthy G., R. Kamalkumar and T. Prabu, 2007. Standardization of organic manures and bioregulators for organic production of turmeric (L.), (in) Tamil selvan M, Homey Cheriyan, Sadanandan A K and Hameed Khan H. (eds). Souvenir of National Seminar on Organic Spices and Aromatic Crops, Calicut, Kerala : 123-130.

Bondre S.V., P.K. Nagre, V.S. Kale, A.P. Wagh and N.S. Gupta, 2019. Effect of organic nutrient management on quality, processed finger yield and economics in turmeric, International J. Chemical Studies., **7**(5): 3066-3069.

Dinesh R, V. Srinivasan, S.Hamja and A.Mahjusha, 2010. Short term incorporation of organic manures and fertilizers influences biochemicals and microbial characteristics of soils under an annual crop turmeric, J. Bioresource Technol., 101(12):4697-702.

Dudhat, M. S., D. D. Malavia, R. K. Madhukia, and B. D. Khanpara,1997. Effect of nutrient management through organic and inorganic sources on growth, yield and quality and nutrients uptake by wheat (*Triticium aestivum*), Indian J. Agron., 42 (3): 455-458.

Govind S., P.N. Gupta, and R. Chandra, 1990. Response of N and P levels on growth and yield components of turmeric in acid soils of Meghalaya, Indian J. Hort., 47: 79-84.

Hossain M. A. and Y. Ishimine, 2007. Effects of Farmyard Manure on Growth and Yield of Turmeric (*Curcuma longa* L.) Cultivated in Dark-Red Soil, Red Soil and Gray Soil in Okinawa, Japan, Plant Production Sci., 10 (1):146-150..

Jagadeeswaran, R., V. Muruggappan and M. Govindswamy, 2007. Effect of slow release NPK fertilizer sources on the nutrient use efficiency in turmeric (*Curcuma longa* L.), World J. Agril. Sci., 1: 65-69.

Kadam, J. H. and B. M. Kamble, 2020. Effect of organic manures on growth, yield and quality of turmeric (*Curcuma longa* L), J. Applied Natural Sci. **1**2(2): 91-97.

Kale, R. N., Bano K. and G. P. Satyavati, 1991. Influence of vermicompost application on growth and yield of cereals, vegetables and ornamental plants, Final report of KSCSI Project, N67004/Vermi (34B (3478): 27-29.

Kamal MZU and M.N. Yousuf, 2012. Effect of organic manures on growth, rhizome yield and quality attributes of turmeric (*Curcuma longa* L.), The Agriculturists., 10(1):16- 22.

Kumar R, S. Kumar, R . Jeet, S. Kumar, H .Singh, 2013. Growth, yield and quality of turmeric (*Curcuma longa* L.) as influenced by organic manures, Agriways, 1(2): 113-117.

Kumar, K. R., N. S. Rao and R. N. Kumar, 2016. Effect of organic and inorganic nutrient sources on growth, quality and yield of turmeric (*Curcuma longa* L.), Green Farming., 7(4): 889-892.

Kumar, D., S. Raizada, A. Kumar, and A. Kumar, 2018. Effect of organic and inorganic nutrient on growth, yield andprofitability of Turmeric (*Curcuma longa* L.), Progressive Agric., 18 (1):78-81 (2018).

Mandal A., A. K. Patra, D. Singh, F. Swarup and R. E. Masto, 2007. Effect of long term application of manure and fertilizer on biological and biochemical properties in a silty loam soil under conventional and organic management, Soil Tillage Res., 90:162- 170.

Manhas, S. S. and B. S. Gill, 2010. Effect of planting materials, mulch levels and farmyard manure on growth, yield and quality of turmeric (*Curcuma longa*), The Indian J. Agril. Sci., 80(6): 227-233.

Mohapatra, S. C. and T. K. Das, 2009. Integrated effect of biofertilizers and organic manure on turmeric (*Curcuma longa*), Environ. Ecol., 27(3A):1444-1445.

Panse, V. G. and P. V. Sukhatme, 1985. Statistical Methods for Agricultural Workers, Indian Council Agricultural Research, New Delhi. 134-153.

Parr J F, S. B. Hornick and C. E. Whitman, 1989. First International Conference on Kyusei Nature Farming, Proceedings of the Conference, Khon Kaen, Thailand, 175.

Poapst, P. A., C. Genier and M. Schnitzer, 1970. Effect of soil fulvic acid on stem elongation in peas, J. Plant and Soil, 32 : 367-372.

Reddy, R.N. and R. Prasad, 1975. Studies on the mineralization of urea, coated urea and nitrification inhibitors treated urea in soil, J. Soil Sci., 26: 304.

Roy S.S. and J.K. Hore, 2011. Effect of organic manures and microbial inoculants on yield, root colonization and total bacterial population in turmeric (*Curcuma longa* L.) intercropped in (*Areca catechu* L.) garden, J. Spices Aromatic Crops. 20(2):66-71.

Sadanandan A K, K. V. Peter and S. Hamza, 1998. Soil nutrient and water management for sustainable spices production, Proc. National seminar on water and nutrient management for sustainable production and quality of spices, IISR, Calicut, : 12-20 .

Sarma I, M. Phukon and R. Borgohain, 2015. Effect of organic manure, vermicompost and neem cake on growth, yield and profitability of turmeric (*Curcuma longa* L.) variety– Megha Turmeric-1, Asian J Bio Sci. 10(2):133-137.

Sreekala, G.S., 2015. Effect of organic manures and biofertilizers on nutrient status of soil in ginger intercropped in coconut garden, Int. J. Cur Res. 7(3) : 13694-13698.

Srinivasan, V., A.K. Sadanadan and S. Hamza, 2000. An INM approach in spices with special references on coircompost, In.: International Conference on Managing Natural Resources for Sustainable Agricultural Production, New Delhi. 3 **:** 1363-1365.

Veeral, D.K. and P. Kalaimathi, 2021. Improving Physiological and Yield Traits of Groundnut (*Arachis hypogaea* L.) by using Various Sources of Organic Wastes and Bio Fertilizers, Rhizobia, Indian J. Agril. Res., 55(4) : 473-477.

Velmurugan, M., N. Chezhiyan, and M. Jawaharlal, 2007. Studies on the effect of organic manures and biofertilizers on rhizome yield and its attributes of turmeric cv. BSR-2, The Asian J. Hort. 2 (2):23-29.

* * *

Received on 8 September, 2022 - Accepted on 18 October, 2022

PKV Res. J. Vol. 46(2), July, 2022

Influence of Fertilizer Levels, FYM and Biofertilizers on Yield, Nutrient Uptake and Protein Content of Mungbean

M. D. Giri[1], A. N. Paslawar[2], Archana Thorat[3] and D. V. Mali[4]

ABSTRACT

The research was carried out at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra), India, from 2018 to 2020. Employing a randomized complete block design with three factors and three replications, the experiment investigated the effects of various parameters on mungbean growth and yield.The three factors studied were fertilizer doses, farmyard manure (FYM) levels, and biofertilizers. The fertilizer doses consisted of (F_1:75% recommended dose, F_2:100 % recommended dose and F_3:125% recommended dose). Two FYM levels tested were (F_1: Control) and (F_2: 5 t ha^{-1}). Three types of biofertilizers were employed (B_1: *Rhizobium*, B_2: *LMn* 16, and B_3: *Rhizobium* + *LMn* 16). Results unveiled that using 125 per cent of the recommended fertilizer dose yielded superior results across numerous parameters such as plant height, branches plant^{-1}, pods plant^{-1}, seed index, and seed yield plant^{-1}. Similarly, applying 5 t ha^{-1} FYM significantly enhanced growth parameters and yield attributes like plant height, pods plant^{-1}, seed index, seed yield plant^{-1}, root nodules plant^{-1}, nodule dry weight, and seed yield. Interestingly, different biofertilizers demonstrated comparable advantages across all parameters, suggesting their equal effectiveness in promoting mungbean growth and yield. Moreover, the research delved into the impact of fertilizer doses, FYM levels and biofertilizers on nutrient content and protein yield. While diverse fertilizer doses influenced nutrient uptake significantly, no noteworthy differences were observed in nutrient content among the various treatments. Likewise, the influence of FYM levels and biofertilizers on nutrient content and uptake did not attain statistical significance. Noteworthy was the finding that using 125 per cent recommended fertilizer dose and 5 t ha^{-1} FYM led to heightened protein yields, underscoring the role of nutrient availability in protein production.

India stands as the world's foremost pulse producer, commanding a significant 24 per cent slice of global production. Key pulse crops cultivated within the nation include chickpea (constituting 48%), pigeonpea (15%), mungbean (7%), urdbean (7%), lentil (5%), and field pea (5%) (Anonymous, 2020). The primary states driving pulse cultivation are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, and Andhra Pradesh, collectively contributing about 80 per cent of the overall output. Despite witnessing an upsurge in production, India's average pulse yields continue to lag behind the global mean. Projected estimations anticipate demand of 32 million tonnes for pulses by 2050, factoring in the projected population surge to 1.69 billion by 2050 (Anonymous, 2020).

The Mungbean (*Vigna radiata* L. Wilczek) holds a significant place in India's agricultural history as one of the oldest and most extensively cultivated leguminous crops. Renowned for its high-quality protein content, Mungbean boasts a protein concentration of approximately 25 per cent. Traditionally a crop of the rainy season, advancements in early maturing varieties have expanded its suitability to spring and summer cultivation. Notably, Mungbean stands out for its elevated levels of valuable amino acids such as lysine (4600 mg g^{-1} N) and tryptophan (60 mg g^{-1} N). Furthermore, the germinated mungbean seeds offer a rich source of essential nutrients including ascorbic acid (vitamin C), riboflavin, and thiamine (Kumar *et al.*, 2013).

The growth, development, and yield of mungbean are significantly influenced by the presence of nitrogen, phosphorus, and potassium. These essential nutrients play a critical role in various aspects of mungbean cultivation. To ensure optimal crop growth and productivity, it is crucial to apply fertilizers appropriately. Unfortunately, inadequate fertilization levels and imbalances in the application of N, P and K have led to substantial negative impacts on mungbean growth and development, resulting in reduced yield and compromised quality (Yin *et al.*, 2018). On the other side, excessive use

1. Assistant Professor , 2.Head, 3.Associate Professor and 4.Assistant Professor , Department of Agronomy, Dr. PDKV, Akola

of fertilizers has also caused problems. This over-application has not only affected agricultural outputs but has also disrupted soil microecology and contributed to the proliferation of soil-borne diseases (Jain *et al.,* 2007). Thus, achieving a balanced approach to fertilizer usage holds the key to enhancing both the yield and quality of mungbean.

The use of chemical fertilizers has led to heightened environmental pollution and has, in certain instances, had detrimental effects on crop performance and yield (Bam *et al.,* 2022). This reckless application of such substances has underscored the need for embracing integrated management within sustainable agricultural systems (Amni *et al.,* 2019). Through the combined utilization of organic and inorganic sources, it becomes possible to maintain productivity levels and enhance soil properties. Plant-based bio-fertilizers play a crucial role in various aspects, including the facilitation of biological nitrogen fixation, the solubilization of usually insoluble phosphorus sources, stimulation of plant growth, and acceleration of the decomposition process for plant residues. For instance, the inoculation of Rhizobium bacteria to mungbean plants can result in fixing 20–40 kg of nitrogen per hectare (Chaudhary, 2010). Tena *et al.* (2016) demonstrated that inoculating Rhizobium strains leads to increased nodulation, nitrogen acquisition, and greater legume yield. Similarly, when mungbean seeds are inoculated with effective strains of Rhizobium and Azotobacter, there is marked improvement in both the morphological and biochemical aspects of crop growth. Notably, Rhizobium inoculation is a cost-effective and advantageous practice for mungbean cultivation. In contrast to chemical fertilizers, the use of biofertilizers holds the advantage of being environmentally friendly (Rana *et al.,* 2012).

Considering the above, this study was designed to determine the optimal fertilizer dose and best biofertilizer for the mungbean crop.

MATERIAL AND METHODS

During the rainy seasons of 2018, 2019 and 2020, a field experiment took place at the Pulses Research Unit, situated within the Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Agricultural University) in Krishi Nagar, Akola Campus, Maharashtra, India. The latitude and longitude coordinates of the location are 20.42 North and 72.02 East, respectively, with an altitude of 307 meters above sea level.

The soil of the experimental plot was clayey (34.1 % sand, 25.2 % silt, 49.1 % clay) in texture, having a pH of 8.1 (1:2.5 soil to water), field capacity of 34.1 per cent, a permanent wilting point of 14.8 per cent, and bulk density of 1.47 Mg m^3. The soil has 0.45 per cent organic C, 190 kg ha^{-1} available N, 20 kg ha^{-1} 0.5 M $NaHCO_3$ extractable available P and 416 kg ha^{-1} NH_4OAc extractable available K. Most of the rainfall occurs in Akola during the South-West monsoon season, which begins in the middle of June. Monsoon season precipitation reaches 770 mm in about 40 to 45 rainy days from June to September.

The experiment was laid out in a randomized complete block design with three factors (Fertilizer doses, FYM, and Biofertilizers) with three replications. Three fertilizer doses (F_1: 75% RDF, F_2: 100% RDF, and F_3: 125% RDF), two FYM levels [F_1: Control and F_2: 5 t ha^{-1}), and three biofertilizers (B1: Rhizobium, B_2: *LMn* 16 and B_3: *Rhizobium* + *LMn* 16) were tested. The plot size was 3.0 m (length) x 3.6 m (width). The mungbean seeds of the genotype PKV Greengold were densely planted at a spacing of 45 cm x 10 cm (23rd June, 2018, 26th June, 2019, 28th June, 2020). The recommended dose of fertilizer used was 20 kg N, 40 kg Phosphors, and 20 kg Potassium ha^{-1}.

The five representative plants were tagged from the net plot area to study mungbean growth and yield components (plant height, branches pods and seed yield $plant^{-1}$). The final harvesting dates were, determined by successive destructive sampling to determine the maximum percentage of mature pods when pods turn brown. The mature pods were picked for final yield determination (27th August 2018, 5th September, 2018, 29th August, 2019, 8th September, 2019, and 3rd September, 2020). The seeds were obtained manually by threshing the mungbean pods, and the final seed weight was recorded.

Based on this experiment's factorial randomized block design, statistical analysis was performed using OPSTAT (Sheoran *et al*., 1998).

RESULTS AND DISCUSSION

Effect of fertilizer doses on growth, yield attributes, root nodules plant^{-1}, nodule dry weight (mg plant^{-1}), and seed yield (kg ha^{-1}) of mungbean

The impact of varying fertilizer dosages on the growth and yield characteristics of mungbean crops exhibited notable significance, as depicted in Table 1. Notably, employing 125 per cent of the recommended fertilizer dosage (RDF) resulted in markedly superior outcomes across several parameters. This encompassed plant height (43.19 cm), branches per plant (2.24 branches plant^{-1}), pods per plant (15.44 pods plant^{-1}), seed index (3.34 g) and seed yield plant^{-1} (6.41 g plant^{-1}), outperforming all other fertilizer dosage levels.

Furthermore, the influence of distinct fertilizer doses on the mungbean crop's root nodules per plant and nodule dry weight (mg plant^{-1}) exhibited statistical significance, as illustrated in Figure 1. Applying 125 per cent RDF led to significantly elevated figures in terms of root nodules per plant (42.11 nodules plant^{-1}) and root nodule dry weight per plant (69.20 mg plant^{-1}), surpassing outcomes obtained with other fertilizer dosages.

Additionally, the ramifications of various fertilizer doses on mungbean crop seed yield (kg ha^{-1}) held substantial importance (Table 2). The application of 125 per cent RDF yielded notably greater seed production (893 kg ha^{-1}) compared to all alternative fertilizer dosage levels. This application resulted in a 30 per cent increase in seed yield in comparison to 75 per cent RDF and 12 per cent rise in seed yield in comparison to 100 per cent RDF.

The observed significant impact of varying fertilizer dosages on the growth and yield characteristics of mungbean crops can be attributed to the fundamental role that nutrients play in plant development and productivity. The results indicating the superiority of employing 125 per cent of the recommended fertilizer dosage (RDF) across various parameters can be justified

Table 1.Effect of fertilizer doses, FYM, and biofertilizers on growth parameters of mungbean (Mean of three years)

Treatments	Plant height (cm)	Branches plant^{-1}	Pods plant^{-1}	Seed index (g)	Seed yield plant^{-1} (g)
Fertilizer Dose (Kg ha^{-1})					
N_1 (75% RDF) (15:30:15)	36.84^{c}	1.77^{c}	11.93^{c}	3.17^{c}	4.65^{c}
N_2 (100% RDF) (20:40:20)	40.24^{b}	1.92^{b}	14.16^{b}	3.23^{b}	5.72^{b}
N_3 (125% RDF) (25:50:25)	43.19^{a}	2.12^{a}	15.44^{a}	3.34^{a}	6.41^{a}
S.E. (m) $\pm$	0.41	0.06	0.24	0.009	0.09
C.D. @ 5 %	1.13	0.18	0.66	0.026	0.25
Farmyard manure (t ha^{-1})					
F_1 (control)	39.38^{b}	1.87^{a}	13.43^{b}	3.23^{b}	5.40^{b}
F_2 (5 t/ ha)	40.80^{a}	2.00^{a}	14.26^{a}	3.26^{a}	5.79^{a}
S.E. (m) $\pm$	0.33	0.05	0.19	0.01	0.07
C.D. @5%	0.92	NS	0.54	0.02	0.21
Biofertilizer					
B_1 (*Rhizobium*)	40.02^{a}	1.89^{a}	13.93^{a}	3.25^{a}	5.62^{a}
B_2 (*LMn* 16)	39.97^{a}	1.93^{a}	13.57^{a}	3.24^{a}	5.46^{a}
B_3 (*Rhizobium* + *LMn* 16)	40.29^{a}	1.99^{a}	14.03^{a}	3.26^{a}	5.70^{a}
S.E. (m) $\pm$	0.40	0.06	0.23	0.03	0.09
C.D. @ 5%	NS	NS	NS	NS	NS

All the interactions for all the parameters were found non-significant

Means followed by the same letter do not differ significantly at the 0.05 probability level.

Table 2. Effect of fertilizer doses, FYM, and biofertilizers on yield parameters and yield of mungbean (Mean of three years)

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Fertilizer Dose (Kg ha^{-1})				
N_1 (75% RDF) (15:30:15)	689^c	1469^c	2158^c	31.93^a
N_2 (100% RDF) (20:40:20)	800^b	1718^b	2518^b	31.74^a
N_3 (125% RDF) (25:50:25)	893^a	1907^a	2800^a	31.84^a
S.E. (m) $\pm$	11	25	36	0.08
C.D. @5%	31	69	100	NS
Farmyard manure (t ha^{-1})				
F_1 (control)	756^b	1619^b	2376^b	31.81^a
F_2 (5 t/ ha)	832^a	1776^a	2608^a	31.86^a
S.E. (m) $\pm$	9	20	29	0.07
C.D. @5%	26	57	82	NS
Biofertilizer				
B_1 (*Rhizobium*)	784^a	1670^a	2454^a	31.93^a
B_2 (*LMn* 16)	782^a	1678^a	2460^a	31.74^a
B_3 (*Rhizobium* + *LMn* 16)	817^a	1745^a	2561^a	31.84^a
S.E. (m) $\pm$	11	25	36	0.08
C.D. @5%	—	—	—	—

All the interactions for all the parameters were found non-significant
Means followed by the same letter do not differ significantly at the 0.05 probability level.

as the increased fertilizer dosage at 125 per cent RDF likely provided an optimal supply of essential nutrients, such as nitrogen, phosphorus, and potassium, which are critical for various aspects of plant growth and yield. This enriched nutrient availability supported enhanced plant development and reproductive processes, leading to taller plants, more branches, more pods and greater seed production. Adequate nutrient supply, particularly nitrogen, positively influences photosynthesis, the process by which plants convert light energy into chemical energy. This augmented photosynthetic activity can result in greater energy reserves, contributing to increased seed and seed production. The synergistic effect of the improved growth parameters, increased pod and seed production, and optimized root nodulation at 125 per cent RDF likely led to an overall higher seed yield plant^{-1}. It is worth noting that while higher fertilizer dosages can enhance yield, they must be carefully managed to avoid environmental concerns, nutrient runoff and economic considerations. The results provide valuable insights into optimizing fertilizer application strategies for mungbean crops, balancing increased productivity with sustainable and efficient resource utilization. Our findings are consistent with prior research conducted by Yin *et al.* (2018), Muchira *et al.* (2018) and Giri *et al.* (2020), highlighting a continuation of the same line of inquiry.

Effect of FYM on growth, yield attributes, root nodules plant^{-1}, nodule dry weight (mg plant^{-1}) and seed yield (kg ha^{-1}) of mungbean

The impact of varying levels of farmyard manure (FYM) on the growth and yield attributes of the mungbean crop showed notable significance (Table 1). Applying 5 t FYM/ha resulted in notably elevated measurements for plant height (40.80 cm), pods per plant (14.26 pods plant^{-1}), seed index (3.26 g) and seed yield plant^{-1} (5.79 g plant^{-1}) in comparison to the absence of FYM treatment. Nevertheless, the influence of different FYM levels on branches per plant and seeds per pod displayed a lack of statistical significance.

Table 3. Effect of fertilizer doses, FYM, and biofertilizers on nutrient content (%) and uptake (%) of mungbean (Mean of three years)

Treatment	Nitrogen Content (%)		Phosphorus Content(%)		Potassium Content (%)		Uptake (kg/ha)		
	Seed	Straw	Seed	Straw	Seed	Straw	Nitrogen	Phosphorus	Potassium
Fertilizer Dose (Kg ha^{-1})									
N_1 (75% RDF) (15:30:15)	3.30[a]	0.61[a]	0.46[a]	0.17[a]	0.82[a]	1.33[a]	32[c]	5.66[c]	25[c]
N_2 (100% RDF) (20:40:20)	3.31[a]	0.62[a]	0.46[a]	0.18[a]	0.83[a]	1.35[a]	37[b]	6.80[b]	30[b]
N_3 (125% RDF) (25:50:25)	3.33[a]	0.63[a]	0.47[a]	0.18[a]	0.85[a]	1.36[a]	42[a]	7.58[a]	33[a]
S.E.(m)	0.01	0.01	0.01	0.003	0.008	0.01	0.5	0.13	0.4
C.D. @5%	-	-	-	-	-	-	1.5	0.36	1.2
Farmyard manure (t ha^{-1})									
F_1 (control)	3.30[a]	0.61[a]	0.45[a]	0.18[a]	0.83[a]	1.34[a]	35[b]	6.31[b]	28[b]
F_2 (5 t/ ha)	3.33[a]	0.63[a]	0.47[a]	0.18[a]	0.84[a]	1.35[a]	39[a]	7.05[a]	31[a]
S.E.(m)	0.01	0.005	0.005	0.003	0.007	0.008	0.4	0.11	0.4
C.D. @5%	-	-	-	-	-	-	1.2	0.29	1.0
Biofertilizer									
B_1 (*Rhizobium*)	3.32[a]	0.62[a]	0.46[a]	0.18[a]	0.83[a]	1.34[a]	36[a]	6.54[a]	29[a]
B_2 (*LMn* 16*)	3.32[a]	0.62[a]	0.46[a]	0.18[a]	0.84[a]	1.35[a]	36[a]	6.59[a]	29[a]
B_3 (*Rhizobium* + *LMn* 16*)	3.32[a]	0.62[a]	0.46[a]	0.18[a]	0.84[a]	1.35[a]	38[a]	6.91[a]	30[a]
S.E.(m)	0.01	0.01	0.01	0.003	0.008	0.01	0.5	0.13	0.4
C.D. @5%	—	—	—	—	—	—	—	—	—

All the interactions for all the parameters were found non-significantMeans followed by the same letter do not differ significantly at the 0.05 probability level.

The influence of the FYM levels on root nodules plant^{-1} and nodule dry weight (mg plant^{-1}) in mungbean cultivation demonstrated noteworthy significance (Fig. 1). The application of 5 t FYM ha^{-1} led to considerably higher values for the number of root nodules plant^{-1} (41.47 nodules plant^{-1}) and the dry weight of root nodules plant^{-1} (67.35 mg plant^{-1}) compared to the absence of FYM treatment.

The impact of diverse FYM levels on mungbean crop seed yield (kg ha^{-1}) displayed marked significance (Table 2). Implementing 5 t FYM ha^{-1} resulted in a substantially higher seed yield (832 kg ha^{-1}) compared to the absence of FYM treatment. The application of 5 t FYM ha^{-1} yielded a 10 per cent increase in seed yield compared to the no FYM treatment.

The significant improvements observed in plant height, pods per plant, seed index, seed yield plant^{-1}, root nodules per plant, nodule dry weight per plant, and seed yield ha^{-1} when using 5 t FYM ha^{-1} can be attributed to the enhanced soil fertility, nutrient availability, and beneficial microbial activity provided by FYM. These results highlight the importance of organic matter management in agriculture to achieve higher crop productivity and yield. Our results are in accordance with the earlier findings documented by Meena *et al.,* 2013 and Meena *et al.*, 2018.

Effect of Biofertilizers on growth, yield attributes, root nodules plant^{-1}, nodule dry weight (mg plant^{-1}) and seed yield (kg ha^{-1}) of mungbean

The impact of various biofertilizers on the growth and yield characteristics of the mungbean crop exhibited no significant differences, suggesting that all the biofertilizers provided comparable benefits (Table 1).

