Vol. 44 No. 1, January 2020
ISSN 0378-813 X

PKV RESEARCH JOURNAL

Dr. PANJABRAO DESHMUKH
KRISHI VIDYAPEETH
(AGRICULTURAL UNIVERSITY)
AKOLA (Maharashtra), INDIA

www.pdkv.ac.in

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA

RESEARCH JOURNAL

---

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).

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

INDEX

Vol. 44 **No. 1** **January 2020**

SHORT NOTES

PKV Res. J. Vol. 44 (1), January 2020

Production Potential of Agricultural Crops Under Citrus Based Agroforestry Systems in Semi-arid Region of Maharashtra

Aarti P. Deshmukh[1] , Lalji Singh[2], V M. Ilorkar[3] and P. D. Raut[4]

ABSTRACT

Traditional agroforestry is very common in Vidarbha region of Maharashtra with forest tree crops. Now fruit tree crops are also introduced to increase the farmer's income. Hence, the experiment was conducted at AICRP on Agroforestry research farm at College of Agriculture, Nagpur under citrus based agroforestry systems. The citrus fruit trees were planted at a distance of 6 x 6 m and forest species including *Tectona grandis, Eucalyptus teretocornis* and *Ailanthus excelsa* at equilateral distance of 3 meter in each treatment between two mandarin trees, where, cowpea crop (*Vigna unguiculata* var. Gomati and Pusa bold) was cultivated as traditional agri-horti-silviculture system during 2020-21. The growth performance and yield of cowpea and mustard under different set of treatments viz. T_1 (Sole cowpea and mustard), T_2 (Sole Mandarine + cowpea and mustard), T_3 (Mandarin + *Tectona grandis* + cowpea and mustard),T_4 (Mandarin + *Eucalyptus teretocornis* + cowpea and mustard) andT_5 (Mandarin + *Ailanthus excelsa* + cowpea and mustard) was recorded. The growth parameter and yield of cowpea and mustard crop was found maximum in open field crop (Sole cowpea and mustard) than the treatment under citrus based agroforestry systems and it was 25.57, 56.35, 44.00 and 63.12 per cent higher as compared to treatment T_2, T_3, T_4 and T_5, respectively. 17.46, 27.74, 23.08 and 33.85 percent higher in grain and 11.87, 21.78, 15.63 and 26.76.The grain and straw yield of cowpea and mustard was 5.75 and 10.31 and 11.38 and 20.48 q ha^{-1} in crop of open field (Sole cowpea and mustard).

Silvi-horticulture is the integration of woody plants with horticultural crops to derive both economic and ecological benefits. Furthermore, annual timber tree intercropping may offer the benefit of decrease tree setup costs, revenue-generating during the unproductive stage of trees, and the effective use of natural and input resources compared to single tree timber trees. *Ailanthus excelsa* native of the Indian peninsula is a leguminous tree, presently getting momentum among the farmers due to its utility in the matchwood industry and protein-rich fodder value (Rajalingam, *et al.,* 2017).

Intercropping especially during tree gestation period, could be economically profitable and environmentally sound indeed. Trees on farm can be made popular, especially fast growing like eucalyptus which also provide fodder, fuel and timber. Thus keeping in view multipurpose uses and role in bio-drainage eucalyptus plantation is likely to be adopted on large scale on government and private lands (Kumar *et al.,* 2013). Intercropping is the technique of simultaneously cultivating several crop species in the same location and has been extensively used throughout agricultural history. Conventionally, Intercropping was utilized to improve crop output and land efficiency, and as a risk mitigation method. It is an important part of small-scale cultivation systems (Kumar, *et al.,* 2013). Intercropping may be economically beneficial and ecologically good, in particular during the gestation period of the trees. On-farm trees may be popular, particularly rapidly growing eucalyptus trees that also offer fuel and timber. Therefore, maintaining multipurpose usage and function of eucalyptus plantation in bio-drainage is expected to be widely implemented in government and private lands (Kumar, *et al.,* 2013).

MATERIAL AND METHODS

The study was conducted on AICRP on Agro forestry farm having loam soil of Nagpur district of Maharashtra. The selected level field of 0.29 ha in which horti-silviculture-system including Mandarin, *Tectona grandis, Eucalyptus teretocornis* and *Ailanthus excelsa* planted during 2015 was selected. The experiment was laid out in Randomized Block Design (RBD) with four replications. There were 20 treatments in four replications. The size of unit plot was 6 x 6 m^2. The Mandarin was

1. Ph. D. Scholar, 2 & 3 Professor and 4. Assistant Professor, Department of Forestry, Indira Gandhi Krishi Vishwavidyalya Raipur -492 012, Chhattisgarh, India.

planted at a distance of 6 x 6 m^2, whereas the forest species were planted at a distance of 3m between two Mandarin plantations.

Cowpea (*Vignaung uiculata*) variety (Gomati) and Mustard (*Brassica juncea*) variety (Pusa bold) was cultivated as per recommended package and practices in Kharif and Rabi season. The treatments includes Sole-Mandarin + Cowpea and Mustard (T_2), Mandarin + *Tectona grandis* + Cowpea and Mustard (T_3), Mandarin +*Eucalyptus teretocornis* + Cowpea and Mustard(T_4), Mandarin +*Ailanthus excelsa*+ Cowpea and Mustard (T_5), while sole Cowpea and Mustard(T_1) without trees were laid down to accesses the growth and yield performances of cowpea and mustard crop under different agro forestry systems as affected by microclimate condition available to cowpea and mustard crop at different growth stages. The observation were made for plant population (m^{-2}), height of plant (cm), number of branches plant^{-1}, number of leaves plant^{-1}, number of siliqua plant^{-1}, seed siliqua^{-1}, length of siliqua (cm), grain yield(q ha^{-1}), straw yield(q ha^{-1}), harvest index (%), test weight (gm)1000 seed^{-1}, fresh weight (kg m^{-2}), dry weight (kg m^{-2}), fresh root weight plant^{-1} (gm) and root length (cm). The dry weight of sample was estimated after drying of sample at 75 ^{0}C for 24 hours. The microclimate observation i.e. solar radiation, atmospheric temperature, humidity were recorded at different growth period by wind LICOR-photo meter, digital thermometer and hygrometer at 9.00 to 10.00, 12.00 to 13.00 and 15.00 to 16.00 hours in each replication of the treatments during crop period.

RESULTS AND DISCUSSION

Plant Population of Cowpea and Mustard

Plant population of cowpea and mustard under different agroforestry model was not significantly affected (Table 1). The highest plant population per square meter of both the intercrops i.e. cowpea (27 m^{-2}) and mustard (30 m^{-2}) was recorded under sole cropping followed by sole Mandarin (26.25 and 29.50 m^{-2}) based agroforestry system. Whereas, the minimum plant population per square meter (24.75 and 27.25 m^{-2}) was recorded under Mandarin + *Eucalyptus teretocornis* based agroforestry system. No significant differences in plant population were found among different citrus based agroforestry systems. The plant population of both the intercrops measured under different agroforestry systems in the order as sole cropping > sole Mandarin > Mandarin + *Eucalyptus teretocornis* > Mandarin + *Tectona grandis* > Mandarin + *Ailanthus excelsa.* Kiran *et al.*, (2002) also revealed that plant population of wheat crop reduced up to 34 to 54 percent, respectively under *Eucalyptus teretocornis* and *Dalbergia sissoo* based agroforestry system. Rahangdale *et al,*. (2014) recorded highest reduction in plant population in soybean (21.61 %) and the lowest in paddy (12.35 %). They also noticed that the green gram and sesame showed almost the similar trend of reduction in plant population (16.06 % and 17.63 %, respectively) under bamboo based agrisilviculture system over the control that is sole crop.

Height of Cowpea and Mustard

No significant difference was observed as regards to plant height in cowpea at 30, 60 and 90 DAS (Table 1). However, maximum plant height i.e. 35.66, 95.78 and 147.50 cm at 30, 60 and 90 DAS in sole cowpea was recorded as compared to different citrus based agro forestry systems. Amongst the different citrus based agro forestry systems, maximum plant height was recorded in sole Mandarin. The lowest plant height of cowpea was recorded under Mandarin + *Ailanthus excelsa* agro forestry system i.e. 29.40, 86.17 and 119.50 cm at 30, 60 and 90 DAS, respectively. In mustard, significant difference in plant height were observed at 30 and 60 DAS (Table 1). Significantly maximum plant height was recorded in sole mustard i.e. 47.00 and 106.25 cm at 30 and 60 DAS. Amongst the different citrus based agro forestry systems, maximum plant height was observed in sole Mandarin. Less height of both intercrops under Mandarin + *Ailanthus excels*a agroforestry system may be primarily due to reduced light intensity. Thus more light intensity in sole cropping increased the photosynthetic efficiency of crops resulting in better growth as reported by Wassinck (1954). The percent reduction of plant height at 90 DAS was 3.73, 12.54, 7.80, 18.98 per cent in cowpea and 2.52, 8.65, 5.95 and 11.53 per cent in mustard observed under sole Mandarin, Mandarin + *Tectona grandis*, Mandarin + *Eucalyptus teretocornis* and Mandarin + *Ailanthus excels* agroforestry system over the sole cropping. Mutanlal (1998) also recorded that the plant height was significantly higher in sole groundnut (31.0 cm) as compared to groundnut with *Tectona grandis* + grass (27.8 cm), *Tectona grandis* + subabul (27.7 cm) and *Tectona grandis*

(27.0 cm). Kumar and Nandal (2004) evaluated that the entire test crop sown in the interspaces of *Eucalyptus teretocornis* showed reduced plant vigour in terms of plant height, stem diameter, number of branches, number of leaves and yield attributes as compared to sole cropping. Rahangdale *et. al.,* (2014) also recorded reduction in plant height of paddy (3.90 %) and sesame (2.84 %) as compared to soybean (8.83 %) and green gram(7.57 %) under bamboo based agri-silviculture system over the control that is sole crop which may be due to the fact that bamboo canopy could have even affected the proper penetration of light on the understory annual crop.

Yield attributes and yields of cowpea and mustard intercrop

It was observed that the due to competition for moisture, light and nutrients among the annual crops, trees and fruit plants, the observed values for different yield attributing parameters were lesser than the sole cropping system. From the result (Table 2), it revealed that maximum grain and straw yield of cowpea was recorded under sole cropping (5.75 and 11.38 q ha^{-1}). Whereas, lowest yield was recorded under Mandarin + *Ailanthus excels* agroforestry system i.e. 2.12 and 4.59 q ha^{-1}. Grain yield under sole cowpea cropping was 25.57, 56.35, 44.00 and 63.12 per cent higher as compared to sole Mandarin, Mandarin + *Tectona grandis*, Mandarin + *Eucalyptus teretocornis* and Mandarin + *Ailanthus excels* agroforestry system, respectively. As regards mustard yield, under sole cropping. Whereas lowest harvest index was recorded under Mandarin + *Ailanthus excels* agro forestry system. In mustard the harvest index under sole cropping was 4.19, 5.08, 5.98 and 6.58 per cent higher as compared to sole Mandarin, Mandarin + *Tectona grandis*, Mandarin + *Eucalyptus teretocornis* and Mandarin + *Ailanthus excels* agro forestry system, respectively may be due to competition of light among the annuals and perennials. These results are in conformity with the findings of Rana *et al.* (2007) and Verma and Rana (2014) who witnessed a yield reduction in paddy and wheat (14.9 and 29.7 percent, respectively) under agroforestry system as compared to the sole cropping. Kaushal and Verma (2003) also reported the negative effect of tree were more on growth and yield of the crop which were grown in its close vicinity. Rahangdale *et al.*, (2014) recorded that the soyabean (67.88 %) and moong (61.30 %) showed relatively higher reduction in grain and straw yield as compared to sesame (49.25 %) and paddy (34.00 per cent) under old bamboo based agri-silviculture system over the sole crops and this reduction in grain yield may be due to less PAR (Photosynthesis active radiation) interception and available energy below the canopy of bamboo species in comparison to sole crop (open condition). These results are also in conformity with the findings of Kaushik *et al.,* (2002), Kiran *et al.,* (2002), Swamy *et. al.*, 2003, Yadav *et al.*, (2005) and Bijalwan *et al,.* (2009).