Similarly, the influence of different biofertilizers on root nodules plant^{-1} and the dry weight of nodules

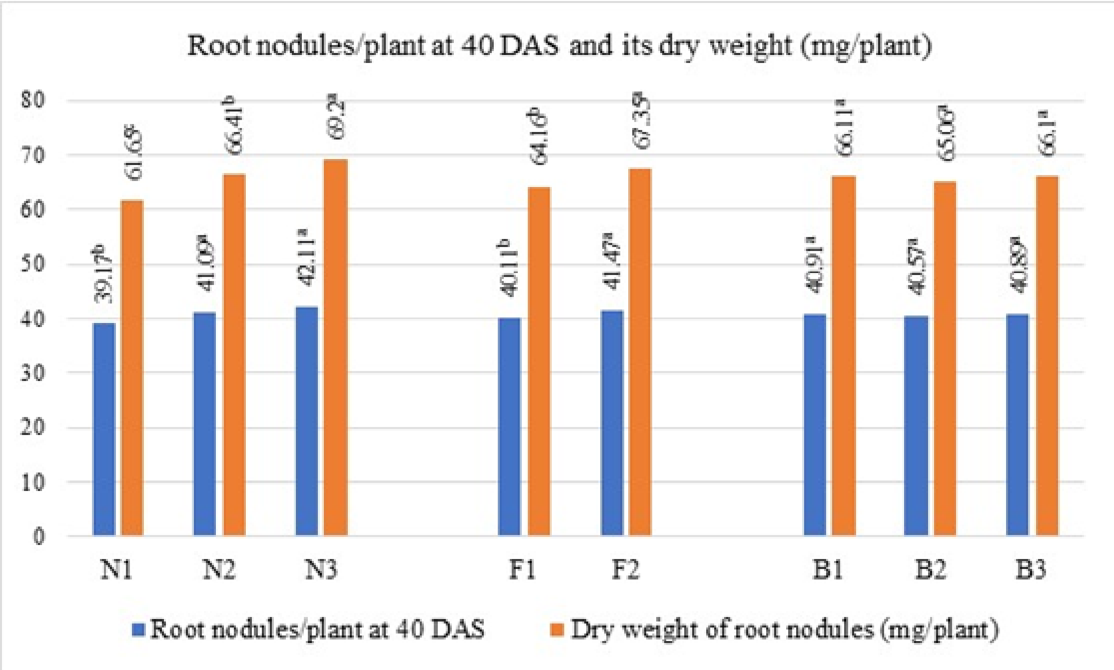
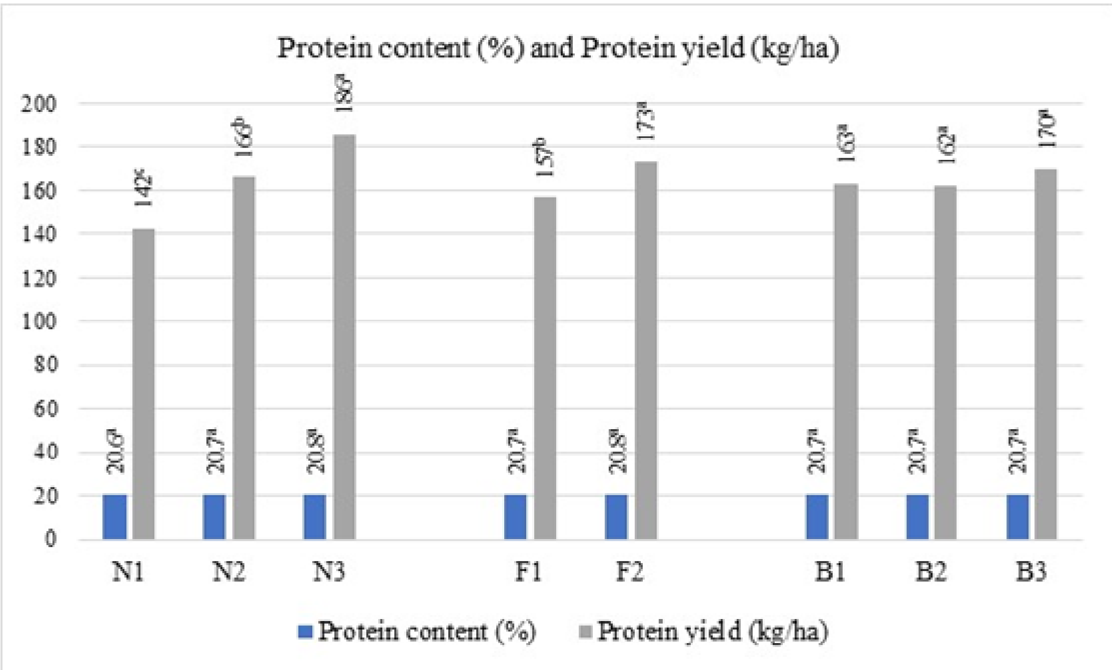


Fig. 1. Effect of fertilizer doses, FYM, and biofertilizers on root nodules/plant and its dry weight of mungbean



Figu. 2. Effect of fertilizer doses, FYM, and biofertilizers on seed protein content (%) and seed protein yield (kg ha^{-1}) of mungbean

(measured in mg plant^{-1}) in mungbean demonstrated no significant variation (Fig.1), implying that all the biofertilizers contributed equally to their benefits.

Likewise, the outcome of employing different biofertilizers on the seed yield (kg ha^{-1}) of the mungbean crop exhibited non-significant results (Table 2), indicating that all the biofertilizers were equally effective in promoting mungbean crop yield.

The consistent and non-significant variations in growth, yield, and nodule-related parameters among the different biofertilizers suggest that each biofertilizer formulation was equally effective in providing the necessary nutrients to support the growth and development of the mungbean crop. This outcome highlights the potential of these biofertilizers to enhance agricultural productivity while offering flexibility in choosing the most suitable option based on other factors such as cost, availability, and environmental considerations. Our findings align with the earlier outcomes documented by Fernandes and Bhalerao (2015) as well as with Verma *et al.* (2017).

Effect of fertilizer doses on nitrogen, phosphorus, potassium content, its uptake, seed protein content, and seed protein yield (kg ha^{-1}) of mungbean crop

The impact of varying fertilizer doses on the nitrogen, phosphorus, and potassium content in mungbean seed and straw did not show statistically significant differences (Table 3).

Conversely, the influence of different fertilizer doses on the nitrogen, phosphorus, and potassium uptake by the mungbean crop exhibited significant variations (Table 3). Notably, when 125 per cent of the recommended fertilizer dose (RDF) was applied, there was a substantial increase in nitrogen (42 kg ha^{-1}), phosphorus (7.58 kg ha^{-1}), and potassium (33 kg ha^{-1}) uptake, surpassing the uptake levels observed with other fertilizer doses.

While the effect of distinct fertilizer doses on seed protein content (%) demonstrated no statistically significant variation (Fig. 2), the impact of these doses on seed protein yield (kg ha^{-1}) was deemed significant. Remarkably, the application of 125 per cent RDF resulted in a notably higher seed protein yield (186 kg ha^{-1}) compared to the other fertilizer doses.

The significant variations observed in nitrogen, phosphorus, and potassium uptake with different fertilizer doses could be attributed to the specific nutrient demands of the mungbean crop. Fertilizer doses play a critical role in determining the availability of nutrients in the soil, and an appropriate balance of these nutrients is crucial for optimal plant growth. The increased uptake of these nutrients when applying 125 per cent of the recommended fertilizer dose could indicate that the mungbean plants were operating at nutrient-limiting conditions with lower doses, and the higher dose allowed the plants to access a more abundant nutrient supply, resulting in enhanced nutrient uptake.

The lack of statistically significant variation in seed protein content might stem from the complex nature of protein synthesis and the various factors influencing it. Protein content in seeds is influenced by multiple genetic and environmental factors, including nutrient availability. The absence of a significant effect of fertilizer doses on protein content could be due to the intricate interplay of these factors. However, the significant impact on seed protein yield suggests that while the protein content per se wasn't affected, the actual protein production (yield) was influenced by the availability of nutrients from the different fertilizer treatments. This emphasizes that the overall protein yield is a more comprehensive measure of nutrient-induced effects on seed quality. Earlier research by Yin *et al.* (2018) and Muchira *et al.* (2018) reported similar outcomes.

Effect of FYM doses on nitrogen, phosphorus, potassium content, its uptake, seed protein content, and seed protein yield (kg ha^{-1}) of mungbean crop

The impact of varying levels of farmyard manure (FYM) on the nitrogen, phosphorus, and potassium content in mungbean seed and straw did not exhibit statistical significance (Table 3).

Conversely, the influence of different FYM levels on the uptake of nitrogen, phosphorus, and potassium by the mungbean crop demonstrated statistical significance (Fig. 3). Notably, the application of 5 t ha^{-1}

FYM led to significantly elevated levels of nitrogen (39 kg ha^{-1}), phosphorus (7.05 kg/ha), and potassium (31 kg ha^{-1}) uptake compared to the absence of fertilizer treatment.

Although the divergence in FYM levels did not yield significant disparities in seed protein content (%) (Fig. 2), it did, however, significantly impact seed protein yield (kg ha^{-1}). Specifically, the utilization of 5 t ha^{-1} FYM resulted in a significantly higher seed protein yield (173 kg ha^{-1}) compared to the no FYM treatment.

Farmyard manure can enhance soil fertility, improve nutrient availability and enhance nutrient uptake by plants. The increased nutrient uptake might be attributed to improved soil structure, increased microbial activity, and better nutrient release from the organic matter in the FYM. The specific result where 5 t ha^{-1} FYM led to elevated nutrient uptake compared to no FYM treatment can be attributed to the fact that at this level, the supply of essential nutrients exceeded the plant's baseline requirements. Our findings align with the research conducted by Meena *et al.* (2013) and Meena *et al.* (2018).

Effect of Biofertilizers on nitrogen, phosphorus, potassium content, its uptake, seed protein content, and seed protein yield (Kg ha^{-1}) of mungbean crop

The variation in nitrogen, phosphorus, and potassium content in mungbean seed and straw, resulting from different biofertilizers, did not exhibit statistical significance (Table 3).

Similarly, the influence of various biofertilizers on the uptake of nitrogen, phosphorus, and potassium by the mungbean crop was not statistically significant (Table 3).

The impact of different biofertilizers on both seed protein content (%) and seed protein yield (kg ha^{-1}) in the mungbean crop was not found to be statistically significant (Figure 2).

All the interaction effects were found non-significant.

CONCLUSION

Higher fertilizer dosages, appropriate FYM levels, and various biofertilizers can positively impact mungbean crop growth, yield, and nutrient uptake. The interactions between different factors did not yield significant effects. These findings contribute valuable insights for optimizing agricultural practices to enhance mungbean productivity while considering sustainable and efficient resource utilization.

LITERATURE CITED

Anonymous, 2020.Annual report 2019-2020, All India Coordinated Research Project on MULLaRP. ICAR, Indian Institute of Pulses Research, Kanpur (Uttar Pradesh), India; 2020.

Bam, R., S.R. Mishra, S. Khanal, P. Ghimire, and S. Bhattarai, 2022. Effect of biofertilizers and nutrient sources on the performance of mungbean at Rupandehi, Nepal. J. Agric. Food Res. 10:100404.

Fernandes, P. and S.A. Bhalerao.2015.Effect of biofertilizer on the growth and biochemical parameters of Mungbean (*Vigna radiata*), Int. J. Adv. Res. Biol.Sci. 2(4): 127–130.

Giri, M.D., M.P. Meshram, R.V. Zanzad, and K.T. Lahariya, 2020. Standardization of plant spacing and fertilizer dose for the newly developed mungbean variety AKM-12-28, PKV Res. J., 44 (2):23-28.

Chaudhary, H.R. Integrated Nutrient Management in Mungbean [*Vigna radiata* (L.) Wilczek]. M.Sc. Thesis (Unpub.), RAU, Bikaner, 2010.

Jain, A.K., S. Kumar and J. Panwar, 2007. Response of mung bean (*Vigna radiata* L.) to phosphorus and micronutrients on N and P uptake and seed quality, Legume Res., 30 (3): 201–204.

Kumar, S., R.S. Meena, P. Kumar, R. Dadhich and A. Singh, 2013. Effect of different spacing and fertilizer levels on yield parameters of mungbean under guava-based Agri-Horti system, J. Progressive Agric., 4(2): 14-16.

Meena, M.D. and D.R., Biswas. 2013. Residual effect of rock phosphate and waste mica enriched compost on yield and nutrient uptake by soybean, Legume Res., 36: 406 – 413.

Meena, N.R., M.K. Meena, K.K. Sharma and M.D. Meena. 2018. Effect of zinc enriched farm yard manures on yield of mung bean and Physico-Chemical Properties of soil. Legume Res. 41(5): 734-739.

Muchira, B., P. Kamau and D. Mushimiyimana, 2018. Effects of spacing and fertilization on growth and grain yields of mungbean (*Vigna radiata* L) In dry areas of Subukia, Kenya, Int. J. Advanced Res. Pub., 2 (7): 3044.

Rana, A., M. Joshi, R. Prasanna, Y.S. Shivay, L. Nain. 2012. Biofortification of wheat through inoculation of plant growth-promoting Rhizobacteria and cyanobacteria, Eur. J. Soil Biol. 50:118-126.

Sheoran, O.P., D.S. Tonk, L.S. Kaushik, R.C. Hasija and R.S. Pannu, 1998.Statistical Software Package for Agricultural Research Workers, Recent Advances in information theory, Statistics & Computer Applications Department of Mathematics Statistics, CCS HAU, Hisar, India : 139-143.

Tena, W., E. Wolde-Meskel, F. Walley, 2016. Symbiotic efficiency of native and exotic Rhizobium strains nodulating lentil (Lens culinaris Medik.) in soils of southern Ethiopia, Agronomy 6: 1–11.

Verma, G., M., Singh, J., Morya, and N., Kumawat. 2017. Effect of N, P and Biofertilizers on Growth Attributes and Yields of Mungbean [*Vigna radiata* (L.) Wilczek] under Semi-arid Tract of Central India, Int. Arch. App. Sci. Technol; 8(2): 31-34.

Yin Z., W. Guo, H. Xiao, J. Liang, X. Hao, N. Dong. 2018. Nitrogen, phosphorus, and potassium fertilization to achieve expected yield and improve yield components of mungbean, PLoS ONE 13(10) : e0206285.

* * *

Received on 25 September, 2022 - Accepted on 5 November, 2022

Effect of Pre and Post Emergence Herbicides on Nutrients Uptake, Microbial Population, Growth and Yield of Bt Cotton (*Gossypium hirsutum* L.)

S. U. Kakade[1]*, S. P. Mohite[2], J. P. Deshmukh[3] and O. S. Rakhonde[4]

ABSTRACT

The field experiment was conducted at AICRP-Weed Management, Agronomy farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the "Effect of Pre and post emergence herbicides on nutrients uptake, microbial population, growth and yield of Bt cotton (*Gossypium hirsutum* L.)" during the *kharif* season of 2019-20 to study the relative efficacy of herbicides and cultural practice on weed control and its effect on growth,nutrient uptake, microbial population, yield and economics of cotton. The experiment was laid out in randomized block design with eight treatments of pre-emergence and post emergence herbicides replicated thrice. The results revealed that, among the various treatments under study, weed free treatment (2 hoeing *fb* 2 hand weeding) recorded significantly higher values of growth, yield attributes and major nutrient uptake by crop whereas, among the herbicidal treatments Pendimethalin 1.0 kg ha^{-1} as pre-emergence *fb* Paraquat dichloride 0.6 kg ha^{-1} was found to be effective in controlling the weeds and found next best treatments.Significantly maximum nitrogen,phosphorus and potassium uptake(47.13 kg ha^{-1} 16.29 kgha^{-1}, 63.29 kg ha^{-1})were observed in the farmers practice (2 Hoieng *fb* 2 hand weeding) followed by in the sequential application of Pendimethalin 1.0 kg ha^{-1} PE *fb* Paraquat dichloride 0.6 kg ha^{-1} PoE 30-35 DAS.After spraying of herbicides there was decline in rate of bacteria,fungi and actinomycets population by different treatments,however there was increased in population at harvest of the crop. Maximum microbial population was recorded in weedy check.Among the herbicides,the pre-emergence application of pendimethalin 1.0 kg ha^{-1} pre fb paraquat dichloride 0.6 kg ha^{-1} recorded highest seed cotton yield (1723 kg ha^{-1})and hence was found most economical with maximum GMR of Rs.101684 Rs. ha^{-1} and B: C ratio of 2.36.

Cotton (*Gossypium hirsutum* L.) is an important commercial fiber crop belonging to *Malvaceae* family grown under diverse conditions around the World. It is called as a 'White gold' and as 'King of fiber crops. Cotton production in India during 2021-2022 was 315.43 lakh bales of 170 kg from 120.55 lakh hectares with productivity of 445 kg lint ha^{-1} (Anonymous,2022). Maharashtra comes under central zone contributing with production of 77.90 lakh bales with the productivity of 306 kg ha^{-1} occupying an area of 39.37 lakh hectares in 2021-22. Cotton is one of the most important cash crops of Vidarbha but average yield per hectare is quite low (363 kg ha^{-1}).

Cotton crop is sensitive to weed competition during initial growth stages due to slow growth and wider spacing. Weeds compete for nutrients, water, light and thus reduce cotton yield substantially (Bukun, 2004). Cotton, a long duration crop coupled with heavy rains during the early vegetative stage inhibits manual and mechanical methods of weed control causing heavy yield loss. Sharma (2008) reported that the losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of weeds. In case of heavy rains, providing timely weed management becomes difficult as soil becomes sticky and wet leading to poor workability while in dry soil, the surface becomes hard making inter-row cultivation difficult. Also, non-availability of human labour for weeding makes timely weed control tedious and uneconomic. Chemical weed control became more important and attractive to farmers (Zhang and Huang, 1999).Timely and effective weed management practices also play an important role in boosting the production of cotton. In India manual and mechanical method of weed control continues to be the mainstay for the control of weeds. These methods are uneconomical, cumbersome in controlling weeds. Manual weeding has traditionally been a labour-intensive operation and hence there is no other alternative rather than use of post-emergence herbicides for control of weeds in the later growth stages of cotton.The weeds (annual and perennial) in cotton can be effectively controlled by non-selective post-emergence application of herbicide like

1. Assistant Professor (Agronomy),Cotton Research Unit,2. PG Student,3. Associate Professor & Chief Scientist,IFSR Unit,4. Assistant Professor (SSAC), Dr. PDKV, Akola

paraquat dichloride, glyphosate, glufosinateammonium etc. Therefore, the use of herbicide as a post-emergence could prove efficient and economical for timely weed control in cotton. Askew *et al*. (2002) reported that weeds were controlled and yield was increased by the application of herbicides at different levels. The pre-sowing and pre-emergence herbicides are not effective against all weeds, whereas, post-emergence herbicides can control weeds. In the absence of interculture and with regular monsoon rains, weeds germinate in different spells and compete with crop plants and finally reduce the seed cotton yield. Hence, there is a need to go for application of non-selective post-emergence herbicides to manage the weeds to eliminate weed competition throughout the critical period for getting higher cotton yield.Nowadays, soil health and microbial diversity have become vital issues for the sustainable agriculture. Loss of microbial biodiversity can affect the functional stability of the soil microbial community and soil health. With the changing scenario of weed management farmers need post-emergence herbicides and there is an urgent need to evaluate the performance of new herbicides for effective weed management in cotton, hence present investigation was conducted to study the "Effect of Pre and post emergence herbicides on nutrients uptake, microbial population, growth and yield of Bt cotton (*Gossypium hirsutum* L.)"with the objectives to study the relative performance of different post-emergence herbicides on nutrient uptake,microbial population, growth, yield and economics in cotton.

MATERIAL AND METHODS

The field experiment was conducted at AICRP-Weed Management, Agronomy farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the "Effect of Pre and post emergence herbicides on nutrients uptake, microbial population, growth and yield of Bt cotton (*Gossypium hirsutum* L.)"during the *kharif* season of 2019-20 to study the relative efficacy of herbicides and cultural practice on nutrient uptake, microbial population, growth and yield of cotton. The experiment was laid out in randomized block design with eight treatments of pre-emergence and post emergence herbicides replicated thrice.The treatments comprised of chemical weed management practices i.e. pendimethalin (PE) 1.0 kg a.i. ha^{-1} (T_1), metalachlor (PE) 50%EC 2.0 kg ha^{-1} (T_2), pendimethalin (PE) 1.0 kg ha^{-1} pre *fb* paraquat dichloride24 per cent SL (POE) 0.6 kg ha^{-1} (T_3), paraquat dichloride24 per cent SL (POE) 0.5 kg ha^{-1}(T_4), glufosinate ammonium 13.5 per cent SL(POE) 0.45 kg ha^{-1}, glyphosate 71 WG (POE) 1.0 kg ha^{-1}, 2 hoeing *fb* 2 hand weeding (T_7), and weedy check (T_8). The soil of experimental field was clayey in texture, low in available nitrogen(197.32 kg ha^{-1}), medium in available phosphorus(12.60 kg ha^{-1}) and high in potassium (339.85 kg ha^{-1}). Cotton seed variety (PKV Hybrid-2 Bt) was sown on 1st July 2019 at 90 x 60 cm spacing with 60:30:30 kg ha^{-1} NPK. During the *kharif* season of 2019, the total rainfall received (22th MW 2019 to 1st MW 2020) at Akola center was 929 mm in 57 rainy days.The application of herbicide was done as per the treatments with manually operated knapsack sprayer attached with a flood jet nozzle. All the non-selective post emergence herbicides were sprayed as directed post emergence towards weed. After calibrating the sprayer, water volume used was 700 lit. ha^{-1} for PE and 500 lit. ha^{-1} for PoE. The biometric observations were recorded on these plants periodically at 30 days interval till maturity of crops.Cost of cultivation, gross returns and benefit cost ratio for each treatment were calculated by taking into consideration of total costs incurred and returns obtained. Data on various growth and yield attributing characters were statistically analyzed as per the standard procedure. Chemical analyses of crop plants for uptake study were carried out by taking representative sample from each net plot at harvest of crop. The samples were oven dried at 60±5 ^{0}C for 24 hrs. and then powdered samples were utilized for extraction of various elements. Serial dilution plate technique was used for isolation and enumeration of soil fungi, actinomycetes and bacteria as described by Pahwa and Prakash (1996).

RESULTS AND DISCUSSION

Nutrients Uptake by Crop

The data presented in Tables 1 revealed that the weed control treatments significantly influenced the major nutrients uptake by crop at harvest. Significantly maximum nitrogen uptake (47.13 kg ha^{-1}) was observed in the farmers practice (2 Hoieng *fb* 2 hand weeding) followed by in the treatment of herbicide application i.e. the sequential application of Pendimethalin 1.0 kg ha^{-1} PE *fb* Paraquat

Table 1: Nutrients uptake by crop and microbial population as influenced by weed control treatments

Treatments	Nutrient Uptake by crop (Kg ha^{-1})			Bacterial count (cfu g^{-1} soil × 10^7)		Fungal count (cfu g^{-1} soil × 10^4)		Actinomycets counts (cfu g^{-1} soil × 10^6)	
	N	P	K	After Spray	At Harvest	After Spray	At Harvest	After Spray	At Harvest
T_1 : Pendimethalin 1.0 kg ha^{-1} PE	39.11	13.18	54.59	17.33	24.31	10.60	14.21	10.85	14.31
T_2 : Metalachlor 50% EC 2.0 kg ha^{-1}PE	37.26	13.51	53.18	17.10	23.70	10.33	12.32	10.45	14.12
T_3 : Pendimethalin 1.0 kg ha^{-1}PE *fb* Paraquat dichloride 0.6 kg ha^{-1}PoE 30-35 DAS	45.19	14.86	60.91	15.76	26.40	9.72	13.45	9.71	15.87
T_4 : Paraquat dichloride 24%SL 0.5 kg ha^{-1}PoE 30-35 DAS	41.38	14.00	57.16	16.59	25.10	10.04	14.26	11.45	14.59
T_5 : Glufosinate ammonium 13.5%SL 0.45 kg ha^{-1} PoE 30-35 DAS	44.34	14.63	60.15	16.67	26.13	10.17	13.11	11.62	15.30
T_6 : Glyphosate 71 WG @ 1.0 kg ha^{-1}PoE 30-35 DAS	42.15	14.10	58.22	16.83	25.80	9.93	12.65	11.72	14.91
T_7 : 2 Hoieng*fb* 2 hand weeding(Farmers practice)	47.13	16.29	63.29	20.13	27.39	12	14.65	14.29	16.53
T_8 : Weedy check	33.79	11.31	45.50	23.79	28.30	14.11	16.89	15.84	17.84
S.E(m)±	0.53	0.44	0.48	0.63	1.64	0.68	0.87	0.61	0.93
CD at 5%	1.62	1.34	1.46	1.91	-	2.06	-	1.85	-

Table 2: Growth, yield attributes, seed cotton yield (Kg ha^{-1}) and economics as influenced by weed control treatments

Treatments	Dry matter plant^{-1} (g)	No. of sympodia at harvest	No. of Bolls Picked plant^{-1}	Weight of seed cotton(g) plant	Seed cotton yield (kg ha^{-1})	GMR (Rsha^{-1})	NMR (Rs ha^{-1})	B:C ratio
T_1 : Pendimethalin 1.0 kg ha^{-1} PE	156.45	21.12	25.95	69.87	1293	76901	37998	1.97
T_2 : Metalachlor 50% EC 2.0 kg ha^{-1}PE	152.33	20.63	25.13	65.78	1217	72493	34001	1.88
T_3 : Pendimethalin 1.0 kg ha^{-1}PE *fb* Paraquat dichloride 0.6 kg ha^{-1}PoE 30-35 DAS	176.59	24.43	30.28	93.10	1723	101684	58747	2.36
T_4 : Paraquat dichloride 24%SL 0.5 kg ha^{-1}PoE 30-35 DAS	160.59	21.28	26.75	75.86	1404	83388	45458	2.16
T_5 : Glufosinate ammonium 13.5%SL 0.45 kg ha^{-1} PoE 30-35 DAS	173.15	23.35	29.87	89.56	1657	97863	56132	2.34
T_6 : Glyphosate 71 WG @ 1.0 kg ha^{-1}PoE 30-35 DAS	163.71	22.37	27.12	77.28	1430	84919	46260	2.23
T_7 : 2 Hoieng*fb* 2 hand weeding(Farmers practice)	182.83	25.34	32.61	101.68	1882	110675	60507	2.20
T_8 : Weedy check	107.33	13.37	19.78	50.5	935	56520	22341	1.65
S.E(m)±	3.38	0.82	0.99	4.15	89.30	4296	4296	-
CD at 5%	10.26	2.50	2.99	12.51	270.85	13032	13032	-

dichloride 0.6 kg ha^{-1} PoE 30-35 DAS.This treatment was found at par with treatment of Glufosinate ammonium 13.5 per cent SL 0.45 kg a.i. ha^{-1} PoE 30-35 DAS.The lowest nitrogen uptake was recorded in weedy check (33.79 kg ha^{-1}). This might be due to more weed competition with cotton crop in this treatment and more uptake of nitrogen by weeds than crop. Similar results were also reported by Patil *et al*. (1998) and Pawar *et al.* (2000). Similar trend of phosphorus uptake and potassium uptake was observed due to different weed management treatments.Lowest uptake of all the major nutrients was recorded in weedy check due to high weed density diverted nutrients for their growth. The result showed that the NPK uptake by crop was highest in treatment of farmers practice might be due to less competition of plant and weed for nutrient, however in weedy check, the rate of uptake of NPK by crop was very slow because the weed suppress the vegetative growth of plants by competition for light, moisture and nutrient. Kakade *et al*. (2002) reported that the maximum uptake of nutrients by cotton crop was under weed free condition and minimum under weedy check treatment.

Effect on Microbial Population

Data pertaining to microbial population after herbicide spray and at harvest of the crop are presented in Table 1. There was decrease in population of all the microbial population after spraying of herbicides, however the population was recovered at harvest stage. The data indicated that,bacterial count after herbicide spray was significantly higher in weedy check (23.79 cfu g^{-1} soil × 10^7**)** than rest of the treatments followed by farmer's practice (20.13 cfu g^{-1} soil × 10^7).The bacterial population was found lower in the treatments where different pre and post emergence herbicides were sprayed.Higher count of all this microflora was recorded in weedy check as no chemicals were used in these treatments. However this was comparable with the count as observed in weed free treatments. There was non-significant differences among the different herbicides spray. Similar results regarding bacterial population were reported earlier by Pal *et al.* (2009) and Ghosh *et al.* (2012). Similar trend of fungi and actinomycetes population were also reported as similar to bacterial population. Significantly maximum population of fungi (14.11 cfu g^{-1} soil × 10^4) and actinomycetes (15.84 cfu g^{-1} soil × 10^6) was recorded in the treatment of weedy check as no herbicide was sprayed in this treatment.

After spraying of herbicides there was decline in rate of bacteria,fungi and actinomycets population by different treatments,however there was increased in population at harvest of the crop.Similar results were also obtained by Pal *et al*. (2009), Sebiomo *et al*. (2011) and Trimurthulu *et al.* (2015).It was clear that the persistence of herbicide on soil microbes was for a temporary period. The increase in microbial population might be due to after decomposition of herbicide, there is activation of different function group attached to herbicide.After decomposition of herbicide it release carbon molecules which are useful for enhancing microbial population in soil .It might be due to the degradation of herbicides may be serving as carbon source for growth of microbes. The microbial population started to regain after the weeds were killed by the herbicides and got mixed in the soil during this period and these might have served to increase the nutrients. It was in conformity with the results of Pal *et.al*. (2009) and Ghosh *et al*. (2012).

Effect on growth, yield attributes and seed cotton yield

The growth, yield attributes and seed cotton yield were influenced significantly due to weed management practices. At harvest, significantly maximum total dry matter g plant^{-1} (182.83g) and number of sympodial branches (25.34) were recorded under treatment of 2 Hoieng *fb* 2 hand weeding (weed free) than rest of the treatment, but it was found at par with pendimethalin 1.0 kg ha^{-1} pre *fb* Paraquat dichloride 0.6 kg ha^{-1} and glufosinate ammonium 13.5 per cent SL 0.45 kg ha^{-1}and followed by glyphosate 71 WG @ 1.0 kg ha^{-1}. This may be due to weed free situation in early stage of the crop growth in these treatments for their growth and development as compared to other treatments and also may be because weed control period in these treatments coincide with the critical period of crop weed competition for cotton which has reflected in higher growth characters. Similar results were also earlier reported by Sangle *et al*. (2007) and Veeramani *et al*. (2009) and Bhoi *et al*. (2010). Lowest dry matter accumulation (107.33 g) and sympodial branches per plant (13.37) were recorded in weedy check treatments.

The yield attributes viz.number of bolls per plant and weight of seed cotton per plant influenced due to pre-emergence,post emergence and cultural practices. Maximum number of bolls(32.61) and weight of seed cotton per plant(101.68 g) was observed in weed free treatment of farmers practice i.e.2 hoeing and 2 hand weeding. However, among the herbicides pendimethalin 1.0 kg ha^{-1} pre *fb* paraquat dichloride 0.6 kg ha^{-1} registered maximum boll numbers(30.28) and weight of seed cotton (93.10 g) followed by glufosinate ammonium 13.5 per cent SL 0.45 kg $ha^{-1}$and further followed by glyphosate 71 WG @ 1 kg ha^{-1}which were found at par with each other.

Different weed management practices registered significant increase in seed cotton yield compared to weedy check. Among the treatments,weedy check registered the lowest average seed cotton yield (935 kg ha^{-1}), whereas the herbicide treatment pendimethalin 1.0 kg ha^{-1} pre *fb* paraquat dichloride 0.6 kg ha^{-1} (1723 kg ha^{-1}) proved as effective as weed free treatment of 2 hoeing and 2 hand weeding (1882 kg ha^{-1}) and recorded significantly higher seed cotton yield over rest of the treatments. It may be due to better control of weeds initially by pre-emergence spray and after that late emerging weeds were controlled by post emergence herbicides like paraquat dichloride and glufosinate ammonium. The higher yield in these treatments might be due to more availability of nutrients and moisture as there was less competition between weeds and crop. Similar results were also reported by Sangle *et al*. (2007), Biswas *et al*. (2019) and Kalaisudarson *et al.* (2019)

Economics

As indicated in Table 2, weed management practices influenced the economics of cotton compared to weedy check. The maximum GMR (Rs. 110675 ha^{-1}) and NMR (Rs. 60507 ha^{-1}) was registered in weed free practice of 2 hoeing and 2 hand weeding followed by pendimethalin 1.0 kg ha^{-1}pre *fb* paraquat dichloride 0.6 kg ha^{-1}. With GMR of Rs. 101684 ha^{-1} and NMR of Rs. 58747 ha^{-1}. These two treatments recorded identical values. This might be owing to good seed cotton yield obtained under these treatments because of better management of weeds. The GMR, NMR, and B:C ratio was lowest in weedy check due to more weed density and lesser yield. These results are in conformity with those reported by Shivashenkaramurthy (2000), Bhol *et al.* (2007) and Kalaisudarson and Shrinivas (2019). However, sequential application of pre-emergence herbicide pendimethalin and paraquat dichloride registered maximum B:C ratio of 2.36 compared to B:C ratio of 2.20 in cultural weed management practice.The differences in B:C ratio is due to the cost of herbicides and productivity of the crop. These results are in conformity with those reported by Prabhu (2012) and Hiremath *et al*. (2013).Though the weed free treatment (2 hoeing *fb*2 hand weeding) resulted in highest seed cotton yield (1882 kg ha^{-1}) owing to 90.68 per cent weed control efficiency but could not found as profitable as herbicidal treatment due to higher expenditure incurred on engaging more labours. Similar results was obtained by Shantveerayya andAgasimani.(2011).

CONCLUSION

It is concluded that, pre-emergence application of pendimethalin 1.0 kg ha^{-1} pre *fb* paraquat dichloride 0.6 kg ha^{-1}or Glufosinate ammonium 13.5 per cent SL 0.45 kg ha^{-1} PoE 30-35 DAS found to be more effective in getting higher seed cotton yield,nutrients uptake and economic returns in Bt cotton.The study also showed that there was a temporary suppression in population of beneficial microorganisms but with passage of time the population again recovered in the biological soil environments.

LITRATURE CITED

Anonymous, 2022. Meeting of the Committee on Cotton Production and Consumption (COCPC).

Askew, S.D., J.W., Wilcut and Cranmar, 2002. Cotton (*Gossypium hirsutum* L.) weed response to flumioxazin applied pre-plant and post-emergence directed, Weed Technol., 16(1): 184-190.

Bhoi, S.K., R. Lakpale, A. Jangre and S. Mishra, 2010. Studies on the effect of weed control methods on growth and yield attributes of hybrid cotton, Res. J. Agric. Sci., 1(4): 434-437.

Bhol, S., R. Lakpale, H.C., Nanda and G.K. Shrivastava. 2007. Effect of weed management practices on productivity and economics of hybrid cotton in vertisols of Chhattisgarh plains, J. Agril. 12 (2):118-121.

Biswas, S. and D. Dutta. 2019. Phytotoxic effects of glufosinate ammonium on cotton and soil micro-flora, Indian J. Weed Sci., 51(4): 362–367.

Bukun, A. 2004. Critical periods for weed control in cotton in Turkey, European Weed Res. Soc. Weed Res., 44: 404-412.

Ghosh, R.K., P. Jana, D. Nongmaithcm, D. Pal, S. Bera, S. Mallick, S. Barman and R. K. Kole. 2012. Prospects of botanical herbicides in system of crop intensification in the GangaticInceptisols of India, In: Proceedings of 6thInternational Workshop on Software Clones, Hangzhou, China, 17-22:116-117.

Hiremath, R., G.S. Yadahalli, B.M. Chittapur, A.D. Siddapur, V.G. Yadahalli and B. R. G. Koppalkar, 2013. Efficacy of chemical weed management in Bt cotton (*Gossypium hirsutum* L.), Acta Biol. Indica., 2(2): 425-429.

Kakade, S.U., P.D Thakre, B.M. Patil and S.T. Dangore, 2002. Effect of sequential application of pre emergence and post emergence herbicides on nutrient uptake and economic s of weed control in cotton, Crop Res., 23(1):116-120.

Kalaisudarson, S. and A.P. Srinivasaperumal, 2019. Effect of chemical method on weed management in hybrid cotton. Plant Archives.,19(1): 809-812

Pahwa, S.K. and J. Prakash, 1996. Studies on the effect of herbicide on the effect of herbicide on the growth, nodulation and symbiotic nitrogen fixation in mungbean, Indian J. Weed Sci., 28(3 &4): 160-163.

Pal, D., R.K. Ghosh, G. Sounda, A.K. Dolai, Pramanick and M. Mallick, 2009. Bio-efficacy of some promising herbicides in transplanted kharif rice and their influence on soil microflora, Indian Agriculturist., 53(3/4): 193-198.

Patil, B. M., Satao R. N. and G. S. Lohariya, 1998. Integrated weed management in cotton, PKV Res. J., 21 (2): 220-221.

Pawar, A. K., B.M. Patil., A. P.Karunakar and R. N. Satao, 2000. Effect of pre and post emergence herbicides on weed control and yield of cotton, Pestology.,24 (7):35-36.

Prabhu,G., A.S. Halepyati, B.T. Pujari and B.K.Desai, 2012. Weed management in Bt cotton (*Gossypium hirsutum* L.) under irrigation, Karnataka J.Agril. Sci., 25: 183-186.

Sangle, B. B., H.M. Patil, A.V. Khairnar and A.G. Wani, 2007. Effect of crop geometries and weed control treatments on yield and quality parameters of irrigated cotton (*Gossypium hirsutum* L.), J. Farming System Res. and Develop..,13(2): 260-262.

Sebiomo, A., V.M. Ogundero and S.A. Bankole, 2011. Effect of four herbicides on microbial population, soil organic matter and dehydrogenase activity, African J. Biotechnol., 10 (5): 770-778.

Shantveerayya H. and C.A. Agasimani, 2011. Effect of herbicides on weed control and productivity of maize (*Zea mays* L.), Karnataka J. Agril. Sci., 25 (1): 137-139.

Sharma, R. 2008. Integrated weed management in field crops, Crop Care., 35 (4): 41- 46.

Shivashenkarmurthy, M., 2000. Sequential application of herbicides for control of *Cyperus rotundus* and *Cynodon dactylon* L.Pers. in hybrid cotton, M.sc.(Agri) Thesis (Unpub.), UAS, Dharwad, Karnataka (India).

Trimurthulu, N., S. Ashok, M. Latha and A. Subramanyeswara Rao, 2015. Influence of Pre-emergence Herbicides on the Soil Microflora during the Crop growth of Blackgram, Vigna mungo. L, Int. J. Curr. Microbial. App. Sci., 4(6): 539-546.

Veeramani, A.,P. Prema and V. Ganesaraja, 2009. Effect of pre and post sowing weed management on weeds, growth and yield of summer irrigated cotton, International J. Agric. Sci., 5(1): 182-186.

Zhang, Y.J and H. Huang, 1999. The review and strategy of agricultural chemical weed control, Proceedings of the 6th Weed Science Conference of China Sustainable Weed Management.

* * *

Received on 10 October, 2022 - Accepted on 22 November, 2022

Weed Management Indices as Affected by Different Weed Control Treatments in *Kharif* Grain Sorghum [*Sorghum bicolor* (L.) Moench]

Pritam Bhutada[1], G. V. Thakre[2] and G. M. Kote[3]

ABSTRACT

An experiment was conducted to study the efficacy of different herbicide alone and in combination against weeds in grain sorghum at Sorghum research station, VNMKV, Parbhani, (MS) India having 16 treatment viz., T_1: Atrazine 50 WP @ 0.50 kg a.i. ha^{-1} , T_2: Metolachlor 50 per cent EC @ 1.00 kg a.i. ha^{-1} as PE , T_3: Pyroxasulfone 85 per cent w/w WG @ 0.1275 kg , T_4: T_1 + Bentazone 480 g/l SL @ 960 g a.i. ha^{-1} , T_5: T_1 + Mesotrione 2.27 per cent w/w + Atrazine , T_6: T_1 + Carfentrazone ethyl 40 per cent DF @ 20 g ,T_7: T_2 + Bentazone 480 g/l SL @ 960 g a.i. ha^{-1} , T_8: T_2 + Mesotrione 2.27 per cent w/w + Atrazine , T_9: T2 + Carfentrazone ethyl 40 per cent DF @ 20 g , T_{10}: T_3 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1} , T_{11}: T_3 + Mesotrione 2.27 per cent w/w + Atrazine , T_{12}: T_3 + Carfentrazone ethyl 40 per cent DF @ 20 g , T_{13}: T_1 (PE & POE), T_{14}: T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i. ha^{-1} and T_{15}: Weed free (15 and 35 DAS) replicated twice in randomized block design during growing seasons of 2021-22. Weed indices were calculated which advocated that all the chemical weed control treatments significantly reduced the weed infestation over weedy check. Study shows that application pre-emergence T_2: Metolachlor 50 per cent EC @ 1.00 kg a.i. ha^{-1} as PE and T_3: Pyroxasulfone 85 per cent w/w WG @ 0.1275 kg a.i. ha^{-1} as PE in grain sorghum, reduced grain sorghum yield compared to atrazine treatments and treatment T_3: Pyroxasulfone 85 per cent w/w WG @ 0.1275 kg a.i. ha^{-1} as PE application affect germination of grain sorghum recorded minimum germination recoded 62 per cent WCE. Treatment T_{15}: Weed free (15 and 35 DAS) recorded highest yield (2605 kg ha^{-1}) which was found at par with the treatment T_{14}: T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i. ha^{-1} T_1: Atrazine 50 WP @ 0.50 kg a.i. ha^{-1} (PE) &T_6: T_1 + Carfentrazone ethyl 40 per cent DF @ 20 g a.i. ha^{-1} as PoE at 3-4 leaves. These treatments shows high WCE and lower WI over rest of treatment and found statistically at par grain yield of grain sorghum as in weed free condition which may be due to higher accumulation of growth and yield attributes of grain sorghum due to lower weed-crop competition.

Grain sorghum mostly famous to grown for food, feed, poultry feed, fencing, pet food, or even for ethanol production. One major advantage of grain sorghum is it's have ability to maintain yields under vegetative drought stress (Kebede *et al.,* 2001). Though extreme drought during reproduction can greatly reduce yields, complex plant responses allow for grain sorghum to adapt to pre-reproduction drought conditions (Crasta *et al.,* 1999). This unique feature of grain sorghum makes it a staple crop in many arid and semi-arid countries (Dicko *et al.,* 2006). *Kharif* Grain Sorghum Production in Maharashtra is an underutilized crop in production systems. Low commodity prices for grain sorghum reduce a grower's potential for a high net return if sub-optimal yields are produced. These low yields often deter producers from planting a risky crop such as grain sorghum and causes them to rely on higher-priced cash crops. Cultural Weed Management in Grain Sorghum Cultural practices are practice that producers can implement simple yet cost effective. During *Kharif* season follow culturally weed management practices may be difficult to adapt as uneven distribution of rainfall it sometime because left the critical growth stage of weed management ultimate reduction in yield. While cotton (*Gossypium hirsutum* L.), corn, soybean, and rice producers may be able to cope with this issue by use of new herbicide-resistant crop technologies, grain sorghum producers are restricted to a narrow selection of labeled herbicides. This small list of herbicides has forced growers to diversify their weed management practice in grain sorghum. Weed control in grain sorghum during rainy season is a major challenge because of the limited number of herbicides available to growers and irregular rainfall cause limit to mechanical weeding. Also atrazine is only herbicide which used in sorghum but now days there are emerging issues about atrazine this lead to search alternative for atrazine herbicide or with combination of

1 &3. Assistant Professor, Sorghum Research Unit, VNMKV, Parbhani (M.S.) and 2. Assistant Professor, Sorghum Research Unit, Dr. PDKV, Akola (M.S.)

different herbicide PE and PoE may helps to control weed in grain sorghum. Competition from broadleaf weeds reduced grain sorghum yields more than grass species competition or mixtures of broadleaf and grass weeds. However, weed competition in sorghum crop found in first 2 wks after that crop emergence has not reduced grain sorghum yields. Sorghum yields were not different when weeds were removed 1, 2 or 3 weeks after planting and each week thereafter, but a significant yield decrease occurred each week when weeds were not removed for 4, 5, 6, or 8 weeks. Sorghum kept weed-free the first 4weeks after planting showed little yield loss from weeds emerging later. (Burnside and Wicks, 1967**).**

MATERIAL AND METHODS

Field Studies

Studies were conducted during the 2021-22 *kharif* growing seasons at AICSIP, Sorghum Research Station, VNMKV, Parbhani site having latitude 19.251624 longitude 76.767015 Soil type of study site was a clayey soil (Black cotton soil) with 0.53 organic matter and pH 7.6 Experiment was conducted in randomized complete-block design with 16 treatment and were replicated twice. Plot size are Gross: 4.50 m X 5.10 m & Net: 2.70 m x 4.50 m. Row to row and plan to plant Spacing used as 45 cm X 15 cm for this experiment Parbhani Shakti sorghum genotype used. Sowing of experiment was carried out on 17th July 2021 and harvested on 23rd Nov 2021 and fertilizer and plant protection was followed as per recommendation. Following treatment combinations were used

Treatments: 16

T_1 : Atrazine 50 WP @ 0.50 kg a.i. ha^{-1}
T_2 : Metolachlor 50 % EC @ 1.00 kg a.i. ha^{-1} as PE
T_3 : Pyroxasulfone 85% w/w WG @ 0.1275 kg
T_4 : T_1 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}
T_5 : T_1 + Mesotrione 2.27% w/w + Atrazine
T_6 : T_1 + Carfentrazone ethyl 40% DF @ 20 g
T_7 : T_2 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}
T_8 : T_2 + Mesotrione 2.27% w/w + Atrazine
T_9 : T_2 + Carfentrazone ethyl 40% DF @ 20 g
T_{10}: T_3 + Bentazone 480 g l^{-1} SL @ 960 g a.i./ha
T_{11}: T_3 + Mesotrione 2.27% w/w + Atrazine
T_{12}: T_3 + Carfentrazone ethyl 40% DF @ 20 g
T_{13}: T_1 (PE & POE)
T_{14}: T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i. ha^{-1}
T_{15} : Weed free (15 and 35 DAS)
T_{16} : Weedy check

Indices used forstudy

Weed density: Weed counts and species distribution were done 20 days after application of pre-emergence herbicides which coincides with the three - leaf stage of crop. The second weed count was done at 20 days after application of post emergence herbicide and 3rd at aharvest. Counting and identification of weed species was done from 1 m^2 quadrat thrown randomly in each plot.

Weed dry matter: It was taken at as per duration of weed count 20 DAS of PE and 20 DAS of PoE by harvesting all the above ground growth of weeds within the 1 m^2 quadrat thrown randomly in each experimental plot. The weeds were gathered together and put in a paper bag and later oven-dried at a temperature of 60°C to a constant weight. The oven-dried weight in grams was then converted to kgha^{-1} for each plot.

Weed control efficiency (WCE) is the percentage of weed reduction due to a weed control treatment and is a measure of effectiveness of control method (Das, 2008).

$$WCE = \frac{DMC - DMT}{DMC} \times 100$$

Weed persistence index (c) by(Mishra and Mishra, 1997).

$$\frac{\text{Dry weight of weeds in treated plot}}{\text{dry weight of weeds in control plot}} \times \frac{\text{weed count in the control plot}}{\text{Weed conut in the treated plot}}$$

Weed Control Index (WCI): worked out taking into consideration the reduction in weed population in treated plot over weed population in unweeded check. It is expressed in per cent.

$$WCI = \frac{WPC - WPT}{WPC} \times 100$$

Where,

WPC = Weed population in control (unweeded) plot.

WPT = Weed population in treated plot.

Herbicide Efficiency Index (HEI) = Indicates the weed killing potential of a herbicide treatment and its phytotoxicity on the crop

$$HEI = \frac{(YT-YC)/YC}{WT/WC}$$

Agronomic Management Index (AMI)

$$AMI = \frac{Yt-yc}{yc} - \frac{wc-wt}{wc} \Big/ \frac{wc-wt}{wc}$$

Where,

YT = Yield of treated plot.

YC = Yield of control (unweeded) plot.

WC = Weed dry weight in control (unweeded) plot.

WT = Weed dry weight in treated plot.

RESULTS AND DISCUSSION

The most dominant weed species found in the experimental site were *Echinochloa colona*, *Cynodon dactylon*, *Digitaria sanguinalis* and *Dactyloctenium aegyptium* among grassy weed; *Trianthema portulacastrum* and *Digera arvensis* among broad-leaf weeds; and *Cyperus rotundus* among sedges. Table 1 revealed that at 20 days after spraying of PE herbicide, significantly lowest weed density and dry weight was reported in treatment T_1,T_4,T_5,T_{13},T_{14} and T_{16} over weedy check where post-emergence (PoE) application of was done Similarly at 20 days after application of PoE , significantly lowest weed density and dry weight were recorded in same treatment T_1,T_4,T_5,T_{13},T_{14} and T_{16} over weedy check. Because of this low infestation of weed flora in treatment T_1, it gave significantly highest grain yield (2450 kg ha^{-1}) of grain sorghum over rest of the other herbicide treatments except T_{15} to which it was at par. Among different weed control treatments, poor weed management indices was reported with treatment T_{16} (weedy check) due to highest weed infestation. While comparing the herbicide treatments, weed management indices improved with application of atrazine as PE and PoE the dose of herbicides used alone or in combination (Table 1).

Table 2 and 3 shows that at 20 days after application of PE herbicide treatment T_1,T_4, T_5,T_{13} and T_{14} significantly highest WCI,WCE, HEI and significantly lowest WPI was observed which was statistically at par with treatments T_{15}. Better weed management indices in treatment T_1, T_4, T_5, T_{13} and T_{14} was due to lowest weed infestation. At 20 DAS, WMI and AMI was not significantly affected by different weed control treatment. Treatment T_3: Pyroxasulfone 85 per cent w/w WG @ 0.1275 kg alone and its combination with PoE herbicide i.e treatment T_{10}: T_3 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}, T_{11}: T_3 + Mesotrione 2.27 per cent w/w + Atrazine and T_{12}: T_3 + Carfentrazone ethyl 40 per cent DF @ 20 g shoed negative impact on grain sorghum.