Effect of agroforestry systems on number of siliqua plant^{-1} and seed siliqua^{-1} of intercrops as compared to sole cropping

The data pertaining to number of siliqua plant^{-1}, seed siliqua^{-1} and length of siliqua (cm) of intercrops revealed that there were no significant differences as regards number of siliqua plant^{-1} amongst the different treatments (Table 3). However, maximum number of siliqua plant^{-1} was recorded under sole cropping in cowpea (37.28) and mustard (130.00), respectively. The lowest was recorded under Mandarin + *Ailanthus excels* agroforestry system i.e. 27.80 and 101.20 number of siliqua plant^{-1}. As regards, number of seed siliqua^{-1}, significantly maximum seed siliqua^{-1} was recorded under sole cropping in both the intercrops i.e. 19.25 and 16.45 seed siliqua^{-1} in cowpea and mustard, respectively. Whereas, the lowest seed siliqua^{-1} were recorded under Mandarin + *Ailanthus excels* agroforestry system i.e. 13.39 and 11.05. The percent reduction in seed siliqua^{-1}was 10.34, 25.25, 14.75 and 30.44 in cowpea and 9.73, 26.26, 16.41 and 32.83 in mustard under sole Mandarin, Mandarin + *Tectona grandis*, Mandarin + *Eucalyptus teretocornis* and Mandarin + *Ailanthus excelsa*, respectively as compared to sole cropping of intercrops. The above parameters were recorded in the sequence as sole cropping> Mandarin> Mandarin + *Eucalyptus teretocornis* > Mandarin + *Tectona grandis*> Mandarin + *Ailanthus excelsa*. Highest length of silica (21.00 and 5.23 cm) of cowpea and mustard were recorded under sole cropping. Whereas lowest was recorded under Mandarin + *Ailanthus excels a*groforestry system (17.60 and 4.30 cm), respectively. All the yield attributing parameters i.e. number of siliqua plant^{-1}, seed siliqua^{-1} and length of siliqua (cm) of intercrops was highest under

Table 1. Effect of citrus based agroforestry system on plant population and height of plant cm) of intercrops as compared to sole cropping.

Treatments	Plant population m^{-2}		Height of plant (cm) Cowpea			Height of plant (cm) Mustard		
	Cowpea	Mustard	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Sole cropping	27.00	30.00	35.66	95.78	147.50	47.00	106.25	138.75
Sole Mandarin	26.25	29.50	34.18	93.00	142.00	46.00	102.00	135.25
Mandarin + *Tectona grandis*	25.00	27.75	29.99	88.91	129.00	42.00	98.00	126.75
Mandarin + *Eucalyptus teretocornis*	25.50	28.50	33.16	92.02	136.00	44.25	99.75	130.50
Mandarin + *Ailanthus excelsa*	24.75	27.25	29.40	86.17	119.50	40.50	94.50	122.75
SE(d) ±	1.32	1.65	5.14	4.07	12.72	2.66	3.50	2.44

Table 2. Effect of citrus based agroforestry systems on grain, straw yield (q ha^{-1}) and harvest index of intercrops as compared to sole cropping.

Treatments	Cowpea		Harvest	Mustard		Harvest
	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Index (%)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Index (%)
Sole cropping	5.75	11.38	33.56	10.31	20.48	33.48
Sole Mandarin	4.28	8.61	33.20	8.51	18.05	32.04
Mandarin + *Tectona grandis*	2.51	5.29	32.18	7.45	16.24	31.44
Mandarin + *Eucalyptus teretocornis*	3.22	6.54	32.99	7.93	17.04	31.75
Mandarin + *Ailanthus excelsa*	2.12	4.61	31.65	6.82	15.00	31.25
SE(d) ±	0.81	1.52	0.82	0.87	1.45	1.06

Table 3. Effect of citrus based agroforestry systems on number of siliqua $plant^{-1}$ and seed $siliqua^{-1}$ of intercrops as compared to sole cropping.

Treatments	No. of siliqua $plant^{-1}$		Seed $siliqua^{-1}$		Length of siliqua (cm)	
	Cowpea	Mustard	Cowpea	Mustard	Cowpea	Mustard
Sole cropping	37.28	130.00	19.25	16.45	21.00	5.23
Sole Mandarin	34.55	128.50	17.26	14.85	19.88	5.03
Mandarin + *Tectona grandis*	30.13	107.55	14.39	12.13	17.95	4.38
Mandarin + *Eucalyptus teretocornis*	33.35	122.10	16.41	13.75	19.38	4.67
Mandarin + *Ailanthus excelsa*	27.80	101.20	13.39	11.05	17.63	4.30
SE (m) ±	2.53	54.46	0.83	1.42	1.81	0.38

sole cropping as compared to sole Mandarin, Mandarin + *Tectona grandis*, Mandarin + *Eucalyptus teretocornis* and Mandarin + *Ailanthus excelsa a*groforestry systems, respectively may be due to competition of light among the annuals and perennials. These results are in conformity with the findings of Kumar *et al.,* (2013) also found that parameters such as plant running meter row lay (161.7) spike length (7.7cm), grains $spike^{-1}$ (37.7) and test weight (26.7 gm) was significantly less under *Eucalyptus teretocornis* than sole cropping. They also revealed that in mustard, seeds per siliqua was less under *Eucalyptus teretocornis* than sole cropping. Yield parameter such as secondary siliqua per plant and test weight were also significantly higher in sole cropping.

LITERATURE CITED

Bijalwan, A., S. L Swamy,. C. M. Sharma, V. K. Shah, and R. K Singh. 2009. Phytosociological analysis of overstory and understory woody perennials along with aspects in Balmdi watershed of mixed dry tropical forest I chattisgarh plain, *I*ndian J. Trop. Biodiversity 17(1) : 47-57.

Kaushik, N., R. A. Kaushik, R.S. Saini and R.P.S. Deswal, 2002. Performance of Agri-silvi-horti systems in arid India, Indian J. Agroforestry 4(1):31-34.

Kaushal, R. and K.S. Verma, 2003. Tree- Crop Interaction Studies in natural agroforestry systems : A case study from western Himalayas in India.

Kiran., R., A.K. Agnihotri and B.C. Saini, 2002. Wheat yield as influenced by net radiation availability below *Eucalyptus teretocornis* and *Dalbergia sissoo* canopies, Indian J. of Agri. Res., 36(1): 68-70.

Kumar, A. and D.P.S. Nandal. 2004. Performance of winter crop under Eucalyptus based agroforestry, Indian J. Soil Sci. 38: 125-131

Kumar A., M. Kumar, D.P.S. Nandal and N. Kaushik, 2013. Performance of wheat and mustard under *Eucalyptus teretocornis* based agrisilviculture system, Range Mgmt. & Agroforestry, 34(2):192-195.

Mutanlal, S.M., 1998, Studies on teak (*Tectona grandis Linn. F.*) based agroforestry system and fertigation, Ph.D. Thesis (Unpub), University of Agricultural Sciences, Dharwad.

Rahangdale, C.P., N. N. Pathak and L. D. koshta, 2014. Impact of bamboo species on growth and yield attributes of kharif crops under agroforestry system in wasteland condition of the central India. Int. J. Agroforetry and Silviculture 1 (3) : 31-36.

Rajalingam G.V., M. Manikandan and K.T. Parthiban, 2017. Performance of Green Leafy Vegetable Crops under Ailanthus Excelsa Based Silvi-horticultural System in Western Zone of Tamil Nadu, Chem. Sci. Lett. 6 (24) : 2159-2162.

Rana, B. S., A.K. Saxena and A.K.S. Parihar, 2007. Status and scope of agroforestry development in eastern part of Uttar Pradesh, In : Agroforestry system and Practices (Sunil Puri and Pankaj Panwar, eds) New India Publishing Agency, New Delhi : 191-211.

Swamy, S.L., A. Mishra and S. Puri, 2003. Biomass production and root distribution of *Gmelina arborea* under an Agrisilviculture system in sub humid tropics of central India, New Forests*,* 26: 167-186.

Verma, S.K. and B.S. Rana, 2014. Effect of light intensity on paddy and wheat Grain yield under *Eucalyptus teretocornis* based Agri-silviculture System. Indian Forester, 140 : 23-28.

Wassinck, E. C., 1954. Remark on energy relation in photosynthesis processes, in: Proc. Is. Int. Photo boil, Congress Amsterdam.

Yadav, R. S., B. L. Yadav, B. R. Chippa and G.L. Keshwar, 2005. Nutrient removal and yield of wheat (*Triticum aestivum linn*) as influenced by different tree species in Agroforestry under Semi-arid condition of Rajasthan, Indian J. Agroforestry,7 : 21-24.

Received on : 28.8.2020

* * *

Carrot (*Daucus carota*) *Kheer* – A Novel Milk Product

M. R. Salunkhe[1], R. M. Zinjarde[2] and S. N. Rokde[3]

ABSTRACT

The present study was undertaken in order to standardize the optimum level of carrot in preparation of kheer, to study the physico-chemical properties and sensory evaluation of kheer and to find out the cost structure of *kheer* at Dairy Farm, College of Agriculture, Nagpur during 2011-2012. The *kheer* as prepared using shredded carrot in different proportions viz.10, 15, 20 and 25 per cent, respectively. Thus there were four treatments and five replications in each treatment. The quality of *kheer* was judged by offering the sample (s)) to a panel of five judges in each trial separately. It was observed that, the average fat content of *kheer* was significantly affected by the addition of shredded carrot in *kheer*. The average fat content and average moisture content of *kheer* was significantly decreased with the addition of shredded carrot in *kheer*. The average protein content, total solids and ash content of *kheer* were significantly increased with the addition of shredded carrot in *kheer*. It was observed that, the *kheer* prepared by addition of 15 per cent shredded carrot in cow milk (T_2) recorded highest flavor score, body and texture score, colour and appearance and overall acceptability scores. This was followed by *kheer* prepared by addition of 20 per cent shredded carrot in cow milk (T_3) *kheer* prepared by addition of 10 per cent shredded carrot in cow milk (8.54) (T_1) *kheer* prepared by addition of 25 per cent shredded carrot in cow milk (T_4). It was further, noticed that, the cost of production of *kheer* prepared by addition of 10 per cent shredded carrot (T_1) was highest Rs. 73.32. This was followed by (T_2) Rs.73.07 ,(T_3) Rs. 72.82 and Lowest in (T_4) Rs.72.57.

The *Kheer* is a traditional,heat dessiccated sweetened and concentrated confection prepared with the addition of non dairy ingredients such as rice, wheat, sugar, tapioca, semolina, carrot etc. The *kheer* is derived from Sanskrit word 'ksheer' for milk and 'Kshrika' for any dish prepared with milk (Aneja *et al*. 2002) a times , dry fruits are added to enhance it's nutritive value and taste, whereas cardamom, nutmeg and saffron are used to enhance it's flavor. It is proporly known 'Paysam'in Southern states , 'Payas' in Eastern India and 'Kheech'in Mewar region of Rajasthan (Thomkinson, 1995). So far various other ingredients such as Singahraetc have been used as additives for kheer .Carrot is a nutritious root crop. It is a rich source of sugar, iron, *B*eta carotene,Vitamin A, C and B complex vitamins. It has a good therapeutic value .It is known to have curing properties against lung, mouth cancer and impedes the development of cancerous cells. It is beneficial to persons suffering from gall stones and heart problem. Hence, the present study was under taken in order to standardize the optimum level of carrot in preparation of kheer .

MATERIAL AND METHODS

Fresh clean whole cow milk was obtained from Animal Husbandry Section, College of Agriculture, Nagpur. The milk was strained through clean four fold muslin cloth and transferred to a clean, sterilized flat bottom stainless steel vessel. The milk was analyzed for it's moisture, milk fat, total solids, protein and ash content. The milk fat was determined by Gerber's method as described in IS:1224 (Part-I) , 1977. The total solids content was determined by gravimetric method as described in IS: 1479 (Part-I)) 1961.The ash content was determined by method described in IS: 1167 (1165). Fresh, carrots are purchased from local market, washed well and wiped dry with clean cloth .The root hairs were removed and the carrots were peeled with a sharp stainless steel peeler. Then they were shredded with sharp stainless steel shredder. The shredded carrot was well fried in pure ghee and used for *kheer* preparation in various proportions.The *kheer* as prepared using shredded carrot in different proportions viz.10 (T_1), 15(T_2), 20(T_3) and 25(T_4) per cent, respectively. Thus, there were four treatments and five replications. The quality of kheer was judged by offering the sample(s) to a panel of five judges in each trail separately. A score card for sensory evaluation of kheer as used as suggested by Pal and Gupta (1985). The cost of newly developed product was worked out by taking into consideration the prevailing rates of all the ingredients such as milk, carrots, sugar, ghee and cardamom in addition

1. PG Student, 2. Assistant Professor (AHDS) and 3. Principal Scientist, CICR, Nagpur

to fuel and labour charges. The collected data was tabulated and analyzed as per standard statistical techniques. (Snedechor and Cochran,1994).

RESULTS AND DISCUSSION

The chemical composition of carrot revealed that the moisture, fat, protein, total solids and ash percentage(s) were 90.51, 0.20, 0.88, 9.49 and 0.90, respectively. This is in agreement with Chauhan (1968).

Effect of different levels of shredded carrot on chemical composition of *kheer*

Fat content of *kheer*

It was observed that, the average fat content of *kheer* was significantly affected by the addition of shredded carrot in *kheer*. The average fat content of kheer significantly decreased with the additionof shredded carrot in kheer (Table 1). This might have happened due to lower fat content in shredded carrot. The maximum average fat content of *kheer* in the present study was 7.23 percent in treatment T_1 . These results are in agreement with Quresshi *et al* . (2005) They reported that the average fat content of *kheer* was 8.2 per cent which is somewhat higher than average fat content of *kheer* in the present study. This might be due to the use of milk having higher milk fat content in milk used in their study.

Protein content of kheer

It was observed that, the average protein content of *kheer* was significantly affected by the addition of shredded carrot in kheer. The average protein content of *kheer* significantly decreased with the additionof shredded carrot in kheer (Table 1). This might have happened due to lower fat content in shredded carrot. The maximum average fat content of kheer in the present study was 5.81 per cent. These results are in agreement with Chaudhri (1989).

Total solids content of *kheer*

It was observed that, the average total solids content of *kheer* was significantly affected by the addition of shredded carrot in *kheer*. The average total solids content of *kheer* significantly increased with the addition of shredded carrot in *kheer* (Table 1). This has happened due to higher total solids content in shredded carrot. The maximum average total solids content of *kheer* in the present study was 33.11 per cent. These results are in agreement with Mani *et al.* (1955) who observed that the total solids content of *kheer* was 31 per cent. Further, these results are in agreement with De *et al*., 1976 who observed that the total solids content of *kheer* was 32.98 per cent.

Ash content of *kheer*

It was observed that, the average ash content of *kheer* was significantly affected by the addition of shredded carrot in *kheer*. The average ash content of *kheer* significantly increased with the addition of shredded carrot in *kheer* (Table 1). This has happened due to higher ashcontent in shredded carrot. The maximum average ashcontent of *kheer* in the present study was observed in T_4 (2 %) .These results are in agreement with Mani *et al.* (1955) who observed that the ash content of *kheer* made from milk having 4.1 per cent fat and 12.5 percent total solids was 2.30 per cent. Further, De *et al*. (1976) reported 1.41 per cent ash in the kheer made from cow milk .

Moisture content of *kheer*

It was observed that, the average moisture content of *kheer* was significantly affected by the addition of shredded carrot in kheer. The average moisture content of *kheer* significantly decreased with the addition of shredded carrot in *kheer* (Table 1). This has happened due to decrease in moisture content in shredded carrot due to frying in *ghee*. The maximum average moisturecontent of kheer in the present study was 69.90 per cent in treatment T_1. These results are in close agreement with the results of De *et al*. (1976).

Sensory evaluation of kheer

Flavour of kheer

It was observed (Table 2) that the kheer prepared by addition of 15 per cent shredded carrot in cow milk (T_2) recorded highest flavor score (43.77). This was followed by *kheer* (T_3) prepared by addition of 20 per cent shredded carrot in cow milk (42.00). Shelke (2010) reported highest flavor score in *kheer* prepared by addition of 20 per cent shredded bottle gourd in cow milk. Singh *et al.* (2005) reported highest flavor score in beverage prepared by addition of 20 per cent carrot juice.

Body and texture of *kheer*

It was noticed that,the body and texture of kheer prepared by addition of 15 per cent shredded carrot

Table 1 : Effect of different levels of shredded carrot onchemical composition of kheer

Treatments	Proportion	Fat (%)	Protein(%)	Ash (%)	Moisture (%)	Total Solids(%)
T_1	90:10	7.23a	5.81a	1.54d	69.90a	30.10d
T_2	85: 15	6.85b	5.54b	1.68c	68.87b	31.13c
T_3	80:20	6.45c	5.25c	1.84b	67.85c	32.15b
T_4	75:25	5.99d	4.97d	2.00a	66.89d	33.11a
F Test		-	-	-	-	-
S.E. (m) $\pm$	-	0.028	0.027	0.032	0.038	0.027
CD at 5 %	-	0.085	0.083	0.097	0.012	0.083

Table 2 : The sensory parameters score of kheer (out of 100) as affected by differentlevels of shredded carrot

Treatments	Parameters			Overall
	Flavor(45)	Body & Texture (35)	Colour& Appearances(20)	acceptability
T1	38.54^{3}	32.22^{3}	16.61^{3}	7.83^{3}
T2	43.77^{1}	34.67^{1}	19.65^{1}	8.41^{1}
T3	42.00^{2}	33.91^{2}	18.37^{2}	8.13^{2}
T4	36.08^{4}	30.86^{4}	15.76^{4}	7.12^{4}
S.E.(m) $\pm$	0.352	0.269	0.091	0.054
C.D. at 5%	1.057	0.808	0.275	0.164

Values with different superscripts differ significantly ($P<0.05$)

Table 3 : Cost structure of 1 kg carrot kheer prepared under different levels of shredded carrot combinations

Ingredients	Rate	Treatments							
	(Rs)	T_1		T_2		T_3		T_4	
		Qty(g)	Cost (Rs)	Qty(g)	Cost (Rs)	Qty(g)	Cost (Rs)	Qty(g)	Cost (Rs)
Cow milk (Rs lit^{-1})	30	900.00	27	850.00	25.50	800.00	24	750.00	22.50
Carrot shreds (Rs Kg^{-1})	25	100.00	2.5	150.00	3.75	200.00	5	250.00	6.25
Sugar (Rs Kg^{-1})	34	80.00	2.72	80.00	2.72	80.00	2.72	80.00	2.72
Ghee (Rs Kg^{-1})	340	40.00	13.60	40.00	13.60	40.00	13.60	40.00	13.60
Cardamom(Rs Kg^{-1})	1500	2	3	2	3	2	3	2	3
Fuel charge(Rs Kg^{-1})	420	400	12	400	12	400	12	400	12
Labour charges(Rs Kg^{-1})	100	1 Hrs	12.50	1 Hrs	12.50	1 Hrs	12.50	1 Hrs	12.50
Total cost of kheer preparation	–	–	73.32	–	73.07	–	72.82	–	72.57

recorded highest flavor score (34.67). This was followed by kheer prepared by addition of 20 per cent (T_3) shredded carrot in cow milk (33.91) . Avinav Kumar *et al.,* (2020) reported that *kheer* prepared with addition of 100 gm paneer and carrot shred paste recorded highest body and texture score.

Colour and Appearance of *Kheer*

It was noticed that,the colour and appearance of *kheer* prepared by addition of 15 per cent shredded carrot recorded highest score (19.65). This was followed by *kheer* prepared by addition of 20 per cent (T_3) shredded carrot in cow milk (18.37). The colour and appearance of *kheer* increased upto 15 per cent level but later it decreased when the quantum of shredded carrot was increased further. The carrot shreds impart natural saffron colour and mild flavor to kheer and eliminates need of

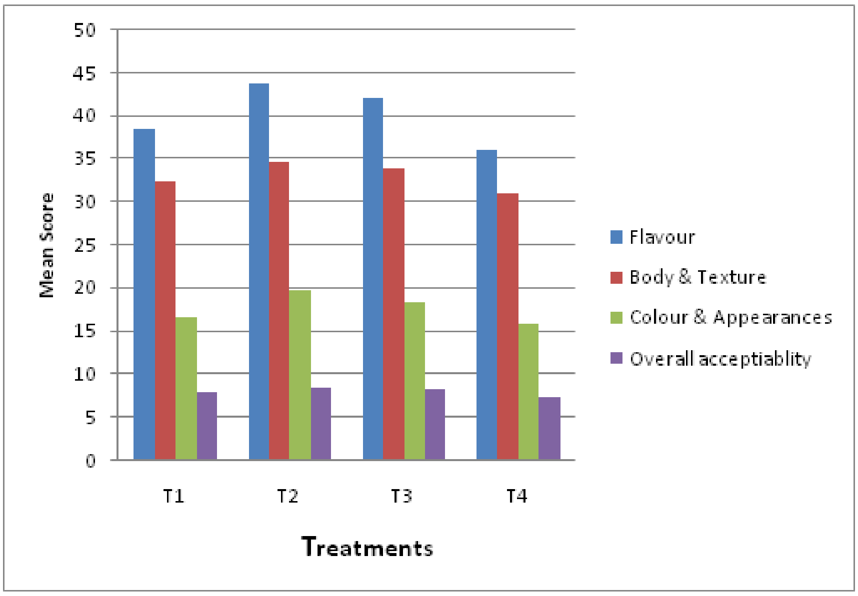


Fig. 6 : Effect of different levels of shredded carrot on score of sensory evaluation of kheer.

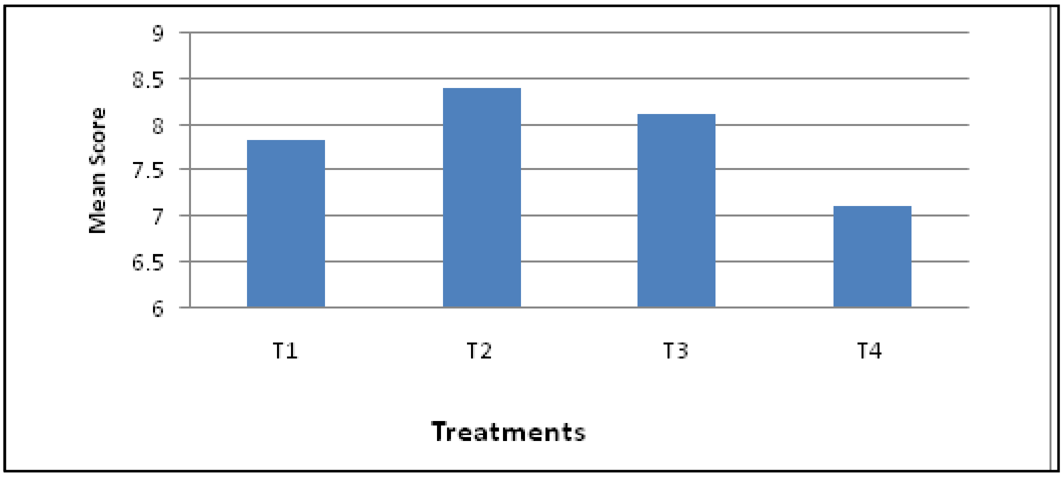


Fig. 7 : Effect of different levels of shredded carroton (9 point Hedonic scale) overall acceptability of kheer.

addition of artificial colour and flavouring agent . Quereshi *et al*. (2005) also reported the same observation. Unnikrushnan 2000 observed that,the colour of Paysam varies from white, light cream, cream light brown and brow and depends upon the type of specific ingredient added to *kheer*, eg. addition of cow milk cream impart cream colour. Addition of saffron impart brownish color. etc.

Overall acceptability of *kheer*

It was noticed that,the overall acceptabilityof *kheer* prepared by addition of 15 per cent (T_2) shredded carrot recorded highest score(8.41). This was followed by kheer prepared by addition of 20 per cent (T_3) shredded carrot (Table 2) in cow milk (8.13). The overall acceptability of *kheer* increased upto 15 per cent level but later it decreased when the quantum of shredded carrot was increased further. Salunkhe *etal.,* (2016) reported that by increasing concentration of carrot shreds the overall acceptability score of kheer decreased significantly.

Cost of production of *kheer*

It was noticed that (Table 3), the cost of production of *kheer* prepared by addition of 10 per cent shredded carrot (T_1) was highest (73.32) .This was followed by (Rs.73.07) with T_2, 72.82 T_3 and Lowest with T_4 i.e. 25 per cent addition.The cost of production was decreased due to increase in rate of addition of shredded carrot.

It was concluded from the present investigation that, good quality of *kheer* can be prepared by using 85:15 milk to shredded carrot ratio with 8 per cent sugar level and had pleasant flavor, smooth body and texture and light yellowish colour. The cost of production of *kheer* decreased with increase in rate of addition of shredded carrot.Further, shredded carrot can be successfully utilized for economic kheer preparation.

LITERATURE CITED

Aneja, R. P. , B. N. Mathur, R C. Chavhan and A. K. Banerjee, 2002. Tecnology of Indian milk Products 1st Edn., A Dairy Indian Publication, Delhi :29

Avinav Kumar, Rajendra Kumar Pandey, Smita Singh, Sanjay Kumar, Pankaj Gautam and Kamla Kant Joshi, 2020, Physico-Chemical and sensory analysis of carrot supplemented paneer *kheer*, Int. J of Current Res and Review.12 : 140-144.

Chauhan D. V.S. 1968. Vegetable Production in India Ramprasad and Sons Agra-3.

Chaudhri, A., 1989. Standardization of the method for preparation and preservation of kheer, M.Sc. Thesis (Unpub), NDRI Deemed University, Karnal.