At 20 days after application of PoE herbicide, efficiency of different PRE herbicides reduces differently, However from table 2 and 3 found that application of Atrazine alone and as post-emergence (T_1 and T_{13}) effective to control weed in grain sorghum than other combination of herbicide. Which was found at par with Treatment T_{15} (weed free). Atrazine is more commonly used as broad-spectrum pre-emergence and post-emergence activity on weeds common to sorghum production systems. Depending on use rate and application timing (pre-emergence versus post-emergence), atrazine has been rated effective for controlling certain weeds such as barnyard grass *[Echinochloa crus-galli* (L.) *P. Beauv], giant foxtail (Setaria faberi Herrm.), yellow foxtail [Setaria pumila (Poir.) Roem. & Schult.], red rice (Oryza sativa* L.*), quackgrass [Elymus repens* (L.) *Gould], morning glory (Ipomoea* ssp.*), eastern black night shade (Solanum ptychanthum Dunal), common cocklebur (Xanthium strumarium* L.*), common ragweed (Ambrosia artemisiifolia* L.*), giant ragweed (Ambrosia trifida* L.*), jimsonweed (Datura stramonium* L.*), kochia (Brassica scoparia* (L.) *Scott), common lambsquarters (Chenopodium album* L.*), Palmer amaranth (Amaranthus palmeri* S. Wats.*), redroot pigweed (Amaranthus retroflexus* L.*), smartweeds (Polygonaceae ssp.), velvetleaf (Abutilon theophrasti Medik.), tall waterhemp (Amaranthus tuberculatus (Moq.) Sauer), prickly sida (Sida spinosa* L.*), common 3 purslane (Portulaca oleracea* L.*), and sicklepod (Senna obtusifolia* L.*)* (Loux *et al.*,2016; Scott *et al.*,2018). Among post-emergence (POE) herbicides treatments (T_4, T_5, T_6, T_{13} and T_{14}), T_{13} gave significantly highest WCI (48 %) and WCE (91 %) which was statistically at par with T_4, T_5, T_6, T_{13} and T_{14}. WPI and WMI are not affected significantly

Table 1: Weed density and weed dry weight as affected by different weed control treatments in *kharif* sorghum

Treatments detail	Total Weed density(No. m^{-2})		Total Weed dry weight(g m^{-2})		Grain yield ($Kg\ ha^{-1}$)
	At 20 days after PE	At 20 days after PoE	At 20 days after PE	At 20days after PoE	
T_1 : Atrazine 50 WP @ 0.50 kg a.i. ha^{-1}	8(16)	6(14)	5	4	2450
T_2 : Metolachlor 50% EC @ 1.00 kg a.i. ha^{-1} as PE	23(28)	13(21)	12	9	1925
T_3 : Pyroxasulfone 85% w/w WG @ 0.1275 kg	19(26)	11(20)	12	8	0
T_4 : T_1 + Bentazone 480 g/l SL @ 960 g a.i. ha^{-1}	8(16)	8(16)	4	6	2225
T_5 : T_1 + Mesotrione 2.27% w/w + Atrazine	7(15)	6(14)	4	4	2172
T_6 : T_1 + Carfentrazone ethyl 40% DF @ 20 g	9(17)	7(15)	4	5	2388
T_7 : T_2 + Bentazone 480 g/l SL @ 960 g a.i. ha^{-1}	19(26)	17(24)	10	12	1900
T_8 : T_2 + Mesotrione 2.27% w/w + Atrazine	20(27)	13(21)	11	9	1952
T_9 : T_2 + Carfentrazone ethyl 40% DF @ 20 g	19(26)	15(23)	10	10	1795
T_{10} : T_3 + Bentazone 480 g/l SL @ 960 g a.i. ha^{-1}	20(26)	17(24)	10	11	0
T_{11} : T_3 + Mesotrione 2.27% w/w + Atrazine	18(25)	14(22)	8	9	0
T_{12} : T_3 + Carfentrazone ethyl 40% DF @ 20 g	18(25)	8(16)	10	5	0
T_{13} : T_1 (PE & POE)	7(15)	6(13)	5	4	2339
T_{14} : T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i. ha^{-1}	8(16)	8(16)	4	5	2389
T_{15} : Weed free (15 and 35 DAS)	4(11)	4(11)	2	3	2605
T_{16} : Weedy check	57(19)	58(49)	33	39	1422
SE(m)$\pm$	1.87	1	1	0.85	118
CD at 5%	5.70	4	4	2.59	360

by any of the POE herbicides (Table 2 and 3).

WMI and AMI are inversely proportion to WCE and increase in yield. Lowest value of WMI and AMI depict higher WCE or/and comparatively higher addition of yield occurs due to effect of treatment whereas, higher the WMI or AMI means lower its WCE or/and comparatively lower addition of yield occurs due to effect of treatment. Superior weed management indices in T1 (Atrazine 50 WP @ 0.50 kg a.i. ha^{-1}) and T_{13}: T_1 (PE & POE) at 60 DAS revealed longer suppression of weed growth by this combination (Table 2 and 3).

index (%) in *kharif* sorghum

Fig. 1 depict that the weed index of different weed

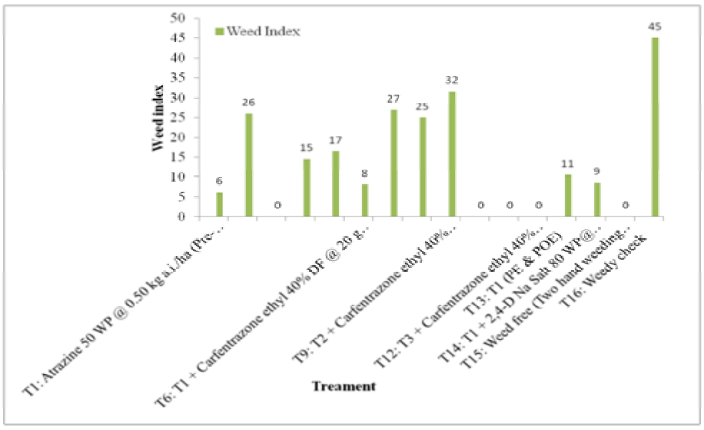


Fig 1: Effect of different weed control treatments on weed

Table 2: Efficiency Weed Control Index (WCI), Weed control efficiency (WCE) and Weed Persistence Index (WPI) in *kharif* sorghum

Treatments detail	WCI		WCE		WPI	
	at 20 days after PE	at 20 days after PoE	at 20 days after PE	at 20 days after PoE	at 20 days after PE	at 20 days after PoE
T_1 : Atrazine 50 WP @ 0.50 kg a.i. ha^{-1}	43	47	86	90	1.0	1.3
T_2 : Metolachlor 50% EC @ 1.00 kg a.i. ha^{-1} as PE	17	35	65	78	0.9	1.6
T_3 : Pyroxasulfone 85% w/w WG @ 0.1275 kg	23	38	65	81	1.1	1.8
T_4 : T_1 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}	43	43	89	86	0.9	0.9
T_5 : T_1 + Mesotrione 2.27% w/w + Atrazine	44	47	89	90	0.9	1.1
T_6 : T_1 + Carfentrazone ethyl 40% DF @ 20 g	41	45	87	88	0.8	1.1
T_7 : T_2 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}	23	28	69	70	0.9	1.1
T_8 : T_2 + Mesotrione 2.27% w/w + Atrazine	21	35	68	77	0.9	1.4
T_9 : T_2 + Carfentrazone ethyl 40% DF @ 20 g	23	31	68	74	0.9	1.2
T_{10} : T_3 + Bentazone 480 g l^{-1} SL @ 960 g a.i. ha^{-1}	21	29	70	72	0.8	1.0
T_{11} : T_3 + Mesotrione 2.27% w/w + Atrazine	25	34	76	77	0.8	1.0
T_{12} : T_3 + Carfentrazone ethyl 40% DF @ 20 g	25	44	69	87	1.0	2.4
T_{13} : T_1 (PE & POE)	44	48	85	91	1.2	1.7
T_{14} : T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i. ha^{-1}	42	44	89	87	0.8	0.8
T_{15} : Weed free (15 and 35 DAS)	50	50	95	93	0.9	0.8
T_{16} : Weedy check	0	0	0	0	1.0	1.0
SE(m)$\pm$	3.28	1.98	4.7	2	0.07	0.23
CD at 5%	9.98	6.05	10.87	6	-	-

Table 3: Efficiency Herbicide efficacy index (HEI), Agronomic Management index (AMI) and weed management index (WMI) in *kharif* sorghum

Treatments detail		HEI		WMI		AMI	
		at 20 days after PE	at 20 days after PoE	at 20 days after PE	at 20 days after PoE	at 20 days after PE	at 20 days after PoE
T_1 :	Atrazine 50 WP @ 0.50 kg a.i./ha	3.3	4.2	0.001	0.001	0.78	0.78
T_2 :	Metolachlor 50% EC @ 1.00 kg a.i./ha as PE	0.7	1.0	0.001	0	0.38	0.38
T_3 :	Pyroxasulfone 85% w/w WG @ 0.1275 kg	-2.9	-5.1	-0.002	-0.001	-1.00	-1.00
T_4 :	T_1 + Bentazone 480 g/l SL @ 960 g a.i./ha	2.0	1.7	0.001	0.001	0.63	0.63
T_5 :	T_1 + Mesotrione 2.27% w/w + Atrazine	2.4	2.7	0.001	0	0.58	0.58
T_6 :	T_1 + Carfentrazone ethyl 40% DF @ 20 g	3.3	3.6	0.001	0.001	0.73	0.73
T_7 :	T_2 + Bentazone 480 g/l SL @ 960 g a.i./ha	0.3	0.4	0.001	0	0.38	0.38
T_8 :	T_2 + Mesotrione 2.27% w/w + Atrazine	0.1	0.2	0.001	0	0.43	0.44
T_9 :	T_2 + Carfentrazone ethyl 40% DF @ 20 g	0.1	0.1	0	0	0.31	0.31
T_{10} :	T_3 + Bentazone 480 g/l SL @ 960 g a.i./ha	-3.6	-3.6	-0.001	-0.001	-1.00	-1.00
T_{11} :	T_3 + Mesotrione 2.27% w/w + Atrazine	-4.2	-4.3	-0.001	-0.001	-1.00	-1.00
T_{12} :	T_3 + Carfentrazone ethyl 40% DF @ 20 g	-3.5	-7.7	-0.001	-0.001	-1.00	-1.00
T_{13} :	T_1 (PE & POE)	3.2	5.5	0.001	0.001	0.67	0.67
T_{14} :	T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i./ha	3.5	2.8	0.001	0.001	0.74	0.74
T_{15} :	Weed free (15 and 35 DAS)	10.3	8.5	0.001	0.001	0.89	0.89
T_{16} :	Weedy check	0.0	0.0	0	0	0.00	0.00
	SE(m)$\pm$	0.45	0.73	0	0.001	0.16	0.16
	CD at 5%	1.39	2.24	-	-	0.49	0.49

control treatments in grain sorghum revealed that if weeds are allowed to grow freely it can causes the yield losses in pigeon pea up to 45 per cent. Best treatment in terms of weed index was T15 (weed free) which was closely followed by T1, T6,T13 and T14. The lower weed growth in these treatments was mainly due to effective control of weeds in the early stage by pre emergence herbicides and at later stage by post emergence herbicides. Maximum weed growth was observed in unweeded check. In general, sequential treatments were found to be superior to one time application of herbicides. Similar observations reported in normal sown sorghum by Sharma *et al.,*(2000).

CONCLUSION

Grain yield of *kharif* sorghum can be reduces up to 45% due to weed infestation. In grain sorghum, weed can be effectively managed by pre-emergence application of atrazine alone and in combination with atrazine and weed indices in grain sorghum can be effectively improved. However, finding shows that among different herbicides treatments, treatment T1, T6, T13, T14 and T15 gave better results in terms of weed management indices and yield of grain sorghum Therefore, pre-emergence application of Atrazine 50 WP @ 0.50 kg a.i./ha(T_1), T_{13}: T_1 (PE & POE) andT_{14}: T_1 + 2,4-D Na Salt 80 WP@ 0.75 kg a.i./ haproved to be an effective and a profitable alternative to the T_{15}: Weed free (15 and 35 DAS) for *Kharif* grain sorghum.

LITERATURE CITED

Dicko, M.H., H. Gruppen,O.C. Zouzouho, A.S.Traore, WJH Berkel, A. G. Voragen.2006. Effects of germination on amylases andphenolics related enzymes in fifty sorghum varieties groupedaccording to food-end use properties, J. Sci. Food Agric.86.

Kebede, H, P. K. Subudhi, D. T. Rosenow, H.T. Nguyen.2001. Quantitative trait loci influencing droughttolerance in grain sorghum (*Sorghum bicolor* L.moench), Theor. Appl. Genet.,103:266-276.

Loux, M.M., D.Doohan, A.F.Dobbels, W.G.Johnson, B.G.Young, T.R.Legleiter, A.Hager 2016. Ohio, Indiana and Illinois weed control guide, bulletin 789, Ohio State University Extension Publication WS, 16 : 218

Mishra , M. and A. Misra 1997. Estimation of integrated pest management index in jute-A new approach, Indian J. Weed Sci., 29: 39–42.

Burnside,O. C. and G. A. Wicks, 1967. The effect of weed removal treatments on sorghum growth, Weeds, 15: 204–207.

Crasta, O.R., W.W. Xu, D.T. Rosenow, J. Mullet, H.T. Nguyen, 1999. Mapping of post-flowering drought resistance traits in grain sorghum: association between QTLs influencing premature senescence and maturity Mol, Gen. Genet., 262 (3) : 579-588.

Scott, R.C., L.T.Barber, J.W Boyd, G.Selden, J.K.Norsworthy, N.Burgos,2018. Recommended chemicals for weed and brush control, Little Rock, AR: The Arkansas Cooperative Extension Service Publication MP : 44.

Sharma, R.P., R.C.Dadheech and L.N..Jat, 2000. Effect of atrazine and nitrogen on weed growth and yield of sorghum [*Sorghum bicolor* (L.) Moench], Indian J. Weed Sci., 32(1&2): 96-97.

Das, S.K., B.Biswas, G.Moinuddin, A.Hansda, 2008. Effect of integrated and purely chemical weed management practices on yield attributing characters, yield, weed density, weed dry weight and total microbial population in soil of pigeon pea (*Cajanus cajan* (L.) Millsp.*), Eco. Env. & Cons.* 22:S75-S80.

* * *

Received on 22 June, 2022 - Accepted on 8 August, 2022

PKV Res. J. Vol. 46(2), July, 2022

Genetic Variability Analysis for Quantitative Traits in Chickpea (*Cicer arietinum* L.)

Archana Thorat[1], Kalyani Waghmare[2], M. N. Ingole[3], Madhuri Sadafale[4] and E. R. Vaidya[5]

ABSTRACT

The present research work was carried out at Pulses Research Unit, Dr, Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Rabi 2020-21. with forty four genotypes of Chickpea (*Cicer arietinum* L.)" genotypes. in Randomized Block Design with three replications with an aim to determine genetic variability, heritability and expected genetic advance . Analysis of variance indicated that there was significant differences among the genotypes for different morphological characters. The phenotypic coefficient of variation was higher than genotypic coefficient of variation. The high values of GCV and PCV observed for number of secondary branches per plant followed by seed yield per plant, number of pods plant^{-1}, seed yield plot^{-1}, number of primary branches plant^{-1} and plant height. High estimates of heritability in broad sense was recorded for 100 seed weight, seed yield per plant, number of secondary branches per plant, number of pods plant^{-1}, number of primary branches plant^{-1}, seed yield plot^{-1} plant height and days to 50 per cent flowering.Where as days to maturity express low heritability. High genetic advance was observed for seed yield plot^{-1} and number of pods plant^{-1}. However moderate value was recorded for character plant height. Lowest value was genetic advance was recorded for number of primary branches plant^{-1} followed by days to maturity, number secondary branches plant^{-1}, days to 50 per cent flowering, 100 seed weight, seed yield plant^{-1}. The highest estimates of heritability coupled with higher genetic advance as per cent of mean was observed for characters number secondary branches plant^{-1} followed by seed yield plant^{-1}, number of pods plant^{-1}, seed yield plot^{-1} and number of primary branches plant^{-1}.

Chickpea is the most important pulse or food legume crop in world as well as in India and plays dominant role in agriculture. Pulses in India have been considered as the poor man's source of protein. (Ladizinsky and Adler, 1976).

Chickpea is highly nutritious as 100 g of chickpea seeds contain 18-22 g of protein, 61-62 per cent of carbohydrates and 4.5 per cent of fat. As they are high in protein, it make excellent replacement for meat in vegetarian diet.The protein quality of chickpea is greater than any other pulses. Chickpea is rich source of vitamins, minerals like calcium – 280 mg per 100 g, iron 12.3 mg per 100 g, phosphorus 301 mg per 100 g. and fibres, so it may offer benefits such as improving digestion, weight management, etc. It is consumed in the form of processed whole seed. It may be boiled, roasted, fried or steamed, etc. or it may be split into dal or use as a dal flour (besan) (Kumar *et al*., 2013).

Despite of the nutritional values and economic qualities of chickpea, its ha^{-1} productivity is very low in our country. This is primarily due to poor genetic makeup of the available cultivars (Kumar *et al*., 2020). For successful hybridization programme the extent of genetic variability is important factor to produce high yielding genotypes.Therefore, the evulation of genetic variability in the base population should have to be a prior action in the breeding programme.The genetic variability can be a choice for selecting suitableparaents. Absolute variability in different characters cannot be a decisive factor for deciding as to which character is showing the highest degree of variability. Genotypic coefficient of variation measures the rang of genetic variability existing in various pant characters and provides the comperative measures of adaptability of the varieties. High genetic coefficient of variation indicates high degree of variability.A better assessment of relative amount of heritable portion of variation can be had from heritability estimates .Burton and De vane (1953) and Johnson *et al.*(1955) has suggested that genetic coefficientof variation together with heritability estimates would give the best features of amount of genetic advance to be expected from selection.

1. PG Student, 2. Associate Professor (Agil. Botany) and 3. Assistant Professor (Plant Pthology), 4. Senior Res. Assistant and 5. Senior Scientist, Pulses Research Unit, Dr. PDKV, Akola (M.S.)

MATERIAL AND METHODS

The experimental material used in the present study comprised of forty four genotypes out of which forty three were collected from International Crops Research Institute for The Semi-Arid Tropics (ICRISAT) and one (1) check was collected from Pulses Research Unit , Dr.Panjabrao Deshmukh Krishi Vidyapeeth , Akola . The experiment was laid down in randomized block design with three replications during *Rabi* season of 2020-21 at Pulses Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeeth , Akola. Each entry was sown in two rows of 4m length with row spacing of 30 cm and plant to plant distance were maintained at 10 cm . The observations were recorded on days to 50 percent fowering, days to maturity, plant height (cm), number of primary branches per plant , number of secondary branches per plant , number of pods per plant , 100 seed weight (g), seed yield per plant (g), seed yield per plot (g). The data so obtained on various characters were subjected to analysis of variance as described by Panse and Sukhatme (1967). Genotypic and phenotypic coefficient of variation were estimated according to by Burton and De vane (1953). The heritability percentage in broad sense was calculated as suggested by Hanson *et al*. (1956).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant difference among all the traits *viz*., days to 50 percent flowering, days to maturity, plant height, number of primary branches plant^{-1}, number of secondary branches per plant, number of pods plant^{-1}, 100 seed weight and seed yield plant^{-1} and seed yield plot^{-1} indicating presence of substantial amount of genetic variability in genotypes.

The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters. The character number of secondary branches plant^{-1} exhibited highest genotypic coefficient of variation (47.36 %) followed by seed yield plant^{-1} (45.44 %) , number of pods plant^{-1} (44.15 %) , seed yield plot^{-1} (34.38 %) , number of primary branches plant^{-1} (29.28 %) and plant height (20.95 %). The character 100 seed weight (17.52 %) exhibited moderate phenotypic coefficient of variation, while the character days to maturity (1.64 %) showed lowest genotypic coefficient of variation followed by days to 50 per cent flowering (8.38 %). The phenotypic coefficients of variation was ranged from 3.78 percent for days to maturity to 48.65 per cent for number of secondary branches per plant. The character number of secondary branches per plant exhibited highest phenotypic coefficient of variation (48.65%) followed by seed yield per plant (46.54 %) , number of pods per plant (45.44 %), seed yield plot^{-1} (37.29 %), number of primary branches plant^{-1} (31.63 %) and plant height (22.82 %). The character 100 seed weight (17.56 %) exhibited moderate phenotypic coefficient of variation , while the character days to maturity (3.78 %) showed lowest phenotypic coefficient of variation followed by days to 50 percent flowering (9.84 %). The heritability estimates indicated that different traits showed very wide range of heritability (h^2) from 43.50 per cent for days to maturity to 99.77 per cent for 100 seed weight . The considerably high estimates of heritability were obtained for 100 seed weight (99.77 %), seed yield per plant (97.50 %) , number of secondary branches per plant (97.35 %) , number of pods per plant (97.10 %) , number of primary branches per plant (92.52 %), seed yield plot^{-1} (92.15 %), plant height (91.81 %), days to 50 per cent flowering (85.20 %). Days to maturity showed low heritability estimates (43.50 %)

The highest magnitude of genetic advance was observed for seed yield plot^{-1} (183.62), followed by number of pods per plant (36.63), while the character plant height (19.78) showed moderate genetic advance. The lowest magnitudes of genetic advance was reported for number of primary branches plant^{-1} (1.15), followed by days to maturity (1.61) , number of secondary branches plant^{-1} (6.90) , days to 50 percent flowering (7.26), 100 seed weight (8.71), seed yield plant^{-1} (8.98).

High estimates of heritability coupled with high genetic advance expressed as percent of mean observed for number of secondary branches per plant, seed yield per plant , number of pods per plant ,for number of primary branches plant^{-1}, 100 seed weight, seed yield plot^{-1} which give lot of scope for selection in a population for these traits.

Based on the present investigation, it is suggested that the genetic variability reported for different character in relation to yield should be exploited for future genetic improvement in chickpea.

Table 1 . Analysis of variance for various characters in chickpea genotype

S.N.	Characters	Mean sum of Genotypes		
		Replications	Genotypes	Error
	Degree of freedom	2.00 *	43.00	86.00
1.	Days to 50 % flowering	0.32	57.97**	6.52
2.	Days to maturity	19.87	23.60**	13.90
3.	Plant height (cm)	21.30	348.59**	20.39
4.	Number of primary branches plant^{-1}	0.13	1.15**	0.06
5.	Number of secondary branches plant^{-1}	0.20	36.18**	0.65
6.	Number of pods plant^{-1}	56.13	1024.78**	19.87
7.	100 seed weight (g)	0.01	53.99**	0.09
8.	Seed yield plant^{-1} (g)	2.19	60.75**	0.98
9.	Seed yield plot^{-1} (g)	1533.34	29691.53**	1649.75

** Significance at 1% level

Table 2 . Range, mean and estimates of genetic parameters in chickpea genotypes

S. N.	Characters	Range		Mean	GCV	PCV	Heritability	Genetic	GAM
		Min.	Max.		(%)	(%)	(bs) (%)	Advance (GA)	(%)
1.	Days to 50% flowering	41.00	57.33	49.42	8.38	9.84	85.20	7.26	14.69
2.	Days to maturity	104.67	115.33	109.42	1.64	3.78	43.50	1.61	1.47
3.	Plant height (cm)	27.73	77.33	49.92	20.95	22.82	91.81	19.78	39.63
4.	Number of primary branches plant^{-1}	1.07	3.67	2.06	29.28	31.63	92.52	1.15	55.84
5.	Number of secondary branches plant^{-1}	3.70	20.53	7.27	47.36	48.65	97.35	6.90	94.98
6.	Number of pods per plant	21.13	84.00	41.46	44.15	45.44	97.10	36.63	88.34
7.	100 seed weight (g)	15.14	35.00	24.20	17.52	17.56	99.77	8.71	35.99
8.	Seed yield per plant (g)	4.15	23.50	9.82	45.44	46.54	97.50	8.98	91.37
9.	Seed yield per plot (g)	143.33	453.33	281.23	34.38	37.29	92.15	183.62	65.29

CONCLUSION

The phenotypic coefficient of variation (PCV) was higher than that of genotypic coefficient of variation (GCV) for all the characters under study. The assessment of genetic parameters like genotypic coefficient of variation , heritability and genetic advance as percent of mean indicated that selection, must be done in to character.

The highest estimates of heritability was observed for 100 seed weight followed by seed yield per plant, number of secondary branches per plant ,number of pods per plant and number of primary branches per plant. Indicating major role of genotype and ultimately less environmental influence and high heritability suggests that selection would be successful for this trait Number of pods per plant and seed yield per plot showed high heritability with high genetic advance indicating the presence ofadditive gene action and direct selectionfor such traits is rewarding in crop improvement

LITERATURE CITED

Burton, G. W. and E.R. De Vane, 1953. Estimating heritability in tall fascuefrom replicated clonal material, Agro. J. 45 (1): 476-1481.

Ladizinsky, G. and A. Adler, 1976. The origin of chickpea (*Cicer arietinum* L.), Euphytica, 25:211-217

Hanson, C.H., H.F. Robinson and R.E. Comstock, 1956. The biometricastudies on yield in segregation population korianlesedeza, Agronomy J. 48 : 268-272

Johnson, H.W., H.F. Robinson and R.E. Comstock, 1955. Estimates ofgenetic and environmental variability in soybean, Agron J. 47:314- 318

Kumar A., M. Kumar Chand, S. K. Singh P. Kumar and L. K. Gangwar, 2020. Studied on genetic variability and inter relationship amongyield and related traits of parents and F1 population in chickpea(*Cicer arietinum* L.), J. Pharmacology and Phytochemistry 9(3):1434-1438.

Kumar, R., J.R.Nizama, A.I. Patel and S.R. Patel, 2013. Estimation ofselection criteria with correlation and path coefficient analysis inchickpea (*Cicer arietinum* L.) breeding, AGRES- An International, e-Journal., 2(4) : 447-452

Panse, V.G. and P.V. Sukhatame, 1967. Statistical Method for AgriculturalWorker, ICAR, New Delhi.

* * *

Received on 27 September, 2022 - Accepted on 12 November, 2022

PKV Res. J. Vol. 46(2), July, 2022

Impact of Agricultural Price Policy on Soybean in Vidarbha Region

P. S. Sawarkar[1], N. V. Shende[2], A. A. Bhopale[3] and N. R. Koshti[4]

ABSTRACT

The present study aimed to analyze the impact of Agricultural Price Policy on Soybean in Vidarbha region of Maharashtra. The Secondary data on Farm Harvest Prices (FHP) and Minimum Support Prices (MSP) of Soybean was collected from Directorate of Economics and statistics and Commission for Agricultural Cost and Prices for the period 2000-01 to 2019-20. The effectiveness of the price policy during the harvest periods was examined by the deviations of FHP from MSP and classified into positive and negative deviations (to examine whether market prices ruled higher or lower than the minimum support prices). Gap between FHP and MSP resulted that in mostly cases FHP is higher than MSP because higher demand due to more procurement for central part than supplies does not allow the market prices to fall below MSP. In recent years, market prices ruled higher than MSP. The impact of MSP on area is higher but there is non-significant impact of MSP on productivity of Soybean. The study revealed that there is significant variation in areas of Soybean due to previous year's minimum support prices of the Soybean but there is non-significant variation in productivity of Soybean.