De Sukumar, DilipThompkinson, D.P. Gahlot and O.N. Mathur, 1976. Study on method of preparation and preservation of kheer, Indian J. Dairy Sci.29(4): 316-318.

IS:1224 (part-I), 1977. Determination of fat by Gerber method (first Ed.) Indian Standard Institute, Manak Bhavan, New Delhi.

IS: 1479(Part-I)), 1961. Method of test of dairy industry Chemical Analysis for milk, Indian Standard Institute, Manak Bhavan, New Delhi.

Mani G.S., G.S. Lily, C. Balasubramanium and B.P.M. Singh, 1955. Composition and Nutritional Value of Some Indigenous Dairy Products, Indian J. Med, Res.43(50: 237- 242.

Pal D. and S.K .Gupta, 1865. Sensory evaluation of Indian milk products, Indian Dairyman 37 (10): 465 -467.

Quresshi, M.A., B.K. Goet, S. Uprit , A. Asgar and K. C. P. Singh,2005.Studies on development and standardization of sterilized carrot kheer, Indian J. Animal Res.5 (10 : 25-28.)

Salunkhe Manojkumar R, Sawant J., Pushkraj Sawant, N. Dhruvaraj, C. Rai Dinesh, 2016. Physicochemical analysis and sensory evaluation of *kheer* fortified with carrot shreds, J. Animal Res 5 (4:849-853).

Shelke,R.R., 2010. Identification and process upgradation of vegetable based milk product (Bottle gourd kheer) Report of Research Project, Dr. PDKV, Akola, 25-28

Singh ,C.K.S., Grewal and H.K. Sharma, 2005. Preparation and properties of carrot flavoured milk beverage, J. Dairying Food and H.S. 24(¾) : 184-189.

Snedechor, G.W. and W.G. Cochran,1994. Statistical Methods.8th edn. Oxford and IBA Publishing Company, Calcutta

Thomkinson, D.K., 1995. Dairy Industry in India Scenario Indian Food Industry, 14(2): 18-20.

UnnikrushnanV, M.K. Bhandania, B.S.Nath, M.K. Vedavathi and N.N. Balasubramanya, 2000. Payasam and sweet delicacy, Indian Dairyman, 52((10) : 37- 42.

Received on : 5.7.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Performance of *Trichogramma pretiosum* on Different Host

Trupti P. Funde[1], S. K. Bhalkare[2], G. K. Lande[3] and P. K. Rathod[4]

ABSTRACT

An experiment was conducted on Biocontrol Laboratory, Dr. PDKV, Akola during 2017-18 in Factorial Completely Randomised Design with six treatments. Factor A as Eggs of *C. cepholonica* and *L. obonalis* and factor B as 24 hres, 48 hrs and 72 hrs old eggs with four replications. The results of the experiments with egg parasitoid *Trichogramma pretiosum* revealed that per cent parasitization was significantly more (63.33%) on the eggs of *Corcyra cephalonica* which was at par with the *Leucinodes orbonalis* (61.87%). *T. pretiosum* required 8.71 and 8.84 days to emergence out from eggs of *L. orbonalis* and *C. cephalonica,* respectively. As far as age of the host concern *T. pretiosum* showed significantly more parasitization (79.58%) in fresh eggs i.e. 24 hrs. old eggs this followed by the 48 hrs old eggs (60.82 %). The eggs of 72 hrs old were less preferred by the *T. pretiosum* and could parasitize only 46.82 per cent. Minimum days (7.98 days) required for adult emergence was noticed in 24 hrs old eggs.

The Hymenopteran parasitoid, *Trichogramma pretiosum* Riley (Hymenoptera: Trichogrammatidae) are considered as an important biological control agent of insects pests in greenhouse and field crops. Trichogrammatids are one of the most important groups of biotic agent for suppression of several lepidopteran pests all over India and abroad. Out of 26 *Trichogramma* species recorded in India, *T. chilonis, T. japonicum, T. acheae, T. pretiosum* are key mortality factor for many crop pests. These *Trichogramma* can be integrated with the other control measures and mass reared cheaply and conveniently in the laboratory on unnatural hosts.

The brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) is the most serious pest of brinjal and important commercial vegetable crops. The yield loss caused by this pest has been estimated up to 60-80 per cent (Krishnaiah and Vijay, 1975). Currently, farmers depend exclusively on the application of insecticides to control *L. orbonalis* (Talekar, 2002). Frequent usages of pesticides threaten the health of farmers, development of resistance in pest population and make the brinjal fruits costly to consumers. Implementation of bio-control programs provides one of the best alternatives to overcome these adverse effects by using of egg parasitoid *Trichogramma* spp. (Niranjana and Sridhar, 2014).

Today, *Trichogramma* species are most widely used insect natural enemy in the world because it's rearing abilities in insectaries and ravenous parasitizing tendency on eggs of variety of target hosts. It has the tremendous ability to parasitize the eggs in lepidopteran pest. The quality parasitoids can be produced by studying biological features of *Trichogramma* i.e. adult longevity, developmental period, fecundity, emergence and parasitism ability. The important of age factor in parasitoids during the time they forage in crop for host eggs (after initial release) and how the aging of host eggs could impact parasitoid biological traits may be important for overall efficiency in terms of crop protection.

It is necessary to demonstrate the capacity of these natural enemies in parasitizing host egg so as to use them in biological control program against the pest. Such an attempt was made in this particular study, where the parasitization rate of *Trichogramma pretiosum* tested on the eggs of *Leucinodes orbonalis* and *Corcyra cephalonica* under laboratory condition. Further study on biological parameters, development period, longevity, parasitism, adult emergence from parasitized eggs, fecundity and sex ratio were recorded to assess efficacy of *Trichogramma pretiosum.*

MATERIAL AND METHODS

The experiment was conducted under laboratory condition at Biocontrol laboratory, Department of Agriculture Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2017-2018 in Factorial Completely Randomized Design (FCRD) with six

1. PG student and 2, 3 & 4. Assistant Professor, Department of Agril. Entomology, Dr. PDKV, Akola

treatments, two factors (i.e. Factor A: Eggs of *C. cephalonica* and *L. orbonalis*; Factor B: 24 hrs, 48 hrs. and 72 hrs old Eggs) and four replications. Larvae of Lepidopteran pests (*L. orbonalis* and *C. cephalonica)* were collected from different host plants and were reared under laboratory conditions for obtaining eggs and testing against *T. chilonis.* The observation on different biological parameters of *T. chilonis* as influenced by host eggs of different ages were recorded

Number of eggs parasitized : In laboratory condition out of 30 eggs exposed for parasitization, parasitized eggs were recorded by counting the blackened eggs (Singh & Jalali 1998). The data recorded was converted into percentage and per cent egg parasitization was calculated.

Number of days for parasitoid emergence : The duration between exposures of eggs to females till adult emergence were recorded in laboratory conditions.

Adult longevity in days: Newly emerged adult parasitoids were kept in a small glass vial (7.5 x 1.21 cm) with streak of honey on its inner wall and strip of eggs. The adult longevity was worked out from their day of emergence to till death in days.

Sex ratio: To determine sex ratio the emerged adults after death were sexed under a microscope based on the morphological characters.

RESULTS AND DISCUSSION

Per cent parasitization of *Trichogramma pretiosum* on different host eggs

The result of the per cent parasitization of *T. pretiosum* on the eggs of *C. cephalonica* and *L. orbonalis* are Tabulated in Table 1. Per cent egg parasitization was recorded on the basis of black coloured host eggs. The results indicated that the per cent parasitization of *T. pretiosum* is significantly more (63.33%) on the eggs of *C. cephalonica* which was at par with the *L. orbonalis* (61.87%). These finding are in corroboration with the work of Prabhulinga *et al.* (2013). They studied the biological parameters among arrhenotokus and thelyokus from of *T. pretiosum* and revealed that the parasitization rate of *T. pretiosum* on eggs of *C. cephalonica* was 76.3 per cent. Similarly, Niranjana and Sridhar (2014) studied potential of egg parasitoids, *T. pretiosum* and *T. chilonis* against brinjal fruit and shoot borer, *L. orbonalis.* The result revealed highest per cent parasitization on the egg of *L. orbonalis* 91.11 per cent.

Per cent parasitization of *Trichogramma pretiosum* on host eggs of different ages

The data (Table 1) indicated that age of host eggs significantly affected the parasitization by *T. pretiosum*. Significantly maximum parasitization (79.58 %) was noticed in fresh eggs i.e. 24 hrs old eggs this was followed by the 48 hrs old eggs (60.82 %). The eggs of 72 hrs old were less preferred by the *T. pretiosum* and could parasitize only (46.82 %).

These finding are in accordance with the work of Niranjana and Sridhar (2014) who revealed that the *T. pretiosum* preferred freshly laid eggs of *L. orbonalis* than older eggs for parasitism. There was a great variation of the parasitizing efficiency of *T. pretiosum* on one, two and three day's old eggs of *L. orbonalis* and was 91.11, 77.78 and 35.56 per cent, respectively. Vitor *et al.* (2017) also studied age and density of eggs of *H. armigera* influence on *T. pretiosum* parasitism and revealed that the 0-12 and 24-36 hours old eggs provided the largest number of parasitized eggs.

Table 1: Per cent parasitization of *T. pretiosum* on the host eggs of different ages

Treatment	Interaction (A×B) Egg parasitization (%)			Factor 'A' (Host)
	24 hrs	48 hrs	72 hrs	
C. cephalonica	80.83	61.66	45.83	63.33
	(64.08)	(51.75)	(42.60)	(52.81)
L. orbonalis	78.33	62.66	45.82	61.87
	(62.27)	(52.75)	(42.60)	(52.54)
Factor 'B' (Age of host eggs)	79.58	60.82	46.82	
	(63.18)	(52.25)	(42.60)	

	Factor 'A'	Factor 'B'	Interaction (A×B)
SE (m) ±	0.56	0.43	0.86
CD at 5%	1.95	1.83	2.59

(Note: Figures in parentheses are corresponding arc sin transformation values)

Interaction effects

Among all the treatment combinations the 24 hrs old eggs of *C. cephalonica* were significantly more accepted by parasitoid *T. pretiosum* recorded highest (80.83 %) egg parasitization which was at par with 24 hrs old eggs of *L. orbonalis* (78.33 %). Whereas, 48 hrs old eggs of *C. cephalonica* and *L. orbonalis* were next in preference by *T. pretiosum* (Table 1). The lowest per cent parasitization was observed on 72 hrs old egg of *L. orbonalis* (45.82 %).

Number of days to emergence of *Trichogramma pretiosum* on different host

Non-significant influence of different host eggs on number of days required for emergence of *T. pretiosum.* The data revealed that number of days required for emergence of *T. pretiosum* were 8.71and 8.84 days on the eggs of *L. orbonalis* and *C. Cephalonica,* respectively (Table 2). Prabhulinga *et al.* (2013) studied biological parameters among arrhenotokus and thelytokous form of *T. pretiosum* on eggs of *C. cephalonica* and reported the number of days to adult emergence ranged from 10.05 to 10.30 under constant and variable number of parasitoid releases in both forms of *T. pretiosum*.

Number of days to emergence of *Trichogramma pretiosum* on host eggs of different ages

The data (Table 2) revealed that minimum days (7.98 days) required for adult emergence was recorded in 24 hrs old eggs, this was followed by 48 hrs old eggs (9.00 days). The maximum period required for adult emergence (9.36 days) was observed on 72 hrs old eggs.

Similar results were also reported by earlier worker Ruberson and Kring (1993) who in their studies tested acceptability and suitability of the parasitoid *T. pretiosum* on the eggs of *H. zea* and noticed that suitability declined in older host eggs for parasitoids *T. Pretiosum*. Developmental time was longer and survival lower in 62hrs old eggs than in younger ones. Thus supports the present finding.

Table 2: Number of days to emergence of *Trichogramma pretiosum* on the host eggs of different ages

Treatment	Interaction (A×B)			Factor 'A'
	Adult emergence (days)			(Host)
	24 hrs	48 hrs	72 hrs	
C. cephalonica	8.30	9.00	9.24	8.84
	(2.82)	(3.00)	(3.04)	(2.97)
L. orbonalis	7.66	9.00	9.48	8.71
	(2.78)	(3.00)	(3.08)	(2.95)
Factor 'B' (Age of host eggs)	7.98	9.00	9.36	
	(2.80)	(3.00)	(3.06)	

	Factor 'A'	Factor 'B'	Interaction (A×B)
SE(m)±	0.01	0.01	0.01
CD at 5%	_	0.03	0.04

(Note: Figures in the parentheses are corresponding square root transformation values)

Interaction effects

Among the treatment combinations 24 hrs old parasitoid eggs of *L. orbonalis* required short duration (7.66 days) for emergence of *T. pretiosum* (Table 2) which was at par with 24 hrs old eggs of *C. cephalonica* (8.30 days) followed by 48 hrs old eggs of *L. orbonalis* and *C. cephalonica* (9.00 days). The longest duration for emergence of *T. pretiosum* was observed on the 72 hrs old eggs of *L. orbonalis* (9.48 days).

Adult longevity of *Trichogramma pretiosum* on the different host eggs

The data on longevity of *T. pretiosum*, revealed that there were significant differences among different hosts (Table 3). The highest adult longevity (10 days) was observed on the eggs of *C. cephalonica* followed by *L. orbonalis* (9.58 days).

These findings are supported by the work of Ruberson and Kring (1993) who studied the longevity of *T. pretiosum* on the eggs of *H. zea* and revealed that *T. pretiosum* female lived for 3 days on honey and 11 days when exposed to bollworm eggs and honey. This prolonged life span can be attributes to their feeding on hosts eggs.

Adult longevity of *T. pretiosum* on host eggs of different ages

The results (Table 3) pertaining to adult longevity of *T. pretiosum* on the host eggs of different ages showed significant differences among different hours old eggs. The maximum adult longevity was observed in 72 hrs old eggs (10.87 days). Whereas, 48 hrs and 24 hrs old eggs recorded 9.62 days and 8.87 days adult longevity, respectively. These finding are in accordance with earlier worker Budhwant *et al.* (2008).

Interaction effects

The significant differences was observed in different treatment combination pertaining to adult longevity of *T. pretiosum*. The adult longevity with maximum day was on 72 hrs old eggs of *C. cephalonica* (11.00 days) which was at par with 72 hrs old eggs of *L. orbonalis* (10.75 days). Minimum days adult longevity of parasitoid was observed on the 24 hrs old eggs of *L. orbonalis* (8.75 days).

Table 3: Adult longevity of *Trichogramma pretiosum* on the host eggs of different ages

Treatment	Interaction (A×B) Adult longevity (days)			Factor 'A' (Host)
	24 hrs	48 hrs	72 hrs	
C. cephalonica	9.00	10.00	11.00	10.00
	(3.00)	(3.16)	(3.31)	(3.16)
L. orbonalis	8.75	9.25	10.75	9.58
	(2.90)	(3.12)	(3.27)	(3.11)
Factor 'B'(Age of host eggs)	8.87	9.62	10.87	
	(2.97)	(3.14)	(3.29)	

	Factor ' A'	Factor ' B'	Interaction (A×B)
SE (m) ±	0.01	0.01	0.02
CD at 5%	0.03	0.03	0.06

(Note: Figures in parentheses are corresponding square root transformation values)

Per cent female progeny of *Trichogramma pretiosum* on different host

The significant differences between *C. cephalonica* and *L. orbonalis* regarding per cent emergence of female progeny of *T. pretiosum* were observed (Table 4). The maximum per cent female parasitoid emergence was noticed from *C. cephalonica* (52.75%) which was at par with *L. orbonalis* (50.31%).

The present findings depicted on per cent female progeny of *T. pretiosum* are in accordance with the finding of Rathi and Ram (2000) and Dileep (2012).

Per cent female progeny of *Trichogramma pretiosum* on host eggs of different ages

Significantly maximum per cent female progeny was observed in 24 hrs old eggs (55.02 %) which were at par with 48 hrs old eggs (51.69 %). The lowest per cent female progeny was observed in 72 hrs old eggs (47.89 %).

Development of the embryo of egg parasitoid *Trichogramma* mostly depends on nutrition they get in the host egg. Thus age of host egg is limiting factor in this sense. The more yolk will be available in the fresh eggs than in older eggs. From the present findings it was revealed that lesser the egg age more was the female emergence. This might be due to the fact that in early stage of the host egg the host embryo remains in the embryonic development and once the egg is parasitized the parasitoid embryo starts fast development and utilizes the yolk very efficiently, which might provide greater chances of more females from such early age eggs. Singh *et al.* (2001) reported that irrespective of host age *T. pretiosum* females were found to be predominant and were above 75 per cent in age group from 0 to 1 to 48 to 49 hrs old eggs.

Interaction effects

The interactions effect of all the treatment combinations were statistically non-significant.

Table 4: Per cent female progeny of *Trichogramma pretiosum* on the host eggs of different ages

Treatment	Interaction (A×B) Female progeny (%)			Factor 'A' (Host)
	24 hrs	48 hrs	72 hrs	
C. cephalonica	55.15 (47.95)	52.55 (46.37)	50.57 (43.00)	52.75 (45.77)
L. orbonalis	54.90 (47.81)	50.83 (45.86)	45.22 (41.46)	50.31 (45.04)
Factor 'B'(Age of host eggs)	55.02 (47.88)	51.69 (46.11)	47.89 (42.23)	

	Factor 'A'	Factor 'B'	Interaction (A×B)
SE(m)±	0.65	0.52	0.92
CD at 5%	1.61	1.98	-

(Note: Figures in parentheses are corresponding arc sin transformation values.)

Sex ratio of *Trichogramma pretiosum* on the eggs of different host

The results revealed that there were no significant differences between *C. cephalonica* and *L. orbonalis* regarding sex ratio.

Sex ratio of *Trichogramma pretiosum* on the host eggs of different ages

The data (Table 5) on sex ratio of *T. pretiosum* on host of different ages revealed significant difference among different ages of host eggs. Sex ratio of *T. pretiosum* was 1:1.23, 1:1.06 and 1:0.83 in 24 hrs, 48 hrs and 72 hrs old eggs, respectively.

These finding are in corroboration with the work of Dileep (2012) who has reported that maximum females were emerged from egg age 0 to 1hrs (1:2.25) followed by 6 to 7 hrs (1:2.13) and 12 to 13 hrs (1:2.04). As the egg age prolonged the sex ratio was male biased as revealed in egg age 54 to 55 hrs (1:0.76) and 60 to 61 hrs (1:0.27) and even no female adult noticed from egg age 66 to 67 hrs and 72 to 73 hrs. Mehendale (2009) recorded that sex ratio in *T. chilonis* was 1:1.40 and 1:1.30 in *S. litura* and *C. cephalonica* eggs, respectively.

Table 5 : Sex ratio of *Trichogramma pretiosum* on host eggs of different ages

Treatment	Interaction (A×B) Ratio			Factor 'A' (Host)
	24 hrs	48 hrs	72 hrs	
C. cephalonica	1: 1.25	1: 1.09	1:0.79	1: 1.04
L. orbonalis	1: 1.21	1:1.03	1:0.87	1: 1.04
Factor 'B'(Age of host eggs)	1: 1.23	1:1.06	1:0.83	

	Factor 'A'	Factor 'B'	Interaction (A×B)
SE(m)±	0.03	0.04	0.05
CD at 5%	_	0.12	0.17

Interaction effects

The data presented in Table 5 revealed that sex ratio of *T. pretiosum* in 24 hrs old eggs of *C. cephalonica* was 1:1.25 and was found at par with 24 hrs old eggs of *L. orbonalis* (1:1.21) and 48 hrs old eggs of *C. cephalonica* (1:1.09), followed by 48 hrs old eggs of *L. orbonalis* (1:1.03). Thereafter the per cent of female progeny reduced drastically as revealed in 72 hrs old eggs of *L. orbonalis* (1:0.87) and *C. cephalonica* (1:0.79).

CONCLUSION

It can be concluded from the present studies that the highest egg parasitization, adult emergence, female progeny, sex ratio was noticed on eggs of *C. cephalonica* which were found at par with *L. orbonalis.* The results pertaining to different hrs. old eggs revealed that freshly laid host eggs (24 hrs. and 48 hrs.) were most preferred by *T. pretiosum* for parasitization under laboratory conditions. Similarly maximum per cent female progeny and male female ratio was recorded on the 24 hrs old eggs.

LITERATURE CITED

Budhwant, N. P., S. M. Dadmal, P. W. Nemade and M. S. Patil, 2008. Efficacy of *Trichogramma chilonis* (Ishii) against Lepidopteran pests and age of host eggs, Annals of Pl. Prot. Sci., 16 (1).

Dileep, R. C., 2012. Performance of egg parasitoid *Trichogramma chilonis* (Ishii) under laboratory conditions, M.Sc Thesis (Unpub) submitted to Dr. B.S.K.K.V., Dapoli (M.S.).

Krishnaiah, K. and O. P. Vijay, 1975. Evaluation of Brinjal varieties for resistance to shoot and fruit borer *Leucinodes orbonalis* Guen, Indian J. Hort. 32, 84-86.

Mehendale, S. K., 2009. Nutritional aspects of factiotious host *Corcyra cephalonica* (Stainton) and parasitisation potential of egg parasitoid *Trichogramma chilonis (*Ishii) under South Gujarat condition, Ph.D. Thesis (Unpub.) submitted to Navasri Agriculture University, Navsari (Gujarat).

Niranjana V. and Philip Sridhar, 2014. Parasitism efficiency of *Trichogramma pretiosum* on the eggs of brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee, J. Biological Control, 28(3): 144-146.

Prabhulinga T., N.E. Thyagaraj, S. K. Jalali, B. Doddabasappa, V. Kammar and S.B. Shambu, 2013. Comparison of biological parameters among arrhenotokus and thelytokous froms of *Trichogramma pretiosum* Rilely (Hymenoptera: Trichogrammatidae), Current Biotica, 7(3):145-152.

Rathi, R. S. and P. Ram, 2000. Effect of eggs of different hosts on some biological and morphological characters of *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae), J. Ent. Res., 24(4): 331-335.

Ruberson, J. R. and T. J. Kring, 1993. Parasitism of developing eggs *Trichogramma pretiosum* (Hymenoptera: Trichogrammatidae): Host age preference and suitability, Biological Control, 3: 39-46.

Singh, S. P. and. S. K Jalali, 1998. Trichogrammatids. Technical Bulletin No. 7, Project Directorate of Biological Control (ICAR), Bangalore : 93.

Singh, S. A., V. N. Paul, and A. K. Singh, 2001. Effect of host age on parasitism by *Trichogramma brasiliensis* and *Trichogramma exiguum*, Indian J. Ent., 63(3): 350-355.

Talekar, N. S., 2002. Controlling Eggplant Shoot and Fruit borer: A simple, safe and economical approach. International Co-operators Guide Publication No.02-534, Shanhua, Taiwan: Asian Vegetable Research and Development, Center.

Vitor Z., H. S. Rodrigues, D., Pratissoli, and R. C. O. Bueno, 2017. Age and Density of eggs of *Helicoverpa armigera* influence on *Trichogramma pretiosum* parasitism, Acta Scientiarum, Maringa, 39 (4): 513-520.

Received on : 15.7.2020

* * *

Evaluation of Some Newer Insecticides Against Stem Borer, Aphids and Natural Fauna on Maize

S. N. Rathod[1], G.K. Lande[2], S.K. Bhalkare[3] and A. K. Sadawarte[4]

ABSTRACT

An experiment was conducted on the farm of Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *Kharif* season of 2019-20 with eight treatments and replicated thrice in RBD. Three treatment sprays were applied at 15 days interval as soon as the incidence noticed. The data thus obtained revealed that, Spinosad 45 SC @ 3 ml 10 L^{-1} proved effective with minimum infestation (5.92 %) of stem borer and was found statistically at par with Chlorantraniliprole 18.5SC @ 4 ml/10 L (7.19%), Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (8.31%) and Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (9.70%). Next best treatment was Indoxacarb 14.5 SC @10 ml/10 L (12.58%). Least effective treatments were, Thiamethoxam 12.6 per cent ZC +Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml/10 L and Dimethoate 30 EC @ 12 ml 10 L^{-1} which recorded 17.83 per cent and 19.10 per cent infestation, respectively. Maximum infestation of stem borer was recorded in control (43.70 %). However, Thiamethoxam12.6 per cent ZC +Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} proved effective in minimizing the aphid population (4.70) at par with Dimethoate 30 EC @ 12 ml 10 L^{-1} (5.69) and Chlorantraniliprole 18.5SC @ 4ml/10 L (6.35) Whereas, the Spinosad 45 SC @ 3 ml 10 L^{-1} (8.64) found at par with Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (8.87), Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (9.52) and Indoxacarb 14.5 SC @10 ml 10 L^{-1} (10.74), which, appeared as next better treatments in this respect.Highest seed yield was recorded in plot treated with Spinosad 45 SC at 3ml 10 L^{-1} (53.20 q ha^{-1}) followed by Chlorantraniliprole 18.5 SC at 4ml 10 L^{-1} (51.87 q ha^{-1}) and Spinetoram 11.7 SC 9 ml 10 L^{-1} (49.53 q ha^{-1}).