Agricultural Price Policy (APP), was introduced by the government to protect the interest of the producers and consumers. The essentials of the establishment of agricultural price policy are to reduce the wide fluctuations in the prices of agricultural produce and production inputs, to maintain a stable price level of commercial crops, to encourage small farmers for making more investment on farms, to provide better incentives to the producers and to assure producer a minimum price for his produce

In recent years, the MSP policy has been criticized by both farmers and proponents of free trade. Farmers always demand a substantial hike in MSP, whereas proponents for free agricultural trade thinkers feel that, most of the times, MSP is not in line with the international prices as well as domestic demand and supply situation. This brings distortions and inefficiencies in the production patterns.

It is further contended that the MSP has outlived its utility and is being used more as a political tool than an economic instrument. It therefore becomes imperative to examine the effectiveness of MSP in different regions of the country as well as its contribution towards growth. The present study has investigated these issues for the Soybean crop, which is the most important oil seed crop from both production and consumption points of view in the country.

MATERIAL AND METHODS

The study was undertaken to examine the parity between cost and prices and district wise impact of MSP on area, production and productivity in Soybean.

Collection of data

The study was based on secondary data of cost of cultivation of Soybean collected from Agricultural Prices Costs Scheme under the Department of Agricultural Economics and Statistics, Dr. P.D.K.V. Akola. The yearly data of Farm harvest prices and Minimum Support Price were compiled for the period of 20 years (2000-01 to 2019-20). The period has been divided into three periods,

Period-I (2000-01 to 2009-10),
Period-II (2010-11 to 2019-20) and
Overall period (2000-01 to 2019-20).

Analytical tools and techniques

The data was collected from secondary sources subjected to appropriate analytical technique in order to arrive at a meaningful conclusion.

1. PG Student, 2. Head, 3. Assistant Professor, 4. Professor (Extn, Edn.), Department of Agricultural Economics and Statistics, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra

Parity between Cost and Prices

The study was based on the farm harvest prices and minimum support price of the major crops in Vidarbha. To study the effectiveness of the price policy during the harvest period of deviation of farm harvest prices from the MSP was worked out and divided into the negative and positive deviation to examine whether the market price ruled higher or lower over the MSP. Hence the absolute positive deviation (APD) or absolute negative deviation (AND) and mean absolute positive derivation (MAPD) or mean absolute negative deviation MAND) calculated. Also adjusted mean positive deviation (AMPD) and adjusted mean negative deviation (AMND) was worked out (Geetha and Mahes, 2019).

MAPD or MAND = 1/n∑ | FHPi – MSPi |

If, FHP > MSP = Positive deviation (PD)

FHP < MSP = Negative deviation (ND)

Where,

MAPD = Mean absolute positive deviation,

MAND = Mean absolute negative deviation,

FHP = Farm harvest price,

MSP = Minimum support price, and

n. = Frequency of positive or negative deviations.

These deviations were adjusted with MSP in order to examine the degree of their deviation from the MSP (Gangadevi *et al.,* 2016). The formulae used for the adjusted mean negative/positive deviation was as follows:

AMPD or AMND = 1/n∑(|FHPi – MSPi|/ MSPi)*100

Where, AMPD = Adjusted mean positive deviation, and

AMND = Adjusted mean negative deviation

The significance of gap between FHP and MSP of major crops was tested by two sample t-test

$$t = \frac{(\bar{x} - \bar{y}) - (u_x - u_y)}{s\sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

Where,

x = mean of FHP of size nx

3 = mean of MSP of size ny

sp2 = pooled variance

$$Sp^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{(n_x - 1) + (n_y - 1)}$$

Impact of Minimum Support Prices

Study the impact of lagged Minimum Support Prices on the cost and prices of the Soybean. Linear, logarithmic forms of equation has been fitted (Shayequa *et al.,* 2012 and Shende, 2020). The previous year Minimum Support Prices generally influence the producer farmer decision on a carrier location for the current year the linear equation has been used as linear regression equation.

1. Linear regression equation:

a. $A_t = a + b\,P_t\text{-}1$

b. $P_t = a + b\,P_t\text{-}1$

c. $Y_t = a + b\,P_t\text{-}1$

2. Logarithmic regression equation:

a. Log. A_t = log a + b P_t-1

b. Log. P_t = log a + b P_t-1

c. Log.Y_t = log a + b P_t-1

Where,

At = Area of major crops at (t^{th}) period,

P_t = Production of major crops at (t^{th}) period,

Y_t = Productivity of major crops at (t^{th}) period,

P_t-1 = Minimum Support Prices of major crops taken in per quintal.at $(t\text{-}1)^{th}$ period.

Linear type of function found a better fit than logarithmic function. Hence it is used.

RESULTS AND DISCUSSION

Parity between cost and prices.

In this objective the gap between Minimum Support Prices (MSP) and cost of production of major crops and gap between the Farm Harvest Prices (FHP) and Minimum Support Prices (MSP) of major crops from 2000-01 to 2019-20 was studied.

Gap between Minimum Support Price and cost of cultivation of Soybean.

The gap between Minimum Support Prices and cost of cultivation of Soybean of Vidarbha region are presented in the Table 1. The gap is calculated for the study period i.e. 2000-01 to 2019-20. The results revealed that the gap between MSP and cost of cultivation of Soybean in Vidarbha region recorded which ranged from -1788.1 (Rs q^{-1}) to 173.54 (Rs q^{-1}).

Table 1. Gap between Minimum Support Price and cost of cultivation of Soybean

YEAR	MSP	Cost of Production	Gap
2000-01	865	1004.9	-139.86
2001-02	885	886.26	-1.26
2002-03	885	1136.6	-251.64
2003-04	930	865.85	64.15
2004-05	1000	1102.6	-102.58
2005-06	1010	995.48	14.52
2006-07	1020	911.15	108.85
2007-08	1050	1014	35.98
2008-09	1390	1426.6	-36.57
2009-10	1390	1978.4	-588.42
2010-11	1440	1635.2	-195.21
2011-12	1690	1928	-237.96
2012-13	2240	2156.2	83.83
2013-14	2560	2695.8	-135.82
2014-15	2560	4189.4	-1629.4
2015-16	2600	4388.1	-1788.1
2016-17	2775	2601.5	173.54
2017-18	3050	3390.1	-340.13
2018-19	3399	3645.8	-246.83
2019-20	3710	3875.3	-165.32

The highest gap was registered in year 2016-17 (173.54 (Rs q^{-1}) followed by 2006-07 (108.85 (Rs q^{-1}), 2012-13 (83.83(Rs q^{-1}), 2003-04 (64.15 (Rs q^{-1}), 2007-08 (35.98 (Rs q^{-1}), 2005-06 (14.52 (Rs q^{-1})). There were 14 negative difference (gap) and 6 positive difference (gap) which shows that cost of cultivation was ruled higher than minimum support price.

Gap between Farm Harvest Price and Minimum Support Price of Soybean in major districts of Vidarbha region

The gap between Farm Harvest Prices and Minimum Support Prices of Soybean in major district markets of Vidarbha region are presented in the Table 2. The gap is calculated for the study period i.e. 2000-01 to 2019-20.The results revealed that the average gap between FHP and MSP of Soybean in major district markets of Vidarbha region recorded which ranged from 39.05 to 280.02 (Rs q^{-1}).

Table 2. Gap between Farm Harvest Price and Minimum Support Price of Soybean

S.N	SOYBEAN	FHP	MSP	GAP
1	Akola	2087.2	1822.5	264.7
2	Amravati	2039.8	1822.5	217.3
3	Bhandara	1950.0	1822.5	127.5
4	Buldhana	2102.5	1822.5	280.0
5	Chandrapur	2051.8	1822.5	229.4
6	Gadchiroli	1861.5	1822.5	39.1
7	Nagpur	2059.7	1822.5	237.2
8	Wardha	2098.3	1822.5	275.8
9	Washim	2049.9	1822.5	227.4
10	Yavatmal	2063.5	1822.5	241.0

The highest average gap was registered in Buldhana district (280.02 (Rs q^{-1}) followed by Wardha district (275.8 (Rs q^{-1}), Akola district (264.7 (Rs q^{-1}), Yawatmal district (241 (Rs q^{-1}),Nagpur district (237.2 (Rs q^{-1}), Chandrapur (229.375 (Rs q^{-1}), Washim district (227.4 (Rs q^{-1}), Amravati district (217.3 (Rs q^{-1}), Bhandara district (127.5 (Rs q^{-1}) and recorded lowest in Gadchiroli district (39.05 (Rs q^{-1}).

Deviations of FHPs from MSPs of Soybean crops in Major districts of Vidarbha region

To examine the effectiveness of MSP policy for Soybean crops in Major districts of Vidarbha region, difference between its FHP and MSP was calculated in different years and is given in Table 4. Wardha, Akola, Yawatmal, Nagpur, Chandrapur, Buldhana experienced positive deviations 15, 13, 13, 12,12 and 11 times in 20 years during 2000-01 to 2019-20. This means that the average FHP was ruled higher than MSP in 15, 13, 13, 12,

Table 3. Significance of gap between FHP and MSP of Soybean crop in major districts of Vidharba region

S.N.	DISTRICTS	Mean FHP	Mean MSP	T Value (t-cal.)	t table	D.f
1	Akola	2087.15	1822.45	0.83	2.021	38
2	Amravati	2039.75	1822.45	0.68	2.021	38
3	Bhandara	1949.95	1822.45	0.41	2.021	38
4	Buldhana	2102.48	1822.45	0.89	2.021	38
5	Chandrapur	2051.83	1822.45	0.78	2.021	38
6	Gadchiroli	1861.50	1822.45	0.20	2.021	38
7	Nagpur	2059.65	1822.45	0.75	2.021	38
8	Wardha	2098.25	1822.45	0.88	2.021	38
9	Washim	2049.85	1822.45	0.68	2.021	38
10	Yavatmal	2063.45	1822.45	0.76	2.021	38

Note – $t_{cal} < _{tab}$ that means h_0 is accepted at (5%) level of significance and conclude that the gap between FHP and MSP do not differ significantly.

Table 4. Deviation of FHP vis-a-vis MSP of Soybean crops in Major districts of Vidarbha region

Soybean	NEGATIVE DEVIATION					POSITIVE DEVIATION				
Districts	Frequency	MAND	RANG	AMND	%	Frequency	MAPD	RANG	AMPD	%
Akola	7.00	-71.71	(-6)-(-188)	-4.49	35	13.00	445.84	4-892	22.95	65
Amravati	11.00	-114.36	(-8)-(-539)	-6.40	55	9.00	622.66	16-850	33.36	45
Bhandara	11.00	-184.45	(-22)-(-800)	-11.40	55	9.00	508.70	67-791	24.56	45
Buldhana	9.00	-93.72	(-12)-(-460)	-5.44	45	11.00	585.81	10-946	30.76	55
Chandrapur	8.00	-109.44	(-24)-(-419)	-7.11	40	12.00	455.25	11-850	22.64	60
Gadchiroli	11.00	-257.42	(-28)-(-856)	-16.38	55	9.00	483.75	151-795	21.68	45
Nagpur	8.00	-108.63	(-12)-(-484)	-7.03	40	12.00	467.75	3-821	65.13	60
Wardha	5.00	-137.00	(-3)-(505)	-4.96	25	15.00	301.93	3-886	20.00	75
Washim	10.00	-154.40	(-4)-(-340)	-10.93	50	10.00	609.20	79-935	27.30	50
Yavatmal	7.00	-85.86	(-27)-(-243)	-4.39	35	13.00	417.00	10-843	23.83	65

and 11 times out of 20 years. The adjusted difference (positive) between MSP and FHP was between 75 per cent to 55 per cent and the negative difference was between 25 per cent to 45 per cent. Washim district experienced equal positive and negative deviations i.e. 10 in 20 years during 2000-20. This means that the average FHP was equals to MSP in given 20 years. The adjusted difference (positive and negative) between MSP and FHP was equal as 50 per cent of MSP. Amravati district experienced negative deviations 11 times and positive deviation 9 time in 20 years during 2000-20. This means that the average FHP was ruled lower than MSP in 11 times and 9 times higher than MSP in one time out of 20 years. The adjusted difference (positive) between MSP and FHP was 45 per cent and negative difference was 55 per cent.

Note: *Zero deviations (FHP=MSP) were considered positive deviations indicating success of the MSP policy

Average= Average of the difference of FHP from MSP (+ve or –ve) and

%= Per centage of average positive or negative deviations over MSP.

Impact of Minimum Support Prices (MSPs) on major crops in Vidarbha region during 2000-01 to 2019-20

To study the impact of lagged Minimum Support Prices (MSPs) on the area, production and productivity, linear and logarithmic form of equations have been fitted. As linear type of Model had found a better fit than logarithmic function, the former had been presented here. The previous year MSPs had been used here since these prices generally influence the farmer's decision on acreage allocation for the current year.

Impact of MSP on area of Soybean in Vidarbha region

The numerical values of the linear function for Soybean indicates that R^2 is significant at 1 per cent level and supports the results that variation in areas of Soybean is explained by the explanatory (Gupta *et al.*, 2020) variable, i.e., previous year's Minimum Support Prices of the Soybean. Table 5 revealed that 82 per cent variation in area of Akola district , 31 per cent variation in area of Amravati district , 35 per cent variation in area of Bhandara district ,87 per cent variation in area of Buldhana district, 50 per cent variation in area of Chandrapur district, 14 per cent variation in area of Gadchiroli district , 50 per cent variation in area of Nagpur district ,36 per cent variation in area of Wardha district , 72 per cent variation in area of Washim district ,34 per cent variation in area of Yawatmal district is explained by independent variable i.e. lagged MSP.

The elasticity for these variables is significant at 1 per cent level in case of areas of Soybean. The value of elasticity has found as 0.81, 0.52, -0.01, 1.25, -0.28, -0.011, -0.39,-0.29, -0.75, 0.56 per cent indicating thereby that previous year price influences current year's areas of major districts of Soybean (like Akola, Amravati, Bhandara, Buldhana, Chandrapur, Gadchiroli Nagpur, Wardha, Washim, Yawatmal).

Impact of MSP on production of Soybean in Vidarbha region

The numerical values of the linear lag function for Soybean indicates that R^2 is significant at 1 per cent level and supports the results that variation in production of Soybean is explained by the explanatory variable, i.e., previous year's minimum support prices of the Soybean.

Table 6. Impact of MSP on production of Soybean in Vidarbha region

S. N.	Districts	R^2	S.E.	Linear Regression Equation
1	Akola	0.35	798.98	y = 198.47 + 0.67x
2	Amravati	0.02	1377.95	y = 2206.4 + 0.26x
3	Bhandara	0.35	31.09	y = 115.92 - 0.02x
4	Buldhana	0.45	1433.91	y = 307.6 + 1.49x
5	Chandrapur	0.51	350.79	y = 1960 - 0.41x
6	Gadchiroli	0.24	18.91	y = 52.73 - 0.01x
7	Nagpur	0.29	706.85	y = 2950 - 0.52x
8	Wardha	0.26	549.90	y = 2625 - 0.37x
9	Washim	0.24	989.41	y = 1109 - 0.66x
10	Yawatmal	0.06	969.67	y = 1543 + 0.28x

y = production, x = MSP

Table 5. Impact of MSP on area of Soybean in Vidarbha region

S. N.	Districts	R^2	S.E.	Linear Regression Equation
1	Akola	0.82	329.85	y = -74.84 + 0.81x
2	Amravati	0.31	684.81	y = 1785.2 + 0.52x
3	Bhandara	0.35	19.13	y = 104.4 - 0.01x
4	Buldhana	0.87	418.32	y = 274.6 + 1.25x
5	Chandrapur	0.50	247.01	y = 1807.2 - 0.28x
6	Gadchiroli	0.14	23.62	y = 56.02 - 0.011x
7	Nagpur	0.50	339.06	y = 2862.8 - 0.39x
8	Wardha	0.36	337.34	y = 2157.6 - 0.29x
9	Washim	0.72	408.20	y = 887.4 - 0.75x
10	Yawatmal	0.34	684.14	y = 1297.7 + 0.56x

y = area, x = MSP

Table 6 revealed that 35 per cent variation in production of Akola district , 2 per cent variation in production of Amravati district, 35 per cent variation in production of Bhandara district , 45 per cent variation in production of Buldhana district , 51 per cent variation in production of Chandrapur district , 24 per cent variation in production of Gadchiroli district, and 29 per cent variation in production of Nagpur district , 26 per cent variation in production of Wardha district, 24 per cent variation in production of Washim district, 6 per cent variation in production of Yawatmal district is explained by independent variable i.e. lagged MSP. The elasticity for these variables is significant at 1 per cent level in case of production of Soybean. The value of elasticity has found as 0.67, 0.26, - 0.02, 1.49, -0.41, -0.01, -0.52, -0.37,-0.66, 0.28 per cent indicating thereby that previous year price influences current year's production of major districts of Soybean (like Akola, Bhandara, Buldhana, Chandrapur, Gadchiroli, Nagpur, Wardha, Washim, Yawatmal).

Impact of MSP on productivity of Soybean in Vidarbha region

The numerical values of the linear lag function for Soybean indicates that R^2 is significant at 1 per cent level and supports the results that variation in productivity of Soybean is explained by the explanatory variable, i.e. previous year's MSPs of the Soybean. Table 7, revealed that 3 per cent variation in productivity of Akola district, 2 per cent variation in productivity of Amravati district, 6 per cent variation in productivity of Bhandara district , 0.000001 per cent variation in productivity of Buldhana district ,5 per cent variation in productivity of Chandrapur district, 13 per cent variation in productivity of Gadchiroli district, 0.4 per cent variation in productivity of Nagpur district , 0.4 per cent variation in productivity of Wardha district , 0.4 per cent variation in productivity of Washim district , 0.4 per cent variation in productivity of Yawatmal district is explained by independent variable, i.e. lagged MSP. The elasticity for these variables is significant at 1 per cent level in case of productivity of Soybean. The value of elasticity has found as -0.11, -0.08, -0.11, -0.0007, -0.09, 0.22, -0.02, -0.02, -0.08 -0.14 per cent indicating thereby that previous year price influences current year's productivity of major Soybean growing districts (like Akola, Amravati, Bhandara, Buldhana, Chandrapur, Gadchiroli, Nagpur, Wardha, Washim, Yawatmal).

Table 7. Impact of MSP on productivity of Soybean in Vidarbha region

S. N.	Districts	R^2	S.E	Linear Regression Equation
1	Akola	0.03	798.98	y= 1306.64 - 0.11x
2	Amravati	0.02	1377.95	y= 1156.6 - 0.08x
3	Bhandara	0.06	31.09	y= 1149.3 - 0.11x
4	Buldhana	0.000001	1433.91	y= 1190.4 - 0.0007x
5	Chandrapur	0.051	350.79	y= 1127.4 - 0.090x
6	Gadchiroli	0.13	18.91	y= 714.7 + 0.22x
7	Nagpur	0.004	706.85	y= 999.8 - 0.02x
8	Wardha	0.004	549.90	y= 1078.7 - 0.02x
9	Washim	0.02	989.41	y= 1216.7 - 0.08x
10	Yawatmal	0.09	969.67	y= 1234.5 - 0.14x

y = Productivity, x =MSP

CONCLUSION

The district wise average gap between FHP and MSP of Soybean ranged from 39.05 to 280.02 (Rs q^{-1}). The highest gap was registered in Buldhana district (280.02 (Rs q^{-1}) and lowest in Gadchiroli (39.05 (Rs q^{-1}).

Soybean crop experienced positive deviations as well as negative deviations. Wardha, Akola, Yawatmal, Nagpur, Chandrapur, Buldhana experienced positive deviations. In which Wardha district experienced positive deviation i.e. MAPD is 301.93 (Rs q^{-1}) and AMPD is 20 (Rs q^{-1}) and negative deviation i.e. MAND is -137 (Rs q^{-1}) and AMND is -4.96 (Rs q^{-1}) with highest positive deviations i.e. 15 times and negative deviation 5 time in 20 years during 2000-01 to 2019-20. This means that the average FHP was equal to or ruled higher than MSP in 10 times and lower than MSP in one time out of 20 years. This indicated that the government intervention was very strong and did not allow the FHPs to move away from MSP in a significant manner despite large marketed surplus.

The impact of MSP shown by linear regression equation analysis. The district wise impact of MSP on the areas of Soybean is explained by the explanatory variable, i.e., previous year's Minimum Support Prices of the

Soybean. The result revealed that 82 per cent variation in area of Akola district, 31 per cent variation in area of Amravati district, 35 per cent variation in area of Bhandara district, 87 per cent variation in area of Buldhana district, 50 per cent variation in area of Chandrapur district, 14 per cent variation in area of Gadchiroli district, 50 per cent variation in area of Nagpur district, 36 per cent variation in area of Wardha district, 72 per cent variation in area of Washim district, 34 per cent variation in area of Yawatmal district. The significant value of elasticity indicating thereby that previous year price influences current year's area.

The linear regression equation analysis showed that the district wise impact of MSP on the production of Soybean is explained by the explanatory variable, i.e., previous year's Minimum Support Prices of the Soybean. The result revealed that 35 per cent variation in production of Akola district, 2 per cent variation in production of Amravati district, 35 per cent variation in production of Bhandara district, 45 per cent variation in production of Buldhana district, 51 per cent variation in production of Chandrapur district, 24 per cent variation in production of Gadchiroli district, and 29 per cent variation in production of Nagpur district, 26 per cent variation in production of Wardha district, 24 per cent variation in production of Washim district, 6 per cent variation in production of Yawatmal district. The significant value of elasticity indicating thereby that previous year price influences current year's production.

The linear regression equation analysis showed that The district wise impact of MSP on the productivity of Soybean is explained by the explanatory variable, i.e., previous year's minimum support prices of the Soybean. The result revealed that 3 per cent variation in productivity of Akola district, 2 per cent variation in productivity of Amravati district, 6 per cent variation in productivity of Bhandara district, 0.000001 per cent variation in productivity of Buldhana district, 5 per cent variation in productivity of Chandrapur district, 13 per cent variation in productivity of Gadchiroli district, 0.4 per cent variation in productivity of Nagpur district, 0.4 per cent variation in productivity of Wardha district, 0.4 per cent variation in productivity of Washim district, 0.4 per cent variation in productivity of Yawatmal district. The significant value of elasticity indicating thereby that previous year price influences current year's productivity.

1. The gap analysis in which deviations of FHPs from MSPs of Soybean crop results in maximum positive deviations (FHP ruled higher than MSP) in seven districts of Vidarbha region and maximum negative deviations (MSP ruled higher than FHP) in 3 districts of Vidarbha region.
2. The increase in MSP over the previous year brought additional area under soybean, but the impact was nominal.
3. From the results we conclude that impact of MSP on area is higher but there is lower impact of MSP on productivity of soybean.

LITERATURE CITED

Ganga Devi, Y.C. Zala, R. Bansal, and K.S. Jadav, 2016. A Study of Minimum Support Price, Farm Harvest Price and their effect on Area of Major Food-grain Crops of Gujarat, Indian J. Econ., 12(1): 555-558.

Geetha, R. S. and V. Mahes, 2019. Minimum Support Prices (MSP) and Its Influence on Cotton Farming in India, Asian J. Agril. Extn.. Econ. Sociol., 30(4): 1-8.

Gupta, R.K., V. Kumar, P. K. Singh, M. Danish and N. Dehariya, 2020. Impact of Minimum Support Price on Agricultural Production in Western India, International J. Curr. Medical Applied Sci., 9(06): 2291-2303.

Shayequa, Z.A., R.S. Sidhub and K. Vattac, 2012. Effectiveness of Minimum Support Price Policy for Paddy in India with a Case Study of Punjab, Agril. Econ. Res. Review. 25(2): 231-242

Shende, N.V., 2020. Impact of Prices on Paddy Performance in Eastern Vidarbha Zone, International J. Curr. Microbiol, Applied Sci. 9(08): 2993-2999.

* * *

Received on 2 November, 2022 - Accepted on 18 December, 2022

PKV Res. J. Vol. 46(2), July, 2022

Growth Dynamics and Decomposition Analysis of Paddy in Vidarbha

U. T. Dangore[1], N.V.Shende[2], R.D.Vaidkar[3], R.D.Walke[4] and A.S.Tingre[5]

ABSTRACT

The present study was undertaken in Vidarbha region. The Paddy crop was selected for the present study. The data were collected on area, production, productivity of Paddy grown in Vidarbha region pertaining to the period from 2001-2002 to 2020-2021 (20 years) For the analysis of growth and instability, the entire study period was split into two sub-periods and overall. The district-wise time series data on area, production, productivity and various prices were collected from Government publication and websites. The compound growth rates of area, production and productivity of Cotton, Soybean and Paddy were estimated for last 20 years. To measure the instability in area, production and productivity, an index of instability was used as a measure of variability through Coefficient of Variation (CV) and Cuddy Della Valle's instability indices. To measure the relative contribution of area, yield to the total output of the Paddy crop, Minhas (1964), Decomposition analysis model was used. The impact of various prices on area was estimated with the help of Narlovian -Lagged Model. At overall level the compound growth rate of area of paddy for Vidarbha region is positive and significant. The compound growth rate of production of paddy is positive and significant at overall level for Vidarbha region. At overall level for Vidarbha region area, the CDVII 4.56 per cent instability. At overall level for Vidarbha region production Vidarbha recorded 2.24 per cent instability. At overall level for Vidarbha region productivity, Vidarbha recorded 2.62 per cent instability Vidarbha as a whole yield effect is most responsible factor for change in paddy production i.e. 73.20 per cent where as area effect and interaction effect were 19.4 per cent and 7.40 per cent, respectively. Prices had not shown any impact in the increase on area of paddy in the study period.

In developing country like India, agriculture even at the present times overwhelmingly important as it provides livelihood for the more than half of total work force and supplies food to the whole nation. The performance of agricultural sector is crucial for the economy in several ways like eradication of poverty, and employment opportunities etc. One thing that stands out in the growth performance of agriculture since independence is that while sources of growth have changed over time, the overall growth rate of agricultural production has failed to get accelerated.