Maize (*Zea mays* L.) is the world's leading crop and is widely cultivated as cereal grain. It is one of the most versatile emerging crops having wider adaptability. Globally, maize is known as 'queen of cereals' because of its highest genetic yield potential. As many as 141 insect pests cause varying degree of damage to maize crop right from sowing till harvest (Reddy and Trivedi 2008). The serious insect pests are, Maize stem borer (*Chilo partellus)*, Fall armyworm (Spodoptera *frugiperda)* and Maize aphid (*Rhopalosiphum maidis*).In India, the stem borer is one of the most serious insect pests of maize at the pre-harvest stage. (Sarup *et al*., 1987). Maize production is severely hampered by maize stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae). Stem-borer starts to infest the crop at 3 to 4 weeks after planting and continue up to maturity stage (Sarup *et al.,* 1978).The results of this study will provide reference data for future insecticide susceptibility surveys and give support to IPM recommendations for the use of newer insecticides against field infestations of stem borer and aphids.

MATERIAL AND METHODS

The experiment was conducted on field of Department of Agricultural Entomology, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in *Kharif* 2019-20. Treatments (spraying) were applied as soon as the incidence of insect pest was noticed and thereafter applied at Fifteen-days of interval. Each treatment was replicated thrice and maize variety Uday (Mahabeej -1114) was used for study. The knapsack sprayer was used for spraying operation. After each treatment application the sprayer was washed thoroughly with clean water. Every care was taken to minimize drift and contamination of the adjacent plot at the time of spraying.

Method of Observations

Pre-treatment observations were recorded 1 (one) day before spray for *Chilo partellus* (stem borer), *Rhopalosiphum maidis* (aphids) and for natural enemies. Post-treatment observations were recorded on 3rd, 7th, and

1. P.G. Student, 2 & 3. Assistant Professor and 4. Associate Professor, Department of Agril. Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

14th days after application of insecticides for each observation.

Observation recorded for stem borer

To assess the incidence of stem borer the total number of plants and number of infested plants (number of dead hearts and pin holes present on the leaves) were counted from each plot. (Farid *et al*. 2003). The data thus obtained were subjected to statistical analysis. The per cent infestation of the maize stem borer was calculated according to the following equation:

$$\text{Percent dead hearts} = \frac{\text{Number of infested plants}}{\text{total number of plants}} \times 100$$

Observation recorded for aphid

Observations were recorded by entering the field from the corner and observed 10 plants randomly moving diagonally at regular intervals and counted the number of aphids present on one top, middle and bottom leaf with the help of the 1cm^2 quadrant and calculated the population of aphid per leaf.

Observation recorded for natural enemies

Population of natural enemies were recorded on 10 randomly selected plants on whole plant basis from each plot at 3rd,7th, and 14th days after application of each treatments.

Yield

In order to compare the response of different treatments on yield, the yield obtained in the net plot of each treatment were recorded at harvest and it was converted into hectare basis.

Statistical analysis

The field data collected so far was subjected to proper statistical analysis as per the statistical design used, in order to test level of significance among the various treatments as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results obtained in the present investigation are presented below under different headings.

Cumulative effect of newer insecticides against *Chilo partellus*

Three days after spray

The data presented in Table 1 pertaining to cumulative effect of newer insecticides against stem borer at three days after spray revealed that Spinosad 45 SC @ 3 ml 10 L^{-1} proved effective in recording the minimum infestation of stem borer (6.62 %). However, this treatment was found statistically equal with Chlorantraniliprole 18.5 SC @ 4 ml 10 L^{-1} (8.06%), Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (9.74 %) and Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (10.86 %). Next best treatment was Indoxacarb 14.5 SC @10 ml10 L^{-1} (15.08%) found at par withThiamethoxam 12.6 per cent ZC +Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} (19.28 %) and Dimethoate 30 EC @ 12 ml 10 L^{-1} (20.17 %). Highest infestation was recorded in control (41.54 %).

Seven days after spray

The data on cumulative effect of different treatments against stem borer at seven days after spray (Table 1) showed that application of Spinosad 45 SC @ 3 ml 10 L^{-1} recorded minimum infestation (5.63 %) and at par with Chlorantraniliprole 18.5 SC @ 4 ml 10 L^{-1} (6.74 %), Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (7.49%) and Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (8.79 %). Next best treatment was Indoxacarb 14.5 SC @10 ml 10 L^{-1} recorded 10.93 per cent infestation. Treatments Thiamethoxam 12.6 per cent ZC +Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml10 L^{-1} and Dimethoate 30 EC @ 12 ml10 L^{-1} at par with each other recorded infestation of 17.07 per cent and 18.69 per cent, respectively as against maximum (44.06 %) in control treatment.

Fourteen days after spray

Among the different treatments cumulative per cent infestation recorded at fourteen days after spray (Table 1) was minimum in the plots treated with Spinosad 45 SC @ 3 ml 10 L^{-1} i.e. 5.51 per cent. This treatment was found at par with Chlorantraniliprole 18.5 SC @ 4 ml 10 L^{-1} (6.69 %) and Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (7.34 %). The next effective treatment was Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} and Indoxacarb 14.5 SC @10 ml 10 L^{-1} recorded 9.28 per cent and 11.72 per cent infestation, respectively. Whereas, Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} and Dimethoate 30 EC @ 12 ml 10 L^{-1} at par with each other recording 17.13 per cent and 18.46 per cent infestation, respectively. Maximum per cent infestation (45.49%)were recorded in control.

It is evident from the cumulative mean data (Table 1) that the treatment with Spinosad 45 SC @ 3 ml 10 L^{-1} proved effective with minimum infestation of stem borer (5.92 %) and found at par with Chlorantraniliprole 18.5 SC @ 4 ml 10 L^{-1} (7.19 %), Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (8.31) and Emamectin benzoate 5 per cent SG @ 4 gm10 L^{-1} (9.70 %). Next best treatment was Indoxacarb 14.5 SC @10 ml 10 L^{-1} (12.58 %). Least effective treatments were, Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} and Dimethoate 30 EC @ 12 ml10 L^{-1} which recorded 17.83 per cent and 19.10 per cent infestation, respectively. Maximum infestation of stem borer was recorded in control (43.70 %).

The present findings pertaining to per cent infestation of stem borer are in agreement with the findings of earlier workers Neupane *et al*.(2016)and Deole et al. (2017) who evaluated the pesticides under field condition to control maize stem borer. They reported that the lower per cent damage (5.3 %) with higher crop yield (4.52 t ha^{-1}) and lowest insect score (1.00) was observed in plot sprayed with spinosad 45 per cent SC at 0.5 ml L^{-1} of water. The highest per cent damage (20.63 %) was observed in the control plot and in reducing the pink borer infestation with minimum leaf injury level (2.94) and tunnel length (2.31cm), respectively.

Similarly, Devananda *et al.* (2018) and Ahmed *et al.* (2002) reported that Carbofuran 3G @ 0.3 kg a.i.ha^{-1}, Spinosad 45SC @ 0.002 per cent and Chlorantraniliprole 18.5 SC @ 0.006 per cent were found highly effective in

Table 1: Cumulative effect of newer insecticides against *Chilo partellus* of 1st, 2nd and 3rd spray

S. N.	Treatment	Doseg or ml/10 L water	Per cent infestation of stem borer			Mean
			3 DAS	7 DAS	14 DAS	
1.	Chlorantraniliprole 18.5 SC	4ml	8.07 (16.43)	6.74 (14.94)	6.76 (12.36)	7.19 (14.57)
2.	Spinetoram 11.7 SC	9ml	9.74 (17.89)	7.58 (15.85)	7.61 (13.21)	8.31 (15.65)
3.	Indoxacarb 14.5 SC	10ml	15.08 (22.48)	10.93 (19.10)	11.72 (16.92)	12.58 (19.50)
4.	Thiamethoxam12.6% ZC + Lambdacyhalothrin 9.5 % ZC	2.5ml	19.28 (25.94)	17.07 (24.35)	17.13 (21.67)	17.83 (23.98)
5.	Dimethoate 30 EC	12ml	20.17 (26.57)	18.69 (25.46)	18.46 (22.67)	19.10 (24.90)
6.	Spinosad 45 SC	3ml	6.62 (14.78)	5.63 (13.50)	5.51 (11.03)	5.92 (13.11)
7.	Emamectin benzoate 5% SG	4gm	10.86 (19.08)	8.79 (17.19)	9.46 (15.04)	9.70 (17.10)
8.	Control	-	41.54 (39.98)	44.06 (41.52)	45.49 (43.80)	43.70 (41.77)
	SE (m) ±	-	1.53	1.39	1.27	1.40
	CD @ 5 %	-	4.63	4.23	3.85	4.24
	CV (%)	-	11.41	11.25	10.18	10.95

Note: Figures in parentheses are corresponding Arcsine transformation values DAS- Days After Spraying reducing the larval population and dead heart and found on par to each other, which can be used for effective management of this *Chilo partellus* on maize.

Moreover, Rameash *et al.*(2012), evaluated the bio-efficacy of botanical pesticides and natural insecticides in the management of stem borer (Chilo *partellus)* in maize and found that, foliar application of Spinosad (0.002 %) and Emamectin benzoate 5 SG (0.002 %) significantly reduced damage of *C. partellus* and bio-efficacy of these natural pesticides were found to be on par.

Cumulative effect of newer insecticides against *R. maidis*

Three days after spray

The data displayed in Table 2 pertaining to cumulative effect of newer insecticides against aphids at three days after spray revealed that Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml10 L^{-1} proved effective in recording minimum population of aphids (5.82 $leaf^{-1}$). This treatment was found statistically equal with Dimethoate 30 EC @ 12 ml/10 L (6.98) and Chlorantraniliprole 18.5 SC @ 4 (7.84). Whereas, the treatments Spinosad 45 SC @ 3 ml 10 L^{-1} (9.90), Spinetoram 11.7 SC @ 9 ml10 L^{-1} (10.20), Emamectin benzoate 5 per cent SG @ 4 gm10 L^{-1} (10.66) and Indoxacarb 14.5 SC @10 ml 10 L^{-1} (11.72) found at par with each other. However, control recorded maximum population (20.62 aphids $leaf^{-1}$).

Seven days after spray

The data on cumulative effect of different treatments against aphids at seven days after spray (Table 2) showed that application of Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} recorded lower aphid population (3.92 $leaf^{-1}$). This

Table 2: Cumulative effect of newer insecticides against *Rhopalosiphum maidis* of 1st, 2nd and 3rd spray

S. N.	Treatment	Dose g or ml/10 L water	Average population of aphids/leaf			Mean
			3 DAS	7 DAS	14 DAS	
1.	Chlorantraniliprole 18.5 SC	4 ml	7.84	5.53	5.70	6.35
			(2.76)	(2.29)	(2.23)	(2.42)
2.	Spinetoram 11.7 SC	9 ml	10.20	8.04	8.38	8.87
			(3.19)	(2.81)	(2.80)	(2.93)
3.	Indoxacarb 14.5 SC	10 ml	11.72	10.40	10.10	10.74
			(3.42)	(3.22)	(3.13)	(3.25)
4.	Thiamethoxam12.6% ZC + Lambdacyhalothrin 9.5 % ZC	2.5 ml	5.82	3.92	4.36	4.70
			(2.35)	(1.90)	(1.95)	(2.06)
5.	Dimethoate 30 EC	12ml	6.98	4.88	5.23	5.69
			(2.61)	(2.15)	(2.13)	(2.29)
6.	Spinosad 45 SC	3ml	9.90	7.84	8.18	8.64
			(3.14)	(2.78)	(2.77)	(2.89)
7.	Emamectin benzoate 5% SG	4gm	10.66	8.98	8.92	9.52
			(3.26)	(2.99)	(2.93)	(3.06
8.	Control	-	20.62	22.09	24.80	22.50
			(4.51)	(4.66)	(4.93)	(4.70)
	SE (m) ±	-	0.15	O.13	0.12	0.13
	CD @ 5 %	-	0.47	0.42	0.40	0.43
	CV (%)	-	8.68	8.66	8.11	8.48

Note: Figures in parentheses are corresponding square root transformation values., DAS- Day After Spraying treatment was closely followed by Dimethoate 30 EC @ 12 ml10 L^{-1} (4.88) and Chlorantraniliprole 18.5 SC @ 4 (5.53). Whereas, Spinosad 45 SC @ 3 ml 10 L^{-1} (7.84 $leaf^{1}$) found at par with Spinetoram 11.7 SC @ 9 ml10 L^{-1} (8.08), Emamectin benzoate 5 per cent SG @ 4 gm10 L^{-1} (8.98) and Indoxacarb 14.5 SC @10 ml10 L^{-1} (10.40) appeared as next better treatments. Highest number of aphid population (22.09 $leaf^{1}$)was recorded in control.