Paddy crop is the one of the main food grain crop. The production of food grains constitute the most significant role in agricultural production of any country which is being recognized as having an urgent need to raise production in view of the large gap between demand and supply of food grains. As a matter of fact, sustained and accelerated development of Indian agriculture is the key to acceleration in economic development and eradication of poverty by supplying food grains to all the sections of the country including the poor. Moreover, a large number of industries like rice, textiles, silk, sugar, flourmills and milk products get raw material from agriculture. It has strongly forward and backward linkages within the rural sector and with the strategy of overall economic growth and development.

Total area of kharif paddy, in Vidarbha region were 7.43 lakh hectare and production (in 00 tonnes) was 13.46 lakh, tonnes, respectively .

The agricultural prices commission (APC) was set up in India in 1965 to advice the government on evolving a valence and integrated price structure. The policy framework was modified in 1980, when the emphasis was shifted on tot the balance between demand and food grain minimum support price (MSP) is a form of market intervention by the government of India to insure agricultural producers against any sharp fall in form prices. The MSP are announced by the government of India at a beginning of the sowing season for certain crops on the basis of the recommendation of the CACP. MSPs are prices fixed by government of India to protect the producer-

1&3. Assistant Professor(Agril. Econ.), 2.Head, 4. Associate Professor (Statistics), 5. Associate Professor(Agril. Econ.), Deptt. of Agricultural Economics & Statistics, Dr.P.D.K.V.Akola

farmers-against excessive fall in price during bumper production years. The MSP are the guarantee price for their produce from the government. If there is a fall in the prices of the crops, after a bumper harvest, the government purchases at the MSP and this is the reason that price cannot be below MSP so this directly help the farmers. Such minimum MSP are fixed at incentive level, so as to induce the farmers to make capital investment for the improvement of their farm and to motivate them to adapt improve crop production technologies to step up their production and there by income.

The farm harvest prices (FHP) are those which is prevail during a six to eight weeks immediately after the harvesting period and wholesale prices are those which prevail in the wholesale markets. Through, there are some years in between when the wholesale prices have fallen below FHP, on an average of kind of pattern observed is – support price Â Farm Harvest PriceÂ Wholesale Price, the farm harvest prices capital and WSP of selected major crops are weighted averages

WSP accordingly is the rate at which a relatively large transaction, generally for further sale, is effected price policy for agric-produce is to set remunerative prices with a view to encourage higher investment and production.

In recent year, the MSP policy has been criticized by both farmers and proponents of free trade. Farmer always demand a substantial hike in MSP, whereas agricultural trade thinkers feel that, most of the times, MSP is in a line with the international prices as well as domestic demand and supply situation. This brings distortions and inefficiency in production pattern. If there is a fall in the prices of the crops, the government purchase at the MSP and this is reason that the priced cannot be below MSP. In the absence of such a guaranteed price, there is a concern that farmer may shift to other crops causing shortage in this commodities.

Baviskar *et al.* (2020) studied trends and decomposition of wheat production in Western Maharashtra. The result reveled that, during Period I area effect was most responsible factor for changing production in Ahmadnagar district. At overall period the area effect was most responsible factor for changing production of wheat in Dhule district. Jain et.al. (2019) studied decomposition analysis of major cereal crops in different agroclimatic region of Chahhattisgarh, the study reveled that, the yield effect is dominating over area effect. Minhas and Vaidyanathan (1965) studied growth of crop output in India, in their study they observed that, area and yield contributed significantly in the growth of total output, whereas a small part of increase was attributed to change in cropping pattern & to interaction term between yield and cropping pattern. Shende *et al.*(2017) studied Growth dynamics and acerage response of paddy in eastern Vidarbha Zone of Maharashtra, they observed that are effect was found most responsible factor for increasing paddy production in eastern Vidarbha region. Highest area effect was recorded in Chandrapur district with both negative yield and interaction effect.

The agricultural price policy (MSP) has outlived its utility and is being used more as a political tool than an economic tool. Therefore, it becomes imperative to examine the effectiveness of MSP in different regions of the country as well as its contribution towards growth. Since MSP policy is consider to have approved mostly the surplus states, its role and contribution towards production was examined for the Vidarbha region of Maharashtra state. Therefore this study was planned with the following specific objectives

1) To estimate the growth and instability of major crops.
2) To measure the relative contribution of area, yield to the total output .
3) To study the impact of various prices on area.

MATERIAL AND METHODS

The present study was undertaken in Vidarbha region. The Paddy crop was selected for the present study

The data were collected on area, production, productivity of Paddy grown in Vidarbha region pertaining to the period from 2001-2002 to 2020-2021 (20 years) For the analysis of growth and instability, the entire study period was split into two sub-periods and overall as follows.

Period I : 2001-2002 to 2010-2011

Period II : 2011-2012 to 2020-2021

Overall : 2001-2002 to 2020-2021

Source of data

The district-wise time series data on area, production, productivity and various prices were collected from Government publication and websites

Growth rate

The compound growth rates of area, production and productivity of Paddy was estimated for last 20 years. The district wise compound growth rates of area, production and productivity were estimated by using following exponential model.

$Y = a.b^t$ .... (1)

Where,

Y = Depended variable for which growth rate is to be estimated

a = Intercept

b = Regression Coefficient

t = Time Variable

This equation was estimated after transforming (1) as follows

Log y = log a + t Log b.................................... (2)

Then the per cent compound growth rate (g) was computed using the relationship.

CGR (r) = [Antilog (log b) – 1] × 100.................................(3)

The significance of the regression coefficient was tested using the student's' 't' test.

Instability

To measure the instability in area, production and productivity, an index of instability was used as a measure of variability through Coefficient of Variation (CV) and Cuddy Della Valle's instability indices.

Coefficient of variation (CV)

$$CV (\%) = \frac{\sigma}{X} \times 100$$

Where,

σ = Standard deviation

X = Arithmetic mean

The simple Coefficient of Variation (C.V) often contains the trend component and thus over estimates the level of instability in time series data characterized by long term trends and Cuddy Della Valle's instability was estimated as follows.

Cuddy Della Valle's Instability Indices (CDVI)

It was used to measure instability of paddy which was close to approximation of the average year to year per cent variation adjusted for trend. The algebraic form of it was;

$$\text{Instability Index} = CV \sqrt{(1 - R^2)}$$

Where,

CV = Simple Estimates of coefficient of variation in per cent and

R^2 = Coefficient of determination from a time trend regression (linear) adjusted by the number of degree of freedom.

Decomposition of output growth

To measure the relative contribution of area, yield to the total output of the Cotton, Soybean and Paddy crop, Minhas (1964), Decomposition analysis model was used which is given below.

Po = Ao x Yo and

Pn = An x Yn ———————— (1)

Ao, Po and Yo are area, production and productivity in base year and An, Pn and Yn are values of the respective variable in nth year item respectively.

Where,

Ao and An = Area

Yo and Yn = yield in the base year and nth year respectively.

$Pn - Po = \Delta P$

$An - Ao = \Delta A$

$Yn - Yo = \Delta Y$ ——————————— (2)

For equation (1) and (2) we can write

$Po + \Delta P = (Ao + \Delta A) (Yo + \Delta Y)$

Hence,

$$P = \frac{Ao\ \Delta Y}{\Delta P} \times 100 + \frac{Yo\ \Delta A}{\Delta P} \times 100 + \frac{\Delta Y\ \Delta A}{\Delta P} \times 100$$

Production = Yield effect + area effect + interaction effect

Thus, the total change in production can be decomposed into yield effect area effect and the interaction effect due to change in yield and area.

The impact of various prices on area and production was estimated with the help of Narlovian - Lagged Model.

$$At = a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7$$

Where

- At = Current year area under Paddy
- X_1 = One year lagged area of Paddy
- X_2 = One year lagged Farm Harvest Prices of Paddy
- X_3 = Current year Minimum Support Prices of Paddy
- X_4 = One year lagged Wholesale prices of Paddy
- X_5 = Farm Harvest Price risk of Paddy
- X_6 = Minimum Support Price risk of Paddy
- X_7 = Wholesale Price risk of Cotton Paddy
- X8 = Yield risk of Paddy

b_1 to b_7 = Coefficient

R^2 = Coefficient of determination

RESULTS AND DISCUSSION

The district wise compound growth rates of area of Paddy crop in Vidarbha during 2001-02 to 2020-21 was shown in below Table 1.

Table 1: Growth rates of area of Paddy in different districts of Vidarbha

Districts	Period I	Period II	Overall Period
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	—	-	-
Amravati Division	-	-	-
Wardha	-	-	-
Nagpur	6.27**	4.12**	5.47**
Bhandara	1.75**	-0.72	0.43
Gondia	0.94	-2.86*	-0.94*
Chandrapur	-1.99	-1.85*	-0.23
Gadchiroli	0.89**	1.06	0.64**
Nagpur Division	**0.96****	**-0.49**	**0.48****
Vidarbha	**0.72****	**-0.48**	**0.40***

Note: ** Significance at 1 % level, * significance 5% level.

The Table 1 reveled that, for period I, the growth rate of paddy for period I is positive and significant except Chandrapur whereas the growth rate is positive but non-significant for Gondia district. However, in period II, except Nagpur district all district of Eastern Vidarbha region (Bhandar, Gondia, Chandrapur) showed negative trend, whereas Gadchiroli district showed non-significant trend. At overall 20 years the compound growth rate of area of paddy was significant in all the district of Nagpur division except Bhandar & Chandrapur district. Vidarbha as a whole the growth rate of area was positive and significant. The district wise compound growth rates of production of paddy in Vidarbha during 2001-02 to 2020-21 was shown in Table 2.

Table 2 : Growth rates of production of Paddy in different districts in Vidarbha.

Districts	Period I	Period II	Overall Period
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	-		-
Amravati Division	-	-	-
Wardha	-	-	-
Nagpur	5.19*	4.46	7.18**
Bhandara	0.64	-0.26	2.96*
Gondia	2.31	-0.55	3.23*
Chandrapur	-3.38	-0.76	0.34
Gadchiroli	3.72	4.14	3.53**
Nagpur Division	**1.29**	**1.49**	**4.07****
Vidarbha	**-0.48**	**1.50**	**2.62****

Note: ** Significance at 1 % level, * significance 5% level.

It could be seen from Table 2 that, during period I , the growth rate of production was positive and significant for Nagpur district and majority of the district it was positive but non-significant. On the other hand the growth rate of production under paddy was negative for Vidarbha region. During Period II the growth rate of paddy crop showed the non-significant trend for Vidarbha (1.50 Per cent) and all the district for production. At overall 20 years the compound growth rate of production showed the positive and significant trend for productivity except Chandrapur district.

The district wise compound growth rates of productivity, paddy in Vidarbha during 2001-02 to 2020-21 was shown in Table 3.

Table 3: Growth rates of productivity Paddy in different districts in Vidarbha.

Districts	Period-I	Period-II	Overall Period
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	-	-	-
Amravati Division	-	-	
Wardha	-		-
Nagpur	-1.01	4.68*	2.76**
Bhandara	-1.09	0.46	2.52*
Gondia	2.80	2.37	4.22**
Chandrapur	-1.42	1.12	0.57
Gadchiroli	2.80	3.05	2.86*
Nagpur Division	**0.33**	**1.99**	**2.70***
Vidarbha	**1.41**	**-0.05**	**0.50**

Note: ** Significance at 1 % level, * significance 5% level.

It could be seen from Table 3 that, during period I , the growth rate of productivity of paddy were non-significant for all the districts. During Period II the growth rate of paddy productivity showed the non-significant trend for all the paddy growing district and Vidarbha (-0.05 %) except Nagpur district (4.68 per cent) for productivity. At overall 20 years the compound growth rate of productivity for was highest in Gondia (4.22 per cent), followed by Gadchiroli (2.86 per cent), Nagpur (2.76 per cent) and Bhandara (2.52 per cent) whereas the growth rate for Vidarbha was non-significant.

One should not be obvious of instability by taking the growth rate only, because the growth rate will explain only the rate of growth over the period, whereas instability judge, whether the growth performance is stable or unstable for the period for the pertinent variable. The simple coefficient of variation (CV) often contains the trend component and thus overestimates the level of instability in the time series data characterized by long term trend. To overcome this problem, this study used the instability index given by Cuddy Della Valle, which corrects the coefficient of variation. District wise Cuddy Della Valle Instability Index of area of paddy in Vidarbha was estimated and presented in Table 4.

Table 4 : Cuddy Della Valle Instability Index of area of Paddy in different districts in Vidarbha.

Districts	Period I	Period II	Overall
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	-	-	-
Amravati Division	-	-	-
Wardha	-	-	-
Nagpur	1.94	0.54	4.22
Bhandara	0.81	0.00	2.81
Gondia	0.86	0.81	0.48
Chandrapur	2.05	0.54	0.96
Gadchilori	0.42	0.46	0.68
Nagpur Division	0.51	0.00	0.43
Vidarbha	0.49	0.34	4.56

It is seen from Table 4 that, during period I Cuddy Della Valle Instability Index of area of paddy was lowest in Gadchiroli district (0.42 %) and highest in Chandrapur district (2.05 %) As a whole Vidarbha recorded low instability i.e. 0.49 per cent. During period II, the CDVII of area of paddy was lowest in Gadchiroli district (0.46 %). As a whole Vidarbha recorded low instability i.e. 0.34 per cent. At overall period the CDVII of area of paddy was lowest in Gondia district (0.48 %) and highest in Nagpur district (4.22 %) As a whole Vidarbha recorded 4.56 per cent instability.

District wise Cuddy Della Valle Instability Index of production of paddy in Vidarbha was estimated and presented in Table 5.

Table 5 : Cuddy Della Valle Instability Index of production of Paddy in different districts in Vidarbha

Districts	Period I	PeriodII	Overall
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	-	-	-
Amravati Division	-	-	-
Wardha	-	-	-
Nagpur	1.72	0.00	7.56
Bhandara	3.07	3.03	4.13
Gondia	3.09	1.60	2.36
Chandrapur	3.44	1.72	2.94
Gadchilori	3.15	2.78	2.70
Nagpur Division	2.88	2.27	2.48
Vidarbha	2.89	1.64	2.24

It is seen from Table 5 that, during period I Cuddy Della Valle Instability Index of production of paddy was lowest in Nagpur district (1.72 %) and highest in Chandrapur district (3.44 %) As a whole Vidarbha recorded 2.89 per cent instability. During period II, the CDVII of production of paddy was lowest in Gondia district (1.60 per cent) and highest in Nagpur district (3.03 per cent). As a whole Vidarbha recorded 1.64 per cent instability. At overall period the CDVII of production of paddy was lowest in Gondia district (2.36 %) and highest in Nagpur district (7.56 %) As a whole Vidarbha recorded 2.24 per cent instability.

District wise Cuddy Della Valle Instability Index of productivity of paddy in Vidarbha was estimated and presented in Table 6.

Table 6 : Cuddy Della Valle Instability Index of Productivity of Paddy in different districts in Vidarbha

Districts	Period I	Period II	Overall
Buldhana	-	-	-
Akola	-	-	-
Washim	-	-	-
Amravati	-	-	-
Yavatmal	-	-	-
Amravati Division	-	-	-
Wardha	-	-	-
Nagpur	2.33	1.65	11.29
Bhandara	3.45	1.69	2.29
Gondia	3.67	1.64	2.03
Chandrapur	3.79	3.02	3.20
Gadchilori	3.71	1.98	2.66
Nagpur Division	3.32	1.68	2.41
Vidarbha	2.80	-	2.62

It is seen from Table 6 that, during period I Cuddy Della Valle Instability Index of productivity of paddy was lowest in Nagpur district (2.33 %) and highest in Chandrapur district (3.79 %) As a whole Vidarbha recorded 2.80 per cent instability. During period II, the CDVII of productivity of paddy was lowest in Gondia district (1.64 %) and highest in Chandrapur district (3.02 %). At overall period the CDVII of productivity of paddy was lowest in Gondia district (2.03 %) and highest in Nagpur district (11.29 %) As a whole Vidarbha recorded 2.62 per cent instability.

Per cent contribution of area, yield and their interaction for increasing production of paddy in Vidarbha was estimated and presented in Table 7.

The data presented in Table 7 revealed that, in case of paddy, during period I area effect was the most responsible factor for changing production in three district of Vidarbha region. Highest area effect was observed Nagpur district (240.4 %), followed by Chandrapur district (91.7 %), and in Bhandara (84.8 %) In Vidarbha yield effect was most responsible factor for changing paddy production i.e. 69.10 per cent, where as the area effect and interaction effect was 27.7 per cent and 3.22 per cent respectively, Hence yield effect indicate that, the yield has been playing a driving force in differential form of paddy production.

Table 7 : Per cent contribution of area, yield and their interaction for increasing production of paddy in Vidarbha

S.N.	District	Particulars	Period I	Period II	Overall
1	Nagpur	Area Effect	240.4	34.3	44.9
		Yield Effect	-83.57	50.59	23.89
		Intr. Infect	-56.83	15.08	31.19
2	Bhandara	Area Effect	84.8	-8.3	29.6
		Yield Effect	11.92	109.78	56.40
		Intr. Infect	3.27	-1.52	14.02
3	Gondia	Area Effect	0.7	-569.9	-46.8
		Yield Effect	99.08	757.04	170.72
		Intr. Infect	0.22	-87.18	-23.91
4	Chandrapur	Area Effect	91.7	382.3	55.6
		Yield Effect	11.11	-312.50	47.50
		Intr. Infect	-2.79	30.24	-3.08
5	Gadchiroli	Area Effect	24.5	25.2	30.8
		Yield Effect	68.47	66.48	57.42
		Intr. Infect	7.08	8.34	11.80
6	Nagpur Division	Area Effect	35.9	1.2	23.4
		Yield Effect	60.08	98.57	67.83
		Intr. Infect	4.04	0.25	8.74
7	Vidarbha	Area Effect	27.7	-1.6	19.4
		Yield Effect	69.10	101.91	73.20
		Intr. Infect	3.22	-0.34	7.40

During Period II, it was observed that, yield effect of Gondia and Bhandara district i.e. 757.04 per cent and 109.78 per cent playing a major role in changing production of paddy and area effect was negative -569.9 & -8.3 per cent and interaction effect was also negative i.e. -87.18 per cent and -1.52 per cent per annum. In this period as for as Vidarbha is concern yield effect was the most responsible factor for change in production i.e. 101.91 per cent and area and interaction effect were -1.6 and -0.34 per cent respectively.

At overall period, the yield effect was most responsible factor for change in production for three district which included Gondia, Gadchioli, and Bhandara, district i.e. 170.72 per cent,57.42 per cent, 56.40 per cent, respectively. Regarding Vidarbha as a whole yield effect is most responsible factor for change in paddy production i.e. 73.20 per cent where as area effect and interaction effect were 19.4 per cent and 7.40 per cent, respectively.

Acreage response functions were fitted to examine the effect of price on farmer's decision in allocating the area of paddy in Vidarbha. The actual area in the current year was express as a linear function of one year lagged area, one year lagged farm harvest prices, one year lagged MSP and one year lagged wholesale prices. The regression coefficient of these explanatory variables are presented in Table 8.

Table 8 : Estimated coefficient of acreage response function of Paddy

Particular	Coefficients	Standard Error	t Stat
Intercept	4579.4	1864.72	2.4558**
Area t-1 (x1)	0.3675	0.2854	1.2874
FHP t-1 (x2)	-0.2708	0.8775	90.3086*
MSP t (x3)	0.8971	1.1694	0.7672
WSP t-1 (x4)	-0.4023	0.3846	-1.0472
Price Risk FHP(x5)	-4.0889	14.9347	-0.2711
Pr Risk MSP (x6)	4.04347	18.9253	0.2137
Price Risk WP (x7)	4.9596	8.5541	0.5798
Yield Risk (x8)	-13.757	6.83691	-2.0122
R^2	0.698		
Adjusted R Square	0.4775		
DF	19		

It was revealed from Table 8 that, the lagged area was found to be positively influential factors in the farmers decision regarding area allocation to paddy and found non-significant in Vidarbha region which indicated lesser rigidity in the adjustment of area under paddy. The coefficient of farm harvest price and wholesale prices were very less i.e. -0.4023 and -0.2708 in Vidarbha, respectively and it was non-significant which implies less and negative relationship between the variation in the hectareage of paddy and farm harvest prices. It implies that prices had not shown any impact in the increase on area of paddy in the study period. The yield risk variable was incorporated

Table 9 : Comparision between producer price, cost of production and MSP of Paddy

S.N.	Items	2017-18	2018-19	2019-20	2020-21	2021-22	Average
1	Producer Price (Rs. q^{-1})	1707.75	1742.18	1836.37	1867.62	2629.06	1956.59
2	Cost of Production (Rs. q^{-1})						
a	at cost A	2065.78	1605.378	2099.64	1956.29	1525.48	1850.51
b	at cost C	3180.69	2208.71	2821.24	2891.21	2202.33	2660.83
3	MSP (Rs. q^{-1})	1550	1750	1815	1868	1940	1784.6
4	Parity Between Cost & MSP						
	at cost A	-515.78	144.62	-284.64	-88.29	414.52	-65.91
	at cost C	-1630.69	-458.71	-1006.24	-1023.21	-262.33	-876.23
5	% of producer price over MSP	110.18	99.55	101.18	99.98	135.52	109.64

in the model to gauge the impact of risk over the variation in the hectarage under paddy. The coefficient of variable had a negative and statistically non-significant response over a period of study. It was also recorded that, regression coefficient of price risk variables or factors were positive , it indicated that, farmers were relatively better risk bearers but are statistically non-significant. The value of coefficient of determination was 0.69 indicates that, variable included in the model explain most of the variation in the area under cotton in the study period,

Table 9 indicates the comparison between producers price, cost of production and MSP of soybean. It was observed that, Farmers were receiving less price as compare to MSP. The parity between cost of production and MSP price was range from Rs. -262.33 to -1630.69 during last six years, Hence, it is necessary to fixed MSP on the cost of production for the paddy.

CONCLUSION

At overall level the compound growth rate of area of paddy for Vidarbha region is positive and significant. The compound growth rate of production of paddy is positive and significant at overall level for Vidarbha region. At overall level for Vidarbha region area, the CDVII 4.56 per cent instability. At overall level for Vidarbha region production Vidarbha recorded 2.24 per cent instability. At overall level for Vidarbha region productivity , Vidarbha recorded 2.62 per cent instability Vidarbha as a whole yield effect is most responsible factor for change in paddy production i.e. 73.20 per cent where as area effect and interaction effect were 19.4 per cent and 7.40 per cent respectively. Prices had not shown any impact in the increase on area of paddy in the study period.

LITERATURE CITED

Baviskar P.P. U.T. Dangore, A.D.Dhunde, U.P.Gaware, A.G.Kadu, 2020 Trends and Decomposition of Wheat Production in Western Maharashtra., Current J. Applied Sci. Technol.. 39(29): 69-78.

Jain Anupama, R.M. Sahu and Yogita Kashyap, 2019. Decomposition analysis of major cereal crops in different agroclimatic regions of Chhattisgarh, International J. Chemical Studies. 7(6): 2198-2200

Minhas B.S. and A. Vaidyanathan, 1965. Growth of crop output in India 1951-54 to 1958-61: An analysis by Component Elements, J. Indian Soc. Agril. Statistics, 17(2): 230-252.

Shende N.V., I.U. Valvi and P.V. Shende, 2017. Growth dynamics and acerage response of paddy in eastern Vidarbha Zone of Maharashtra, International Res. J. Agril. Econ. Statistics, 8(1): 121-129.

* * *

Received on 10 August, 2022 - Accepted on 27 September, 2022

PKV Res. J. Vol. 46(2), July, 2022

Economic Analysis of Production and Marketing of Keshori Chilli in Gondia District

P. S. Hattimare[1], A. A. Bhopale[2], N. V. Shende[3] and N. R. Koshti[4]

ABSTRACT

The present study of economic analysis of keshori chilli in Gondia district was under taken to estimate the cost and return of keshori chilli growers, to study the marketing of keshori chilli, to workout the resource use efficiency of keshori chilli, to access the advantage and constraints in production and marketing of keshori chilli. Primary data pertains for the year 2021-2022 of rabi season.The standard cost concepts were used for estimating per hectare cost and return. The Cobb-Douglas production function was used to study the resource use efficiency, Marketing aspects was studied by calculating producer's share in consumer's rupee. The advantage and constraints in production and marketing were identified and results and conclusion were drawn from the present study.The gross cropped area was the highest in large size group 8.64 hectare followed by medium 3.88 hectare and small group 1.87 ha of keshori chilli growers. The cropping pattern of keshori chilli growers was dominated by paddy and tur in kharif season whereas wheat, gram and keshori chilli in rabi season. In rabi season the contribution of area under keshori chilli was 17.55 per cent by small, 9.53 per cent by medium and 5.32 per cent by large size group of keshori chilli growers.The gross returns from keshori chilli were Rs 3,47,598.02, Rs. 3,58,307.80 and Rs. 3,60,969.35 for small, medium, and large size group of keshori chilli growers, respectively. At overall level, the gross return was Rs.3,53,172.59. Whereas ha^{-1} total cost of cultivation of keshori chilli was the highest in the large size group at cost "C" (Rs.1,95,526.21) followed by small size group (Rs. 1,83,796.61) and medium size group (Rs.1,83,358.06). The highest input- output ratio of keshori chilli at cost "C" was recorded 1.95 in medium size group followed by 1.89 in small size group and 1.85 in large size group. The coefficient of determination (R^2) for small, medium, and large size of keshori chilli growers 0.65, 0.81, 0.58, respectively and at overall level it was 0.48 Channel III (i.e., Producer - Wholesaler - Retailer -Consumer) was observed major channel of distribution. Producer's share in consumer's rupee was the highest in channel I (98.54 %). Major constraints faced by keshori chilli growers in production and marketing were electricity problem, nonavailability of labours during peak period, lack of regulated market. Garratt mean score of these constraints was 69.75, 58.02, 59.63, respectively.