Fourteen days after spray

Among the different treatments cumulative aphid population recorded at fourteen days after spray (Table 2) was minimum in the plots treated with Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml10 L^{-1} i.e. 4.36 aphids $leaf^{1}$. This treatment was found at par with Dimethoate 30 EC @ 12 ml10 L^{-1} and Chlorantraniliprole 18.5 SC @ 4 in which 5.23 and 5.70 aphids per leaf, were recorded, respectively. The next effective treatments was Spinosad 45 SC @ 3 ml 10 L^{-1} (8.18 $leaf^{1}$) found at par with Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (8.38 $leaf^{1}$), Emamectin benzoate 5 per cent SG @ 4 gm 110 L^{-1} (8.92 $leaf^{1}$) and Indoxacarb 14.5 SC @10 ml 10 L^{-1} (10.10 $leaf^{1}$). Maximum number of aphids were recorded in control 24.80 aphids $leaf^{1}$.

It is evident from the cumulative mean data presented in Table 2 that after sprays treatment with Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} proved effective with minimum number of aphids (4.70 $leaf^{1}$) and found at par with Dimethoate 30 EC @ 12 ml 10 L^{-1} (5.69) and Chlorantraniliprole 18.5 SC @ 4ml 10 L^{-1} (6.35). Whereas, the Spinosad 45 SC @ 3 ml 10 L^{-1} (8.64 $leaf^{1}$) found at par with Spinetoram 11.7 SC @ 9 ml 10 L^{-1} (8.87 $leaf^{1}$), Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (9.52 $leaf^{1}$) and Indoxacarb 14.5 SC @10 ml 10 L^{-1} (10.74 $leaf^{1}$). appeared as next better treatments in this respect. Maximum population of aphid was recorded in control (22.50 $leaf^{1}$).

The present results regarding efficacy of different newer insecticides against aphid found supports with the earlier researchers like Kumar *et al.* (2019), Patil *et. al.* (2009), Singh and Jat (2011). Sallam *et al.* (2009) reported the Bio-residual activity declined with days, started with more than 80 per cent on zero time and reached 12 per cent after 7 days in deltamethrin, while it was 70 per cent on zero time and reached 10 per cent after 7 days in lambda-cyhalothrin. Deltamethrin, lambda-cyhalothrin were considered the most effective in controlling cereal aphids.

Bio-efficacy of the treatments evaluated against aphid (*R. maidis*) on barley crop studied by Chaudhary et al. (2017) showed that lowest population of 20.95 and 21.13 $tiller^{-1}$ in thiamethoxam (0.005 %) and dimethoate (0.03), respectively and were at par in their efficacy with each other. Thus, the above finding confirms the present results.

Cumulative effect of newer insecticides on population of natural enemies

The data from Table 3 on the ladybird beetle population at different intervals of observations after each spray indicated non-significant differences among the treatments. The population of ladybird beetle was observed in the insecticide treatments ranged from 0.10 to 0.40 per plant. However, numerically a greater number of ladybird beetles were recorded in untreated control plots (1.19 $plant^{-1}$).

The results tabulated in Table 4 revealed non-significant differences among the treatments in respect of spider population recorded at different intervals of observations after each treatment sprays. The population of spider recorded in different plots treated with newer insecticides ranged between 0.12 to 1.09 spiders $plant^{-1}$. Whereas, in control plots numerically higher number of spiders were observed (1.54 spiders $plant^{-1}$).

The results revealed that the treatments Spinosad 45 SC @ 3ml 10 L^{-1}, Emamectin benzoate 5 per cent SG @ 4gm 10 L^{-1} and Chlorantraniliprole 18.5 SC @ 4 ml 10 L^{-1} proved less detrimental to the predatory fauna like spiders, carabids and coccinellids in maize ecosystem. Earlier workers Daibin *et al.* (2013) conducted the experiment on maize canopies at flowering period and its effects on the efficacy of Emamectin benzoate, Lambda-cyhalothrin and chlorantraniliprole against the toxicity to spiders. Field investigation showed that Lambda-cyhalothrin was extremely toxic to hunting spiders, *X. ephippiatus,* and not suitable to IPM programs Emamectin benzoate can reduce the populations of *X. ephippiatus* by 58.1~61.4 per cent , but the populations can recover at the end of the experiment. Chlorantraniliprole was relatively safe to *X. ephippiatus*. It only reduced the populations of *X. ephippiatus* by 22.3~33.0 per cent and the populations can totally recover nine days after application.

Similarly, Wagh *et al.* (2017) conducted field experiment with eight insecticides and revealed that, Spinosad 45 SC @ 125 g a.i. ha^{-1} (1.76), Abamectin 1.9 EC @ 3 g a.i. ha^{-1} (1.69) and Chlorantraniliprole 18.5 SC @ 30 g a.i. ha^{-1} (1.62) and Novaluron 10 EC @ 75 g a.i. ha^{-1} (1.51) were found safer to the predatory coccinellids. Whereas, Flubendamide 39.35 SC @ 60 g a.i. ha^{-1} was moderately toxic to coccinellids. Cypermethrin 25 EC @ 62.50 g a.i. ha^{-1} was found detrimental to the natural enemies.

Efficacy of newer insecticides on maize yield

The data indicated significant differences among the various treatments (Table 5) in respect to yield of maize. The highest yield (53.20 q ha^{-1}) was obtained in the treatment Spinosad 45 SC @ 3 ml 10 L^{-1}. Chlorantraniliprole 18.5 SC @ 4ml 10 L^{-1}, Spinetoram 11.7 SC @ 9 ml 10 L^{-1} and Emamectin benzoate 5 per cent SG @ 4 gm 10 L^{-1} (51.87, 49.53 and 47.87 q ha^{-1}) yield, respectively. These treatments were found at par with each other and significantly superior over rest of the treatments. Further the next best treatments in respect of yield were Indoxacarb 14.5 SC @10 ml 10 L^{-1} (46.37 q ha^{-1}) Thiamethoxam 12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC @ 2.5 ml 10 L^{-1} (39.60 q ha^{-1}) and Dimethoate 30 EC @ 12 ml 10 L^{-1} (36.40 q ha^{-1}) which were also found statistically at par with each other and significantly superior over untreated control (27.63q ha^{-1}).

The findings of present investigation are in close conformity with the worked carried by Deole *et al.* (2017), Neupone *et. al.* (2016), Ramesh *et. al.* (2012) who reported highest yield of maize (61.63 q ha^{-1}).

CONCLUSION

Spinosad 45 SC at 3ml 10 L^{-1} was found most

Table 3: Cumulative effect of newer insecticides on population of ladybird beetle

S. N.	Treatment	Dose g or ml/10 L water	Average population of ladybird beetle $plant^{-1}$ 3 DAS	7 DAS	14 DAS	Mean
1.	Chlorantraniliprole 18.5 SC	4ml	0.18 (0.42)	0.15 (0.39)	0.15 (0.39)	0.16 (0.40)
2.	Spinetoram 11.7 SC	9ml	0.16 (0.40)	0.14 (0.37)	0.14 (0.37)	0.14 (0.38)
3.	Indoxacarb 14.5 SC	10ml	0.17 (0.41)	0.14 (0.37)	0.15 (0.39)	0.15 (0.39)
4.	Thiamethoxam12.6% ZC + Lambdacyhalothrin 9.5 % ZC	2.5ml	0.15 (0.39)	0.13 (0.36)	0.12 (0.35)	0.13 (0.36)
5.	Dimethoate 30 EC	12ml	0.12 (0.34)	0.10 (0.32)	0.10 (0.32)	0.10 (0.32)
6.	Spinosad 45 SC	3ml	0.33 (0.58)	0.28 (0.52)	0.33 (0.58)	0.31 (0.56)
7.	Emamectin benzoate 5% SG	4gm	0.28 (0.53)	0.24 (0.49)	0.27 (0.52)	0.26 (0.51)
8.	Control	-	1.14 (0.89)	1.20 (0.92)	1.24 (0.92)	1.19 (0.91)
	SE (m) ±	-	0.15	0.15	0.14	0.15

Note: Figures in parentheses are corresponding square root transformation values., DAS- Day After Spraying

Table 4: Cumulative effect of newer insecticides on population of spider

S. N.	Treatment	Doseg or ml/10 L	Average population of spider plant^{-1}			Mean
			3 DAS	7 DAS	14 DAS	
1.	Chlorantraniliprole 18.5 SC	4ml	1.13 (0.87)	0.78 (0.74)	1.09 (0.86)	1.00 (0.82)
2.	Spinetoram 11.7 SC	9ml	0.17 (0.41)	0.16 (0.40)	0.16 (0.40)	0.16 (0.40)
3.	Indoxacarb 14.5 SC	10ml	0.20 (0.44)	0.18 (0.42)	0.15 (0.38)	0.17 (0.41)
4.	Thiamethoxam12.6% ZC + Lambdacyhalothrin 9.5 % ZC	2.5ml	0.15 (0.39)	0.13 (0.36)	0.12 (0.35)	0.13 (0.36)
5.	Dimethoate 30 EC	12ml	0.14 (0.37)	0.12 (0.34)	0.11 (0.33)	0.12 (0.34)
6.	Spinosad 45 SC	3ml	1.23 (0.97)	0.85 (0.82)	1.21 (0.95)	1.09 (0.91)
7.	Emamectin benzoate 5% SG	4gm	1.22 (0.96)	0.85 (0.82)	1.14 (0.93)	1.07 (0.90)
8.	Control	-	1.47 (0.98)	1.54 (1.03)	1.61 (1.08)	1.54 (1.03)
	SE (m) ±	-	0.23	0.19	0.21	0.21

Note: Figures in parentheses are corresponding square root transformation values., DAS- Day After Spraying

effective against stem borer recording minimum per cent infestation and highest seed yield at par with Chlorantraniliprole 18.5 SC and Spinetoram 11.7 SC. Thiamethoxam12.6 per cent ZC + Lambdacyhalothrin 9.5 per cent ZC at 2.5 ml10 L^{-1} was found most effective treatment to reduce the population of aphid leaf^{1} followed by Dimethoate 30 EC and Chlorantraniliprole 18.5 SC.Spinosad 45 SC, Emamectin benzoate 5 per cent SG and Chlorantraniliprole 18.5 SC are relatively safer to natural enemies i.e. Lady bird beetle, spider and carabid larvae, while other treatments had deleterious effect and reduce the population of natural enemies.

Thus, newer insecticides are the better option to manage the major insect pest of maize and can be included in IPM as one of the chemical components and can be use alternatively.

LITERATURE CITED

Ahmeds, S., A. Mushtaq and I. Rauf, 2002. Field efficacy of some bioinsecticides against maize and gowar stem borer, Int. J. Agric. Biol. 4(3) : 332-334/

Devendra, K. M., N.A.V. Khanpara and A.M. Vija, 2018. Bio-efficacy of various insecticides against maize stem borer in Junagarh conditions, J. Pharmacoggosy and Phytochemistry, 7 (4) : 2349-2352

Deole, V.K. Dubey, D.K. Rana and Rashmi Gauraha, 2017. Evaluation of newer insecticides against maize pink stem borer: major constraint insect pest of maize in Raipur, Chhattisgarh, J. of Plant Development Sciences. 9 (4): 335-339.

Farid, A., M. Khan, A.Khan , S. U. Khan, A. Khattak and A.Sattar, 2007. Studies on Maize Stem Borer, *Chilo partellus* in Peshawar Valley Pakistan, J. Zoology. 39(2):127-131.

Gomez, K. A. and A. A. Gomez,1984. Statistical procedure for agricultural research (2 ed.), John Wiley and sons,New York : 680.

Kumar, V., and Swarnali Bhattacharya, 2019. Effect of

Table 5: Cumulative effect of newer insecticides on yield of maize

S. N.	Treatment	Dose g or ml/10 L water	Seed yield (q ha^{-1})			Mean (q ha^{-1})
			RI	RII	RIII	
1.	Chlorantraniliprole 18.5 SC	4 ml	49.60	54.80	51.20	51.87
2.	Spinetoram 11.7 SC	9 ml	49.60	48.80	50.20	49.53
3.	Indoxacarb 14.5 SC	10 ml	45.40	46.80	46.90	46.37
4.	Thiamethoxam12.6% ZC + Lambdacyhalothrin 9.5 % ZC	2.5 ml	37.40	40.60	40.80	39.60
5.	Dimethoate 30 EC	12ml	35.20	37.50	36.50	36.40
6.	Spinosad 45 SC	3ml	59.20	50.40	50.00	53.20
7.	Emamectin benzoate 5% SG	4gm	48.50	47.30	47.80	47.87
8.	Untreated Control	-	21.00	22.40	39.50	27.63
	SE (m) ±	-	-	-	-	0.21
	CD @ 5%	-	-	-	-	0.65

different insecticidal treatments on Aphid (*Aphis craccivora)* infesting groundnut, Indian J. Entomology and Zoology Studies. 7(2): 513-515.