Chilli is one of the most important commercial crops of India. It is grown almost throughout the country. There are more than 400 different varieties of chillies found all over the world. It is also called as hot pepper, cayenne pepper, sweet pepper, bell pepper, etc. In recent times, production and marketing of agricultural and horticultural crops received wide attention from the policy makers, planners and scholars due to its profitable enterprise and export potential. The marketing of farm products is an intricate process and includes the entire marketing functions in moving the produce from the producers to the final consumers. The shortest channel of marketing produce is from producer to consumer while other channel linking producer and consumer consist of intermediary viz. wholesaler and retailer in the study area of chilli production. Maharashtra ranks third in terms of green chilli production in India with an area 30,182 hectares with production 3,43,687 metric tonnes and productivity 11.38 metric tonnes per hectares in the year of 2019-20. Nagpur was the largest producer of green chilli in Maharashtra and contributed about 23.04 percent to the total production followed by Pune (16.14 %), Palghar (10.03 percent), Nandurbar (9.75 %) and Nashik (5.28 %). (Anonymous, 2020).In Gondia district the area under cultivation of chilli crop is less as compared to other crops because of the climatic condition and most of the area are non-irrigated. The demand of chilli is increasing day by day and also it contributing sizable share in the total earning of cultivators. The aim of marketing is that the production should realize a suitable net returns from the produce.Market accelerating the rate of economic development but still there some defects in agriculture

1. P.G. Student, 2. Assistant Professor, 3. Head and 4. Professor (Extn. Edn.), Dept. of Agricultural Economics & Statistics, Dr. PDKV, Akola

marketing. In the extent to above the present study was completed.

MATERIAL AND METHODS

Multistage type of sampling was followed for selection of state, district and thereafter random sampling is employed for selection of Panchayat samiti, villages and respondents.The present study was undertaken in Gondia district. The district was selected purposively based on optimum area under Keshori Chilli cultivation. The list of Keshori Chilli cultivator was obtained from Sub-Divisional Agriculture Office /Divisional Agriculture office of respective tahsil. A sample of 60 farmer were selected and grouped under different categories on the basis of size of holding such as small (less than 2 ha) medium (2.01 to 4 ha) and large (above 4.01 ha). Primary data was collected from selected sample by survey method with personal interviewed through a specially designed schedule. The data pertained to the year 2021-22. The data related to marketing were collected from selected farmer as well as10 wholesalers cum commission agent and 10 retailers in various market functionaries with the help of questionnaires. Simple tabular analysis was carried out to work out the socio-economic characteristics of Keshori Chilli growing farmer. The expenditure incurred by the selected farmer for cultivation of Keshori Chilli will be workout by using standard cost concept *viz.* cost A, cost B and cost C. Simple tabular analysis will be done to work out per hectare cost of cultivation, gross returns and net return from the crop produce. The arithmetic averages were used to work out yields, cost, gross and net returns.

RESULTS AND DISCUSSION

It is seen from the table 1 that per hectare hired human labour utilization was observed in small, medium, and large farmers size were 241.08 days, 232.10 days, 198.61 days and at overall level it was 229.47 labour in days. It is observed that the hired human labour utilization was highest in small size group. Among the groups, the utilization of hired female labour was observed highest in small size group of keshori chilli growers followed by

Table 1. Input utilization ha^{-1} for selected keshori chilli growers.

S.N.	Particulars		Unit ha^{-1}	Small	Medium	Large	Overall
1	2	3		4	5	6	7
1	Hired Human Labour	a) Male	Days	75.68	67.02	58.70	69.67
		b) Female	Days	165.40	165.08	139.91	159.80
	Sub total			241.08	232.10	198.61	229.47
2	Bullock Power		Pair Days	9.44	10.39	3.35	8.77
3	Machine Power		Hours	10.98	12.21	17.62	13.18
4	Seeds		Kg.	1.10	1.14	1.18	1.13
5	Manures		q	76.91	82.94	73.12	77.60
6	Fertilizers	a) N	Kg.	110.91	95.85	96.44	104.01
		b) P	Kg.	49.38	36.70	54.28	47.27
		c) K	Kg.	32.06	34.87	49.46	36.53
	Sub total			**192.35**	**167.42**	**200.18**	**187.81**
7	Plant protections		Lit.	2.96	3.41	3.98	3.62
8	Bio/ Micr		Kgs.	3.73	2.35	2.52	3.12
9	Growth Regu		Lit.	1.21	1.32	1.49	1.30
10	Irrigation (electric charges)		Rs.	4037.13	4141.74	4756.75	4219.20
11	Family Human Labour	a) Male	Days	19.33	26.43	30.94	23.62
		b) Female	Days	38.45	37.52	24.60	35.22
	Sub total			**57.78**	**63.95**	**55.54**	**58.84**

medium and large size group of growers i.e.,165.40 days, 165.08 days, 139.91 days, respectively at overall it was 159.80days.The bullock power utilization was observed highest in medium size group i.e., 10.39 pair days, followed by small and large size group were 9.44 and 3.35 pair days, respectively at overall level it is 8.77 pair days.The average per hectare utilization of machinery power was found to be highest in large size group i.e.,17.62 hours followed by medium and small size group were 12. 21 hours and 10.98 hours and at overall level it is 13.18 hours. In large and medium size group ha^{-1} utilization of seed was highest i.e. 1.18 kg ha^{-1} and 1.14 kg $ha^{-1}$and small size group of growers were utilized i.e., 1.10 kg $ha^{-1}$and at overall level utilization of seeds was 1.13 kg ha^{-1}.The farmers of medium size group used more amount of manures i.e., 82.94 q ha^{-1} followed by small and large size group was 76.91 q $ha^{-1}$and 73.12 qha^{-1} and at overall level it was 77.60 q ha^{-1}.It is observed that amongst all three size of holdings groups the use of per hectares fertilizers was observed highest in large size group i.e., 200.18 kg ha^{-1} followed by small size group i.e., 192.35 kg per hectare and medium size group i.e., 167.42 kgha^{-1}. At overall level it was 187.81 kg ha^{-1}.The average per hectare consumption of plant protections was found to be the highest in large size group i.e., 3.98 litre ha^{-1} followed by medium size group i.e.,3.41 litre ha^{-1} and small size group i.e.,2.96 litre ha^{-1}. At overall level it is 3.62 litre ha^{-1} (Srikala *et al.,* 2016).

The table 2 indicates that the per hectare production of quintal, keshori chilli for small, medium, and large farmer was 21.28, 21.74 and 22.07, respectively. At overall level it was 21.55 quintal/ha. The average per hectare net returns received by the small, medium, and large farmers at total cost i.e., cost C was Rs.163801.41 Rs.174949.74 /- and Rs. 165443.14/-. At an overall the net returns was Rs. 165931.66/-. The input - output ratio at cost C was 1.89, 1.95 and 1.85 for small, medium, and large farmer, respectively. At overall level output-input ratio was 1.89. It indicates that the keshori chilli cultivation was profitable (Jagtap *et al.*, 2012).

Table 3 revealed that channel III (Producer-Wholesaler- Retailer- Consumer)was the major channel of distribution and percent share of 37 farmers is 61.67% sold their produce by this channel, followed by channel II (23.33 %) and channel I (15.00 %). In channel I was i.e. (Producer – Consumer) quantity sold was less 66.70 q. i.e., 14.53 per cent. In channel II was (Producer – Retailer – Consumer) quantity sold was 88.00 q. i.e., 19.18 per cent.

Table 2: Cost and return from keshori chilli (Rs ha^{-1})

SN	Particulars	Small	Medium	Large	Overall
1	Main produce (q ha^{-1})	21.28	21.74	22.07	21.55
2	Value of main produce	347598.02	358307.80	360969.35	353172.59
3	Gross returns	347598.02	358307.80	360969.35	353172.59
4	Per qtls. Price received by growers	8637.06	8434.13	8859.37	8688.67
5	Cost of cultivation at				
	Cost “A”	113244.01	105731.34	105384.01	109662.84
	Cost “B”	174931.76	173195.04	186140.49	177920.49
	Cost “C”	183796.61	183358.06	195526.21	187240.93
6	Returns at				
	Cost “A”	234354.01	252576.46	255585.34	243509.75
	Cost “B”	172666.26	185112.76	174828.86	175252.10
	Cost “C”	163801.41	174949.74	165443.14	165931.66
7	Input- Output ratio at				
	Cost “A”	3.07	3.39	3.43	3.22
	Cost “B”	1.99	2.07	1.94	1.99
	Cost “C”	1.89	1.95	1.85	1.89

Table 3: Quantity of keshori chilli sold through different channels

S. N.	Channels	No. of farmers	Quantity sold (qt.)
1	Channel I (Producer-consumer)	9.00	66.70
		(15.00)	(14.53)
2	Channel II (Producer -retailer - consumer)	14.00	88.00
		(23.33)	(19.18)
3	Channel III (Producer- wholesaler- retailer- consumer)	37.00	304.09
		(61.67)	(66.28)
	Total	**60.00**	**458.79**
		(100.00)	**(100.00)**

(Figures in parentheses indicates the percentage to the total)

Table 4: Marketing cost of keshori chilli (Rs. q^{-1})

S.N.	Particulars	Channel I	Channel II	Channel III
A	**Marketing cost incurred by producer**			
1	Cost of gunny bags	77.00	—	77.50
2	Cost of packing	5.50	—	5.50
3	Cost of loading & unloading	16.00	—	32.00
4	Transportation	22.50	—	40.00
5	Naka	00.00	—	00.00
6	Weighing charges	2.00	—	2.00
7	Hamali	8.00	—	16.00
8	Commission charge	00.00	—	138.50
	Total marketing cost	132.00	—	311.50
	Selling price of producer	16233.33	16385.71	16541.08
B	**Marketing cost incurred by wholesaler**			
1	Cost of gunny bags	—	—	75.00
2	Labour charges	—	—	12.00
3	Weighing charges	—	—	2.00
4	Hamali	—	—	8.00
5	Market cess fund	—	—	165.41
	Total marketing cost	—	—	187.41
	Market margin of wholesaler	—	—	910.49
	Selling price of wholesaler	—	—	17684.11
C	**Marketing cost incurred by retailer**			
1	Cost of gunny bags	—	70.00	70.00
2	Transportation	—	22.50	24.35
3	Hamali	—	8.00	8.00
4	Weighing charges	—	2.00	2.00
	Total marketing cost	—	102.50	104.35
	Market margin of Retailer	—	1406.07	1472.57
	Selling price of Retailer	—	17824.64	19259.03
	Purchase price of consumer	16233.33	17824.64	19259.03
D	**Total market cost**	132.00	102.50	678.26
E	**Total market margin**	—	1406.07	2383.06

Table 5: Price spread in marketing of keshori chilli (Rs. q^{-1})

S.N.	Particulars	Total Cost (Rs. q^{-1})		
		Channel I	**Channel II**	**Channel III**
1	Net price received by producer	16113.89	16385.71	16254.22
		(99.26)	(91.92)	(84.70)
2	Total marketing cost	132.00	102.50	603.26
		(0.81)	(0.58)	(3.14)
3	Total market margin of Retailer and wholesaler.	—	1406.07	2383.05
		(00.00)	(7.88)	(12.42)
4	Price spread	238.89	1438.93	2934.81
5	Producer shares in consumer rupees (%)	98.54	91.93	84.71
6	Purchase price of consumer	16233.33	17824.64	19189.03
		(100.00)	(100.00)	(100.00)

(Figures in parentheses indicates the percentage to the total)

Table 6: Regression coefficient of Cobb – Douglas production function analysis of keshori chilli

S.N.	Variables	Size of land holdings			
		Small	**Medium**	**Large**	**Overall**
1	Constant (intercept)	0.5052	1.9592	3.1661	0.3204
		(0.4217)	(2.2470)	(6.3829)	(0.3867)
	Coefficient				
2	Human Labour (X1)	0.1783	-0.7773	0.1948	0.2682
		(0.1595)	(1.1591)	(1.1658)	(0.1522)
3	Bullock Pair (X2)	-0.0052	-0.0945	0.2217	0.0074
		(0.0242)	(0.0970)	(0.3627)	(0.0141)
4	Machine Power (X3)	0.1528***	0.1077	-0.0299	0.1065***
		(0.0543)	(0.0975)	(0.2560)	(0.0336)
5	Seeds (X4)	-0.0223	0.2135*	0.6753	-0.0245
		(0.0492)	(0.1149)	(1.4323)	(0.0386)
6	Manures (X5)	0.0907	-0.6453	-1.1495	0.0188
		(0.0858)	(0.5099)	(1.9741)	(0.0680)
7	Fertilizers (X6)	0.0249	0.9953	-0.3028	0.0992
		(0.1502)	(0.6546)	(1.2951)	(0.0981)
8	Plant protection (X7)	-0.0199	0.2215	0.5850	-0.0411
		(0.0759)	(0.2160)	(1.3209)	(0.0562)
9	Biofertilizers (X8)	0.0196	0.1000*	0.1232	0.0156
		(0.0226)	(0.0555)	(0.3133)	(0.0188)
10	Growth Regulators (X9)	0.0610*	-0.1347	-0.4608	0.0467*
		(0.0335)	(0.1012)	(0.7949)	(0.0243)
11	Area (X10)	0.0017	-0.3502	-0.5498	0.0373
		(0.1757)	(0.6311)	(1.5370)	(0.1231)
12	Coefficient of Determination (R^2)	**0.65**	**0.81**	**0.58**	**0.48**

(Figures in parentheses indicates standard errors of regression coefficients)

(*, *** significance at 5%, and 1% level of significant)

In channel III (Producer- Wholesaler- Retailer -Consumer) quantity sold was 304.09 q i.e.,66.28 per cent (Jorwar, *et al.*, 2018).

It is revealed from table 4 that highest marketing cost of Rs. 187.41 incurred by the wholesaler out of the total cost of marketing was Rs. 603.26 in channel III in marketing of per quintal of keshori chilli. Is decrease channel wise as in channel I it is Rs. 132.00 and the total cost of marketing and in channel II it is low as compared to the other channel as Rs. 102.50 (Jorwar, *et al.*, 2018).

Table 5 indicates theProducer's share in consumer's rupee in channel III was 84.71 per cent, in channel II was 91.93 per cent and in channel I was 98.54 per cent. It showed that if share of various intermediates decreases the producers share in consumers rupee increases. Net price received by producer in channel III was Rs.16254.22, selling price of wholesaler was Rs.17682.11 and retailer selling price was Rs.19189.03 (Naik *et al.*, 2012).

From table 6 it is observed that, for small farmer's regression coefficient of machine powers was found to be statistically significant at 1 per cent level of significance, and growth regulators was found to be statistically significant at 10 per cent level of significance. Value of coefficient of determination i.e., R2 was 0.65 means 65 percent variation in yield explained by variables, included in the model.

For medium farmer's regression coefficient of seeds and bio fertilizers were found to be statistically significant at 10 per cent level of significance. Value of coefficient of determination i.e., R^2 was 0.81 means 81 per cent variation in yield explained by variables, included in the model. For large farmer's regression coefficient was found to be statistically non-significant at 1 per cent, and 10 percent level of significance. Value of coefficient of determination i.e., R^2 was 0.58 means 58 per cent variation in yield explained by variables, in the function.At overall level regression coefficient of machine powers was found to be statistically significant at 1 per cent. Growth regulators was found to be statistically significant at 10 per cent level of significance. Value of coefficient of determination i.e., R^2 was 0.48 means 48 percent yield explained by selected variables. Negative elasticity of production of variables indicates variation in excessive use of these inputs which increase in further quantity decreases the yield (Tirlapur *et al.,* 2015).

The table 7 revealed that, the problems faced by keshori chilli growers while production were electricity problems, non-availability of labour during peak period, high cost of inputs, lack of open field for drying keshori chilli, and lack of knowledge about improved varieties. Garratt mean score of these were 69.75, 58.02, 46.32, 40.07, and 34.83, respectively.

Problem faced by keshori chilli growers while lack

Table7: Constraints faced by the keshori chili growers in production and marketing of keshori chilli.

SN	Problems	Garratt mean score	Rank
A.	**Constraints in production of keshori chilli**		
1	Electricity problem (load shading)	69.75	1
2	Non availability of labour during peak period	58.02	2
3	High cost of inputs	46.32	3
4	Lack of open field for drying keshori chilli	40.07	4
5	Lack of knowledge about improved varieties	34.83	5
B.	**Constraints in marketing of keshori chilli**		
1	Lack of regulated market	59.63	1
2	High transportation charges	54.18	2
3	Inadequate storage facilities	52.60	3
4	Lack of market information	46.63	4
5	Uncertainty of price	44.75	5
6	Lack of grading facilities	41.38	6

of regulated market, high transportation charges, inadequate storage facilities, lack of market information, uncertainty of price, lack of grading facilities. Garratt mean score of these were,59.63, 54.18, 52.60, 46.63, 44.75, 41.38 respectively (Dangore *et. al,* 2015).

CONCLUSION

The Per hectare cost of cultivation of keshori chilli at cost 'C' was highest in the large size group i.e., Rs.1,95,526.21.The input output ratio of keshori chilli at cost 'C' was 1.89 in small size group, which indicates that, Cultivation of keshori chilli crop was economically profitable. Producer – wholesaler - Retailer - Consumer was found important channel through which maximum quantity was sold by the keshori chilli growers.Producers share in consumer's rupees was highest in Channel I i.e., 98.54 per cent. The major constraints faced by keshori chilli growers was electricity problems, non-availability of labour during peak period, high cost of inputs, lack of technical knowledge (Garratt mean score of these were 69.75, 58.02, 46.32, 40.07) and regulated market, high transportation charges, inadequate storage facilities (Garratt mean score of these were, 59.63, 54.18, 52.60).

LITERATURE CITED

Anonymous, 2020. Horticulture area production information system, Ministry of Agriculture and Farmers Welfare, Government of India.

Dangore, U.T., A.K.Bahekar, S.B.Datarkar and A.S.Darekar, 2015. Constraints faced by the Dry Chilli Growers in Production and Marketing of Dry Chilli in Wardha district of Maharashtra, Agriculture Update, 10 : 252-255.

Jagtap, P.P., U.S. Shingane and K.P.Kulkarni, 2012. Economics of Chilli Production in India, African Journal of Basic and Applied Sciences, 4(5) : 161-164.

Jorwar, R.M., S.M.Sarap and V.U. Chauhan, 2018. Economics of Production and Marketing of Chilli in Amravati District of Maharashtra, J. Pharm. and Phytochem., 7(2) : 310-316.

Naik, V.R.,L.B. Kunal, S.S. Patil and S. S. Guledagudda, 2012. Organic and Inorganic cultivation of chilli and its marketing- An Economic Analysis, Karnataka J. Agri. Sci., 25(2) : 203-207.

Srikala, M.,I.D.Bhavani, V. Subramanyam and T. Ananda, 2016. Cost of cultivation and price spread of chilli in Guntur district of Andhra Pradesh, International J. Agri., Environ. and Biotech., 9(2): 299-303.

Tirlapur,L.N.andS.M.Mundinamani , 2015. Resource use efficiency in cultivation of major crops of Dharwad district, Agriculture Update, 10(2) : 93-99.

* * *

Received on 7 October, 2022 - Accepted on 17 November, 2022

PKV Res. J. Vol. 46(2), July, 2022

Economic Analysis of Production and Marketing of Maize in Bhilwara District

Mahendra Kumar[1], A. A. Bhopale[2], N.V.Shende[3] and D.K.Nemade[4]

ABSTRACT

This study comprised of economic analysis of maize in Bhilwara district of Rajasthan. With the objective to estimate the cost and return of maize, to study the marketing of maize, to work-out the resource use efficiency of maize and to access the advantage and constraints in production and marketing of maize. The study was based on primary data collected for a period of 2021-22. For this study 60 farmers were selected from 6 villages of two tehsils. Data were analysed by using statistical tools like Standard Cost concept, Input-out putratio, Price spread, Garrett ranking. Out of 60 farmers, 75.00 per cent farmers were from small farmer category,18.34 per cent farmers were from medium category and remaining from large farmer category with average land holding of 1.32, 3.34 and 6.5 hectares, respectively. At overall level, sorghum and maize were dominant crops in kharif season with share of 18.76 & 12.87 per cent in gross cropped area while gram and wheat were major crops in rabi season. Cost of cultivation of maize ha^{-1} was highest for large farmers i.e., Rs. 78334.25 Followed by medium farmers (Rs. 70262.66) and small farmers (Rs. 55595.85). Input- output ratio at cost C was highest for medium farmer (1.36) followed by Large (1.34) and small farmers (1.33). Three major marketing channels were identified in study area. Channel III was major channel in study area. Net price received by farmers was highest in channel I followed by channel II and Channel III. Producer's share in consumer rupee was also highest in channel I (96.07 %) followed by Channel II (80.55 %) and Channel III (75.68 %) At overall level, Coefficient of determination (R^2) was 0.67. variable seed was found to be negative indicating excessive use of this input. The major problems faced by maize farmers while production was wild animal attack, high input cost and labour shortage with Garrett means score of 64.4,63.87 and 54.58, respectively. The major problems faced by farmers during marketing was high distance between farm and mandi, fluctuation in prices and high commission charges with Garrett means score of 61.42, 57 and 55.42, respectively.

Maize is one of the important cereal crops in the world's Agricultural Economy both as food for men and feed for animals. Maize is called "Queen of Cereals" Because of it's higher yielding potential as compared to other cereal crops. Maize provides nutrients for humans and animals and serve as a basic raw material for the production of starch, oil, protein, food sweetener and more recently biofuel. In the Indian context, Approx. 15 million farmers are engaged in maize cultivation and it generates employment for more than 650 million person-days at farming and its related business ecosystem levels. Importantly, maize contributes more than 2 per cent to the total value of output from all agricultural crops. Global maize production touched 1219.76 million MT in 2021-22, where in, US has been the leading producer, followed by China, accounting for about 38 per cent and 23 per cent, respectively (Anonymous, 2022[a]). India contributes around 2 per cent of this production chart with a quantum of 33.62 million MT in 2021-22. During 2021-22, world's total area of maize was 207.08 million hectares while production of maize was 1219.76 million metric tons. Among the maize growing countries India rank 4th in area and7th in production, representing around 4.8 per cent of world maize area and 2.7 per cent of total production. During 1950-51 India used to produce 1.73 million MT maize, which has increased to 33.62 million MT by 2021-22, recording close to 19 times increase in production. Among the major maize producing states, Rajasthan rank 4th in area and 7th in production with 10.9 per cent share in India's maize area and 7.20 per cent share in total maize production. In 2020-21, area under maize was 9.76 Lakh hectare while total production of maize was 2.7 million tonnes in Rajasthan. In Rajasthan, Bhilwara, Chittorgarh and Udaipur are top three states in terms ofarea and production of maize. Maize productivity of Rajasthan is 2769 kg ha^{-1} which is near to national average maize productivity. Bhilwara district has highest area under maize production in thestate which is 1.87 lakh hectore while maize production is 5.77 lakh tonnes (Anonymous 2022[b]).

1.PG Student, 2 & 4. Assistant Professor, 3. Head, Dept. of Agricultural Economics & Statistics, Dr.PDKV,Akola

MATERIAL AND METHODS

Multistage type of sampling was followed for selection of state, district and thereafter random sampling is employed for selection of villages, tehsils and maize farmers. The present study has been under taken in Bhilwara district of Rajasthan. The district was selected purposively based on optimum area under Maize cultivation. For the present study out of 16 tehsils in the district 2 tehsils namely Viz. Phuliyakalan and Shahpura were selected randomly. Three villages were selected from each tehsil by obtaining the list of maize growing villages from revenue office of respective tehsils office. The selected villages from Phuliyakalan tehsil were Nathriyas, Diyas and Panotia and from Shahpura Tehsil were Goverdhanpura, Rampuraand Behkakheda. A sample of 60 farmer were selected randomly and groupedunder different categories on the basis of size of holding such as small (less than 2 ha) medium (2.01 to 4 ha) and large (above 4.01 ha). From each village10 farmers were selected randomly for the present study. The data related to marketing were collected from farmers aswell as 10 wholesaler-cum commission agent and 5 retailers through personal visit. The data pertains to year 2021-22. Primary data were collected from selected sample by survey method with personally interviewed through a specially designed schedule. The data pertains to the year 2021-22. Simple tabular analysis was carried out to work out the socio-economic characteristics of maize growing farmers. The expenditure incurred by the selected farmer for cultivation of Maize was workout by using standard cost concept viz. cost A,cost B and cost C. Simple tabular analysis was used to work out per hectare cost of cultivation, gross returns and net return from the crop produce. The arithmetic averages were used to workout yields, cost, gross and net returns. The input out put ratio was worked out by dividing gross return by the total cost. It is calculated at cost A, cost B and cost C. Market cost and market margin was worked out from the actual data collect from market intermediaries. Price spread is the difference between net price received by the producer and price paid by ultimate consumer to produce in the retail Producers Share in Consumers rupee is the percentage of the net price received by the producer to the price paid by the consumer or selling price of retailer expressed in percentage. The Cobb-Douglas model was selected for the present analysis. The Six appropriate variables will be used to work out resourceuse efficiency. Constraints faced by the farmers during Production and Marketing of Maize was identified and analysed with the help of Garrettran king method.

RESULT AND DISCUSSION

It is seen from the table 1 that per hectare hired human labour utilization was observed in small, medium and large farmers size were 48.76 days, 67.83 days, 63.33 days and at overall level it was 53.23 labour in days. It is observed that the hired human labour utilization was highest in medium size group. Among the groups, the utilization of hired female labour was observed highest in medium size group of maize growers followed by large and small size group of growers i.e., 44.55 days, 38.50 days, 32.50 days, respectively at over all it was 35.11 days. The bullock labour utilization was observed zero in all categories of farmers. The average ha^{-1} utilization of machinery was found to be highest in large size group i.e., 9.93 hours followed by medium and small size group were 9.77 hours and 8.14 hours and at overall level it was 8.56 hours.In small and medium size group ha^{-1} utilization of seedwas highest i.e., 30.33 kg ha^{-1} and 28.73 kg ha^{-1}and large sizegroup of growers were utilized i.e., 25.00 kg ha^{-1}seed and at overalllevelutilization ofseeds was 29.68kg ha^{-1}. The farmers of large size group used high quantity of manuresi.e., 60 q ha^{-1}followed by medium and small size group was 52.73 q ha^{-1}and 30.02 q ha^{-1} and at overall level it was 36.18 q ha^{-1}. It is observed that amongst all three size of holdings groups the use of ha^{-1} fertilizers was observed highest in small size group i.e., 50.45 kg ha^{-1} followed by medium size group i.e., 49.24 kg ha^{-1} and large size group i.e., 48.60 kg ha^{-1}. At over all level it was 50.10 kg ha^{-1}. The average ha^{-1} consumption of plant protections was found to be the highest in small size group. Medium and large farmers did not use any plant protection chemicals (Kumaresan *et al.*, 2005).

From table 2 it was observed that channel– III was the major marketing channel in study area which was using by 60 per cent farmers and selling 263 quintal of

Table 1: Input utilization ha^{-1} of selected maize growers

S.N.	Particulars	Unit ha^{-1}	Small	Medium	Large	Total	
1	2		3	4	5	6	7
1	HiredHumanLabour	Male	Days	16.26	23.88	24.83	18.12
		Female	Days	32.50	44.55	38.50	35.11
	Subtotal			48.76	67.83	63.33	53.23
2	Bullock Labour	Pair (Days)	0.00	0.00	0.00	0	
3	Machine Charges	Hrs.	8.14	9.77	9.93	8.56	
4	Seeds	Kgs.	30.33	28.73	25.00	29.68	
5	Manures	Qtl	30.02	52.73	60.00	36.18	
6	Fertilizers	a) N	Kgs.	32.24	30.00	30.20	31.69
		b) P	Kgs.	18.21	19.24	18.40	18.41
		c) K	Kgs.	0.00	0.00	0.00	0.00
	Subtotal	Kgs.	50.45	49.24	48.6	50.1	
7	Irrigation charges	(Rs.)	53.33	0.00	1000.00	106.67	
8	Plant protections	(Rs.)	17.92	0.00	0.00	13.44	
9	Family Labour	a)Male	Days	10.50	6.24	6.33	9.44
		b)Female	Days	35.45	32.91	43.00	35.49
	Subtotal	Days	45.95	39.15	49.33	44.93	

Table 2 : Marketing Channels used by selected farmers

S.N.	Channels	No.offarmers	QuantitySold(Qtl.)
1	ChannelI(Producer-consumer)	12.00	66.00
		(20.00)	(15.35)
2	Channel II (Producer-Wholesaler-Retailer-Consumer)	12.00	101.00
		(20.00)	(23.49)
3	Channel III (Producer-Village Trader-Wholesaler-Retailer-Consumer)	36.00	263.00
		(60.00)	(61.16)
	Total	60.00	430
		(100.00)	(100.00)

(Figures in parentheses in dicates the percentage to the total)

maize. channel II was using by 20 per cent farmers and selling 101 quintal of maize. Chanel I which was direct channel using by 20 per cent farmers and selling only 66 quintal of maize (Ravekar *et al.*, 2015).

It is revealed from table 3 that highest marketing cost of Rs.153.06 incurred by the wholesaler out of the total cost of marketing was Rs.358.14 in channel III in marketing of q^{-1} of maize. It was observed that marketing cost was highest in channel–III i.e., 358.14 followed by channel –II and channel–I i.e., 313.07 and 95.84, respectively (Mukund *et al.*, 2018).

It is revealed from table 4 that price spread was observed highest in channel–III i.e.,Rs. 662.01/- followed bychannel–II (Rs.526.75/-) and Channel–I (Rs.95.83/-). It was observed that producer share in consumer rupee was highest in channel–I (96.07 %) due to no intermediary followed by channel – II (80.55 %) and channel – III (75.68 %). Net price received by producer was highest in channel

Table 3: Marketing cost of maize (Rs. q^{-1})

		Channel I	ChannelII	ChannelIII
A	**Marketingcostincurred byproducer**			
1	Cost of gunny bags	54.17	50.00	0.00
2	Cost of packing	5.00	5.00	0.00
3	Cost of loading & unloading	0.00	0.00	0.00
4	Transportation	14.17	50.83	0.00
5	Naka	0.00	0.00	0.00
6	Weighing charges	0.00	2.00	21.10
7	Hamali	22.50	20.00	0.00
8	Dalali	0.00	23.33	21.06
	Total marketing cost	95.84	151.16	42.16
	Selling Price of Producers	2483.33	2333.33	2102.86
B	**MarketingCost Incurred by Village Traders**			
1	Cost of gunny bag	0.00	0.00	60.00
2	Transport Charge	0.00	0.00	37.71
3	Weighing Charge	0.00	0.00	2.00
4	Hamali	0.00	0.00	29.86
5	Dalali (Commission)	0.00	0.00	23.49
	Total Marketing Cost	0.00	0.00	153.06
	Market Margin of Village Traders	0.00	0.00	92.66
	Selling price of Village Traders	0.00	0.00	2348.57
C	**Marketing cost incurred by wholesaler**			
1	Cost of gunny bags	0.00	50.00	50.00
2	Labour charges	0.00	41.67	41.43
3	Weighing charges	0.00	2.00	2.00
4	Hamali	0.00	20.00	20.00
5	Market cess fund	0.00	11.67	11.79
	Total marketing cost	0.00	125.33	125.21
	Market margin of wholesaler	0.00	93.42	91.21
	Selling price of wholesaler	0.00	2552.08	2565
D	**Marketing cost incurred by retailer**			
1	Cost of gunny bags	0.00	0.00	0.00
2	Transportation	0.00	14.58	15.71
3	Hamali	0.00	20.00	20.00
4	Weighing charges	0.00	2.00	2.00
	Total marketing cost	0.00	36.58	37.71
	Market margin of Retailer	0.00	120.25	120.00
	Selling price of Retailer	0.00	2708.92	2722.71
	Purchase price of consumer	2483.33	2708.92	2722.71
E	**Total market cost**	95.84	313.07	358.14
F	**Total market margin**	0.00	213.67	303.87

Table 4: Channelwise prices preadinmaize marketing (Rs.q^{-1})

SN	Particulars	Total Cost (Rs. q^{-1})		
		Channe lI	Channe lII	Channel III
1	Net price received by producer	2387.50	2182.17	2060.70
		(96.07)	(80.55)	(75.68)
2	Total marketing cost	95.83	313.08	358.14
		(3.93)	(11.55)	(13.15)
3	Total Market Margin	—	213.67	303.87
		(00.00)	(7.90)	(11.17)
4	Price spread	95.83	526.75	662.01
5	Purchase price of consumer	2483.33	2708.92	2722.71
		(100.00)	(100.00)	(100.00)
6	Producer shares in consumer rupees(%)	96.07	80.55	75.68

(Figures in parentheses indicates the percentage to the purchase price)

– I which was Rs. 2387.50 q^{-1} followed by channel – II (Rs. 2182.17 q^{-1}) and channel – III (Rs.2060.70q^{-1}) (Minithra *et al.*, 2019).

Table 5: Resource use efficiency of maize cultivation

SN	Variables	TotalFarmers
1	Constant (intercept)	-0.8670
		(0.4340)
2	Coefficients	
A	Human Labour(X1)	0.9462***
		(0.1721
B	Machine charges(X2)	0.3890**
		(0.1524)
C	Seeds(X3)	-0.0249
		(0.0835)
D	Manures(X4)	0.0002
		(0.0181)
E	Fertilizers(X5)	0.3214**
		(0.1370)
F	Plant protection(X6)	4.7813***
		(1.0522)
G	Area(X7)	0.0536
		(0.0564)
3	**Coefficient of Determination (R^2)**	**0.67**

(Figures in parenthesis are standard error of regression coefficients.)
(**indicates significant at 5% level of significance.)
(***indicates significant at1%level of significance.)

From table 5 it is observed that, at overall level regression coefficient of human labour and plant protection was found to be statistically significant at 1per cent level of significance. Machine charge and fertilizers was found to be statistically significant at 5 per cent level of significance. Value of coefficient of determination i.e., R^2 was 0.67 means 67 percent variation in yield explained by variables. Negative elasticity of production of variables indicates excessive use of these inputs which increase in further quantity decreases the yield (Laxmi and Mundinaman, 2015).

Table 6 : Constraints faced by maize farmers in production of maize

S.N.	Problems	Garrett Mean Score	Ranking
1	High Cost of Inputs	63.87	2
2	Wild Animal Attack	64.4	1
3	Uncertainty of Rainfall	49.2	4
4	Labour shortage	54.58	3
5	Insect-Pest Attack	39.53	5
6	Lack of Technical Knowledge	28.42	6

The table 6 revealed that, the major problems faced by maize farmers while production were wild animal attack, high input cost and labour shortage. Other problems faced by farmers were uncertainty of rainfall, insect-pest attack and lack of technical knowledge. Garrettmean score of these were 64.4, 63.87, 54.58, 49.20, 39.53 and 28.42, respectively (Srikanth *et al.*, 2017).

Table 7 : Constraints faced by maize farmers in marketing of maize

S.N.	Problems	Garrett Mean Score	Rank
1	High Distance between Farm & Mandi	61.42	1
2	Fluctuation in Prices	57	2
3	High Commission Charge	55.42	3
4	Higher Transport Charge	42	4
5	Lack of Market Information	34	5

The table 7 revealed that, major problems faced by maize farmers during marketing of maize were high distance between farm and mandi, fluctuation in price and high commission charge. Other problems faced by farmers were high transport charge and lack of market information. Garrettmeans core of these were61.42,57,55.42,42 and 34, respectively (Krishna *et al.*,2018).

CONCLUSION

The ha^{-1} total cost of cultivation of maize crop i.e.cost 'C' was highest in the small size group i.e., 78334.25 Rs ha^{-1}. The average yield and gross returns ha^{-1} increased with the increase in size of farms. The input - output ratio of maize cultivation at cost 'C' was higher in medium size group i.e., 1.36 which indicates the Cultivation of maize crop was economically profitable. Producer- Village Trader – Wholesaler - Retailer - Consumer was found important channel through which maximum quantity was sold by the maize farmers. The producer share in consumer rupee was the highest in channel I i.e., 96.07 per cent. The major problems faced by maize farmers while production was wild animal attack, high input cost and labour shortage.

LITERATURE CITED

Anonymous, 2022[a]. Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Govt. of India.

Anonymous, 2022[b]. World Agricultural Production, Foreign Agricultural Service, United State Department of Agriculture.

Krishna, M., K.V. Deshmukh, R.V. Chavan and Ritesh Arvind Chand, 2018. Constraints in Production and Marketing of Maize in Karimnagar District of Telangana, India, Int. J. Curr. Microbiol. App. Sci.,7(9):1786-1788.

Kumaresan, P., G. Srinivasa, and N.B. Vijaya Prakash, 2005. Productivity andprofitability in rainfed sericulture: A study in the district of Chamaraja Nagar in Karnataka, Agricultural Economic Research Review, 18:91-102

Laxmi,N.T.and S.M.Mundinaman,2015.Resource use efficiency in cultivation of major crops of Dharwad district, Agriculture Update, 10(2):93-99.

Minithra R., Ashok K.R. and Vidhiyawathi A., 2019. Economic Analysis of Production and Marketing of Maize in Perambalur district in Tamil Nadu, International J. Agri. Sci.,11(9):8412-8415.

Mukund, B.S. Reddy, G.M. Hiremath, Amrutha T. Joshi and S.B. Goudappa, 2018. Efficiency of Mango Market in North-Eastern Region of Karnataka, Indian J. Agril. Mktg., 32 (3) : 155-156.

Ravekar, S.F., P.M. Tayade and M.M. Jakate, 2015. Economics and Marketing of Cauliflower and Cabbage in Hingoli District of Marathwara Region of Maharashtra, Int. Res. J. Agril. Econ. Stat.,6(2):403-409.

Srikanth, B., H.H. Kausadikar, R.N. Jondhale and N. Gandhi, 2017. EconomicAnalysis of Maize Production and Marketing in Khammam District, Telangana, Asian J. Agri. Extn., Econ. and Sociol., 20 (4) :1-13.

* * *

Received on 15 October, 2022 - Accepted on 26 November, 2022

SHORT NOTE

Effect of Potting Mixture on Growth and Development of Quality Planting Material of *Bambusa balcooa*

Bamboo is one of the important forest species used in paper industry, house construction, ornaments making etc. Most of the bamboo species are propagated both by seeds and vegetative means. *Bambusa balcooa* is mainly multiplied by seeds, culms, rhizomes etc. The seedlings in the nursery usually vary in vigor and other growth characters. Therefore, production of good quality seedlings is an important step for ensuring uniform plantation. Seedling quality can be improved.

Nursery through utilizing proper container and media mixture. Many researchers reported the increased seed germination (Bahuguna *et. al.,* 1989; Vanangamudi *et. al.,* 1993; Biradar *et. al.,* 1998) and seedling vigor (Maronek *et. al.,* 1980; Young, 1990) in the forest species due to the use of the nursery mixture. However, the information on use of the nursery mixture with suitable organics for *Bambusa balcooa* is limited. Hence, the present study was aimed to find out the suitable nursery mixture for the production of more offsets for vegetative propagation or forest planting through seed.

The nursery pot mixtures were prepared by using different media and manure as per the following details. The Treatments are T1 - Garden soil alone; T2 - garden soil + Cocopit (1:1); T3 - garden soil + FYM (1:1); T4 - garden soil + Vermicompost (1:1), T5 - cocopit + FYM (1:1), T6 - garden soil + neem cake (1:1), T7 - garden soil + poultry manure (1:1), The different nursery mixtures were filled separately in the polythene bags (8 x 12 Inch) in four replications comprising of 25 bags in each replication by following the completely randomized design. The bamboo saplings having a height 25 cm are planted in polythene bags filled with different potting mixtures and watered regularly for the proper growth of saplings. The survival per cent and other growth characteristics were recorded six months after planting. The data were analyzed using the statistical method described by Panse and Sukhatme (1967) and the critical difference values were calculated at 5 per cent probability level.

Significantly maximum number of branches was recorded in treatment T3 (3.25) in comparison to other treatments. The base diameter was high (7.50) in the treatment T3 (garden soil + Vermicompost (1:1). The next best treatment viz., T4 (garden soil + Vermicompost (1:1) produced 5.75 number of branches which had no significant difference with previous treatment. Gardem soil + cocpit (2.50) and garden soil + neemcake (2.75) recorded minimum number of branches during six months after transplanting of tiller (table1). Among the treatments, the

Table: 1. Growth characteristics of *Bambusa balcooa* saplings in different potting.

Treatments	Initial sapling height (cm)	Height of tiller (cm)	No. of branches	Base diameter (mm)	No. of internode	Internode length (cm)	New tillers	Total no. of tillers	Weight of tiller (gm)
Garden soil (100 %)	25	52.00	1.00	4.00	6.75	7.50	0.00	1.00	24.56
Garden soil + Cocopit (1:1)	25	38.75	1.00	2.50	4.50	4.75	1.00	2.00	17.75
Garden soil + FYM (1:1)	25	93.75	3.25	7.50	8.00	11.25	1.00	1.75	119.50
Garden soil + Vermicompost (1:1)	25	80.00	1.75	5.75	7.75	9.75	0.75	1.75	63.75
Cocopit + FYM (1:1)	25	48.75	2.00	3.25	6.00	8.00	1.75	2.75	50.50
Garden soil + Neemcake (1:1)	25	44.00	2.00	2.75	5.50	7.75	1.25	2.50	33.75
Garden soil + Poultry manure (1:1)	25	57.75	2.00	4.25	7.00	9.50	1.00	2.00	39.75
SE+		3.11	0.30	0.59	0.66	1.28	0.41	0.45	4.36
CD@ 5%		9.31	0.89	1.78	1.98	—	—	—	13.07

maximum number of internode tiller^{-1} (8.00) and internode distance (11.25 cm) was recorded in treatment T3 (garden soil + Vermicompost (1:1) These characters was least recorded in treatment (T2 : Garden + cocpit (1:1), respectively. No significant difference was observed in regards with new tillers and total number of tillers amongst the different treatments. Significantly maximum weight of tillers (119.50 gm) was reported in treatment T3 (garden soil + FYM (1:1). It was followed by treatment T4 (garden soil + Vermicompost (1:1). Whereas, lowest weight of tiller (17.75 gm) was reported in potting mixture of garden soil + cocopit (1:1). The significant growth characteristics viz., height of tillers (cm), number of branches, base diameter (mm), number of internodes, internodal length and weight of tillers was recorded maximum in potting mixture contacting garden soil with FYM and Vermicompost. Bhat (1999) found that the vermicompost acts as a good pot mixture because it contains rich nitrogen (1.5-2.5%), phosphorus (0.9- 1.7%), potassium (1.5-2.4%), Magnesium (0.2- 0.3%), calcium (0.5-1.0%), sulphur (0.4-0.5%) and vitamins. It also has growth hormones like gibberellins, which regulate the plant growth. It can supply full requirement of micronutrients and enhances the availability of both native and added micronutrients in soil (Purakayastha and Bhatnagar, 1997). The farmyard manure has 0.5 per cent nitrogen, 0.2 per cent phosphorous and 0.5 per cent potassium which are slightly higher in poultry manure (3.03% N, 2.63% P, and 1.4 % K) (Sankaranarayanan, 2004). This might be the reason for enhanced performance in bamboo seedlings. The increased nutrient level in poultry manure might be the cause of the seedling vigour improvement in the bamboo after the Vermicompost treatment. The Vermicompost has the additional nutrients and vitamins other than nitrogen, phosphorous and potassium which showed positive effect on the seedling vigour. The other treatments including cocpit, neemcake had no significant effect on the performance of the seedlings.

It is concluded that the pot mixture comprising of soil + FYM (1:1) have recorded the maximum height of tiller, number of branches, base diameter, number of internode, Internodal length and weight of tiller. Therefore, this pot mixture can be recommended for getting the vigourous seedlings through saplings propagation. Maximum number of offsets produced can also be separated for further vegetative propagation or planting.

ACKNOWLEDGMENT

We also thank the Project Director, AICRP on Agroforestry, CAFRI, Jhansi for financial support and guidance.

Fig 1.Effect of the potting mixture on tillers of bamboo

LITERATURE CITED

Bahuguna, V. K., K. P. Unnikrishnan and U. C. Dhaundiyal, 1989. Studies on the performance of Philippines and Malaysian provenance of *Albizia falcatoria* (L.). Febrez.at nursery stage under north Indian tropical conditions, Indian Forester, 115(4): 209-215.

Biradar, K. M., M. Shekhargouda, M. N. Merwade and Ravi Hunje, 1998. Studies on seed dormancy and germination in sandal (*Santalum album* L.), Seed Tech News 28(4):54.

Maronek, D. M., J. M. Hendrix and J. Kiernan, 1980. Differential growth response to the mycorrhizal fungus Glomus fasciculatum of southern Magnolia and Junipers grown in containers in composted hardwood bark shale, J. Amer. Soc. Hort. Sci. 105:206-208.

Panse, V. G. and P. V. Sukhatme. 1967. Statistical Method for Agricultural Workers, Indian Council of Agricultural Research, New Delhi.

Purakayastha, T. J. and R. K. Bhatnagar. 1997. Vermicompost: a promising source of plant nutrients, Indian Farming 46(11): 35-37.

Sankaranarayanan, K., 2004. Nutrient potential of organic sources for soil fertility management inorganic cotton production, http://www.cicr.org.in/research_notes/ nutrient organic cotton:1-6.

Bhat Sreekrishna, 1999. Organic farming- An eco friendly agriculture for spices growing, Spice India 12(3):7-10.

Vanangamudi, K., S. Padmavathi, V. Manonmani and C. Surendran. 1993. Effect of pelleting with biofertilizer, biocides and nutrients on the viability and vigour of neem seed, In: World Neem Conference, Feb.24-28, Bangalore : 64.

Young, C. C. 1990. Effect of phosphorus – solubilizing bacteria and vesicular arbuscular mycorrhizal fungion the growth of tree species in subtropical and tropical soils, Soil Sci.& Plant Nutrition, 36(2) : 225-231.

All India Co-ordinated Research Project on Agroforestry,
College of Agriculture, Nagpur
(Dr. PDKV, Akola), Maharashtra, India.

Prashant D. Raut
Vijay M. Ilorkar and
Aarti P. Deshmukh

* * *

Received on 12 November, 2022 - Accepted on 27 November, 2022

Particulars about PKV Research Journal
as per Press and Regulation of Book Act (Clause 8)

FORM IV

1.	Place of Publication	:	Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
2.	Periodicity of Publication	:	Six monthly
3.	Printer's Name	:	Mr. Mohan G. Thakre
4.	Nationality	:	Indian
5.	Address	:	Tanvi Graphics, Ranpise Nagar, Akola
6.	Publisher's Name	:	Dr. V. K. Kharche
7.	Nationality	:	Indian
8.	Address	:	Director of Research, Dr. PDKV, P.O. Krishi Nagar, Akola
9.	Editor-in-Chief	:	Dr. V. K. Kharche
10.	Nationality	:	Indian
11.	Address	:	Editor-in-Chief Dr. PDKV, P.O. Krishi Nagar, Akola - 444 104 (Maharashtra)
12.	Owner's Name	:	Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

I, V. K. Kharche declare that the particulars given above are true to the best of my knowledge and belief.

Date : February, 2023

Dr. V. K. Kharche
Publisher

SUGGESTIONS FOR AUTHORS

General : The PKV Research Journal is published twice a year to promote the cause of research and disseminate the knowledge in the field of agricultural sciences. Subject matter should fall in the categories of (i) Original research articles (ii) Research notes and (iii) Review papers.

Manuscript : It should be typed on full scape good quality, double spaced, on one side of the page only, with sufficient margin, 5 cm on the left side and 2.5 cm on each of the remaining sides. The author(s) may submit paper in duplicate. He may not type his name, designation and acknowledgement on the first copy. All sheets in the copy should be of one side only and should not ordinarily exceed 10 in numbers including tables. Writing style should be simple, concise and precise. Presentation of article should have the components in the following sequence : TITLE, NAME (S) OF AUTHOR(S), FOOT NOTE, ABSTRACT, INTRODUCTION (without heading), MATERIAL AND METHODS, RESULTS AND DISCUSSION, ACKNOWLEDGEMENT if any and LITERATURE CITED. Format of Research note may be as per the pattern of PKV Res. J. Vol. 17 No. 2 of 1992. All calculations, tables, figures, names, quotations, citations, etc. should be carefully verified before submission.

The metric system of measurements should be followed and standard abbreviations be used.

The paper need necessarily to be accompanied by an undertaking that it is not published earlier in any journal. The author(s) are advised to adhere to the format of this journal strictly. In the event of not following the format, the paper(s) may not be attended to.

Title : The title of the article should be short and precise and should be followed in the next line, by name(s) of author(s). Foot note on the first page should include the department(s) contributing the article, designation and present address of author(s).

Abstract : Concise summation of findings not exceeding 200 words should be written at the beginning of the papers. The abstract should start with the objective. It should be intelligible without reference to the original paper. It should be written in such a way that will facilitate abstracting of the paper in the world of abstracts.

Table : Type each table on a separate sheet. They should be numbered in arabic numerals with title of the table in the same line. Table should be placed at the end of the manuscript, but its place in the text should be indicated.

Figures : Identify graphs, line drawings and photographs with consecutive arabic numbers as Fig. 1, Fig. 2. Place figures after tables. Photographs must be clear, glossy prints, original graphs and drawing must be in Indian ink or equivalent on plain white drawing paper. Lettering should be large and bold enough to permit reduction. Each figure number should placed on the back of each figure in pencil for identification.

Nomenclature : The latin binomial or trinomial and authority must be should for all plants, insects and pathogens at first listing either in the title or when first mentioned in the text. Crop varieties (not experimental lines and strains) should be identified by a single quotation mark at first listing only. Generic and specific names should be in italic e.g. *Lycopersium esculentum* Mil Morgtobe.

Reference : They should be double space throughout and arranged alphabetically according to author's names and should be placed under the heading "**LITERATURE CITED**" at the end of the article. Each reference should contain the name of author with initials, the year of publication, title of article, the abbreviated title of publication, volume and page e.g.

Sarode, S.V. and U.S. Kulkarni, 1998. Sustanability of *Helicoverpa armigera* (Hubner) on weed partheninum hysterophorous, Indian J. Entomol., 60 (4) : 421-422

Kawarkhe, V.J., R.N. Jane and Manisha Deshmukh, 2003.Effect of nitrogen and specing levels on growth and flower yield of China Aster, PKV Res. J., 27 (2) : 163-165.

In the text, the reference should be indicated by author's name followed by year of publication. When more than one paper by the same author appears in a single year they should be distinguished as a, b, c,......

Please refer to annexure of PKV Res. J. Volume 11(2), 1987 for abbreviation of journals to be given under **LITERATURE CITED**.

Correspondence : Manuscripts should be sent in duplicate directly to Editor-in-Chief, PKV Research Journal, Director of Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 (Maharashtra). E-mail: editor.pkvrj@gmail.com. Manuscripts are examined by the Editorial Board and referred to competent referees.

The Editorial Board takes no responsibility for the facts of the opinions expressed in the journal which rests with the authors.

Published by Dr. V. K. Kharche, Director of Research, Dr. PDKV, Akola for and on behalf of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India in 2023 and Printed by him at Tanvi Graphics, Ranpise Nagar, Akola

INDEX

Vol. 46 **No. 2** **July, 2022**

SHORT NOTES