Neupane,S., G. Bhandari, S.Sharma, R.Yadav, and S. Subedi, 2016. Management of stem borer (*Chilo partellus (*Swinhoe) in maize using conventional pesticides in Chitwan, Nepal, J. Maize Research and Development 2(1) :131.

Patil, S.D., P.N. Rasal, K.S. Babu, D.A. Shambharkar and B.C. Game, 2009. Efficacy of different newer chemicals and seed treatment against foliage feeding wheat aphids, International J. Plant Protection.(2): 271-275.

Rameash, K., A.Kumar, and K.,Kalita, 2012. Biorational management of stem borer, *Chilo partellus* in Maize, Indian J. Plant Prot.40 (3): 208-213.

Reddy, YVR. and S. Trivedi, 2008. Maize Production Technology, Academic Press :190-192.

Sallam, A.A., C.Volkmar and N.E. Wakeil, 2009. Effectiveness of different bio–rational insecticides applied on wheat plants to control cereal aphids, J. of Plant Diseases and Protection. 116 (6): 283–287.

Sarup, P., K. H. Sddiqui and K. K. Marwada, 1987. Trends in maize pest management research in India together with bibliography, J. Entomol. Res., 11(1) : 19-68.

Sarup,P.,VPS. Panwar, K. K. Marwada and K. H. Sddiqui, 1978. Management of maize pest with particular reference to the *C. partellus* (Swinhoe) under resource constraints, J. Entomol. Res.2 (1) : 5-14.

Singh, H., and B.L. Jat, 2011. Bio-efficacy of some newer insecticides and bio-pesticides against barley aphid, *Rhopalosiphummaidis* (fitch), Indian J. of Applied Entomology, 25 (2): 122–126.

Wagh, B.M., K.S. Pagire, Dipali P. Thakare and A.B. Birangal, 2017. Management of sucking pests by using newer insecticides and their effect on natural enemies in tomato (*Lycopersicon esculentum* Mill.), Int. J. Curr. Microbiol. App. Sci. 6 (4): 615-622.

Received on : 25.8.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Evaluation of Different Insecticidal Sequences Against Cotton Pink Bollworm (*Pectinophora gossypiella*)

P. W. Nemade[1] S. B. Deshmukh[2] and D. T. Deshmukh[3]

ABSTRACT

Field experiment was conducted at Cotton Research Unit farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2018 with fifteen treatments and three replications in Randomised Block Design. The data thus obtained revealed that, Rosatte flowers differences among different treatments were statistically non significant at 45 and 60 days after sowing. Minimum green boll damage (1.61%) and loculi damage (0.41 %) due to pink bollworm was recorded in treatment T_{14} i.e. azadirachtin spray (40ml 10 l^{-1}) at 45 days after sowing followed by thiodicarb spray (20g10 l^{-1}) at 60 days after sowing followed by chloropyriphos spray (25ml/10 lit.) at 90 days after sowing followed by lambda cyhalothrin spray (10 ml10 l^{-1}) at 120 days after sowing and proved the best insecticidal sequence for management of pink bollworm in cotton. Similarly, at harvest, minimum open boll damage (18.33%) and loculi damage (4.96%) due to pink bollworm was also recorded in treatment T_{14} and it was on par with treatment T_{12}, T_9, T_{13}, T_7 and T_8. Maximum seed cotton yield i.e. 12.76 q ha^{-1} was also obtained in treatment T_{14} where as minimum seed cotton yield (3.10 q ha^{-1}) was recorded in unsprayed control.

Cotton (*Gossypium* spp.) is the leading natural fibre and oil seed crop which plays a key role in Indian economy with second position in production after China and offering livelihood security for the Indian farming community. It has a unique place in social affairs. Many allied activities like ginning, fabric production, textile processing, garment manufacture and their marketing etc. provide employment to around 6 million people. It also provides 65 per cent raw material to textile industry and contributed 1/3rd of total foreign exchange earning of India.

The pink bollworm *Pectinophora gossypiella* (Saunders) is the most important cotton pest in the world (Amin and Gergis, 2006) reported greatest loss (20-40 %) in cotton seed yield. Pink bollworm is the most destructive pest of cotton in later stages of the crop growth. It causes locule damage of 37.5 per cent and 13.58 per cent on non-Bt and Bt cotton, respectively, at 160 days of planting resulting into heavy loss in cotton production (Naik et al., 2014). During 2014, severe damage to bolls by pink bollworm and yield-losses were observed in Bt-cotton in many regions of Gujarat and some parts of AP, Telangana and Maharashtra (Kranthi, 2015). Abd El-Mageed *et al.* (2007) indicated that application of insecticides in sequential use induced higher reduction in larval number as compared with the lower reduction resulting from several applications with the same insecticide alone. The present work is an attempt to evaluate the effectiveness of sequence insecticides mixtures with azadirachtin against cotton pink bollworm infesting cotton green bolls in the field.

MATERIAL AND METHODS

Taking this into consideration, the field experiment was conducted at Cotton Research Unit, Dr. PDKV, Akola during *Kharif* 2018, with the objective to study the most effective insecticidal schedule for the management of pink bollworm in Bt cotton. Field experiment was laid out in Randomized Block Design (RBD) with fifteen treatments replicated thrice (Table 1). The cotton hybrid Ajeet 155 BG II Bt seed was sown on 29.06.2018 at 90 x 60 cm spacing in such a manner that each plot measured 6.30 x 6.00 m in size and the regular agronomic practices were followed. The observations on rosette flowers were recorded at 45 and 60 days after sowing. The incidence of pink bollworm larvae was observed through destructive sampling of 20 randomly collected green bolls from each plot and per cent green boll damage and loculi damage were recorded at 90, 120 and 150 days after sowing. Open boll and loculi damage on boll basis was also recorded at the time of harvest. The yield of seed cotton per plot was recorded and converted to quintal per hector. The data thus obtained was statistically analysed.

1 & 2 . Asstt. Professor and 3. Senior Research Scientist, Cotton Research Unit, Dr. PDKV, Akola

Table 1 : Treatment application details

Treat No	Insecticide applications at			
	45 Days after sowing	60 Days after sowing	90 Days after sowing	120 Days after sowing
T_1	A	-	-	-
T_2	-	B	-	-
T_3	-	-	C	-
T_4	-	-	-	D
T_5	A	B	-	-
T_6	A	-	C	-
T_7	A	-	-	D
T_8	A	B	C	-
T_9	A	-	C	D
T_{10}	-	B	C	-
T_{11}	-	B	-	D
T_{12}	-	B	C	D
T_{13}	-	-	C	D
T_{14}	A	B	C	D
T_{15}	Control			

A= Azadirachtin 3000 ppm@ 40ml/10 Lit., **B**= Thiodicarb 75WP@ 20g/10 Lit., **C**= Chlorpyriphos 20EC @ 25ml/10 Lit., **D**= Lambda-Cyhalothrin 4.9 CS @ 10 ml/10 Lit.

RESULTS AND DISCUSSION

1) Rosette flowers (%) :

Rosette flowers were not observed at 45 days after sowing where as at 60 days after sowing statistically non significant differences were recorded among the different treatments. This might be due to low pressure of pink bollworm during the early phase in season.

2) Green boll damage due to pink bollworm infestation :

In case of green boll damage due to pink bollworm infestation, significant differences were recorded at 90, 120 and 150 DAS. At 90 DAS, all the treatments were superior over unsprayed control except treatment T_4, T_1, T_{13}, T_3, T_7 which were at par with each other. Maximum per cent green boll damage (13.33 %) was recorded in untreated control.

At 120 DAS, minimum per cent green boll damage (1.67%) was recorded in treatment T_8, T_9 and T_{14} and these treatments were at par with T_{10} and T_{12}. Other treatments recorded per cent green boll damage in the range of 12.92 to 34.67. Maximum green boll damage (31.67%) was recorded in untreated control.

Similar type of trend was recorded at 150 DAS recording minimum 1.67 per cent green boll damage in treatment T_{14} which include application of azadirachtin 3000 ppm@ 40ml at 45 DAS, thiodicarb 75WP@ 20 g at 60 DAS, chlorpyriphos 20EC @ 25ml at 90 DAS and lambda-cyhalothrin 5EC @ 7.5 ml at 120 DAS. This treatment is at par with T8, T10, T9 and T12. Maximum per cent green boll damage (48.33 %) was recorded in untreated control. Other treatments recorded green boll damage in the range of 18.33 to 43.33 per cent.

3) Green boll loculi damage due to PBW infestation:

In case of green boll loculi damage due to PBW infestation, significant differences were recorded at 90, 120 and 150 DAS. At 90 DAS, all the treatments were superior over unsprayed control except treatment T_4, T_{15}, T_1 and T_{13} which were at par with each other. Maximum per cent green boll loculi damage (3.31 %) was recorded in untreated control.

Table 2 : Effect of different treatments on pink bollworm infestation at different crop stages.

Treat No	Insecticide applications at				Rosette flowers (%)			
	45 Days after sowing	60 Days after sowing	90 Days after sowing	120 Days after sowing	5 DAS		60 DAS	
					OV	TV	OV	TV*
1	**A**	-	-	-	0.0	0.0	0.00	0.71
2	-	**B**	-	-	0.0	0.0	2.56	0.71
3	-	-	**C**	-	0.0	0.0	3.33	1.97
4	-	-	-	**D**	0.0	0.0	3.70	0.71
5	**A**	**B**	-	-	0.0	0.0	0.00	0.71
6	**A**	-	**C**	-	0.0	0.0	0.00	0.71
7	**A**	-	-	**D**	0.0	0.0	0.00	0.71
8	**A**	**B**	**C**	-	0.0	0.0	0.00	0.71
9	**A**	-	**C**	**D**	0.0	0.0	3.33	1.97
10	-	**B**	**C**	-	0.0	0.0	0.00	0.71
11	-	**B**	-	**D**	0.0	0.0	6.36	1.90
12	-	**B**	**C**	**D**	0.0	0.0	2.56	1.78
13	-	-	**C**	**D**	0.0	0.0	3.70	2.06
14	**A**	**B**	**C**	**D**	0.0	0.0	0.00	0.71
15	Control				0.0	0.0	3.33	0.71
SE (m) ±					-	-		0.616
CD at 5%					-	-		-
CV%					-	-		88.75

* square root (x+0.5) A= Azadirachtin 3000 ppm@ 40ml 10 Lit.$^{-1}$, B= Thiodicarb 75WP@ 20g 10 Lit.$^{-1}$, C= Chlorpyriphos 20EC @ 25ml 10 Lit.$^{-1}$, D= Lambda-Cyhalothrin 4.9 CS @ 10 ml 10 Lit.$^{-1}$

At 120 DAS, minimum per cent green boll loculi damage (0.41 %) was recorded in treatment T_8, T_9 and T_{14} and these treatments were at par with T10. Other treatments recorded per cent green boll loculi damage in the range of 1.22 to 7.74. Maximum green boll loculi damage (7.74 %) was recorded in untreated control.

As days progress, increasing trend of pink boll infestation was observed. At 150 DAS, minimum 0.41 per cent green boll loculi damage was recorded in treatment T_{14} which include application of azadirachtin 3000 ppm@ 40ml at 45 DAS, thiodicarb 75WP@ 20g at 60 DAS, chlorpyriphos 20EC @ 25ml at 90 DAS and lambda-cyhalothrin 5EC @ 7.5 ml at 120 DAS. This treatment is at par with T_8, T_{10}, T_9 and T_{12} where as maximum (14.68 %) per cent green boll loculi damage was recorded in untreated control. Other treatments recorded green boll loculi damage in the range of 4.44 to 13.00 per cent.

4) Open boll & loculi damage (%) at harvest :

Per cent open boll damage at harvest revealed that all the treatments were statistically superior over unsprayed control. Minimum open boll damage (18.33 %) was recorded in treatment T_{14} which consist of azadirachtin 3000 ppm spraying at 45 DAS followed by Thiodicarb spraying at 60 DAS, Chloropyriphos spraying at 90 DAS and Lambda-Cyhalothrin at 120 DAS and it was on par with treatment T_{12}, T_9, T_{13}, T_7 and T_8. Rest of the treatments recorded open boll damage in the range of 40.00 to 81.67 per cent. Maximum open boll damage (81.67%) was recorded in unsprayed control treatment.

Similar trend was observed in case of per cent loculi damage recording minimum in the treatment T_{14}

Table 3: Effect of different treatments on pink bollworm infestation in green bolls at different crop stages.

Treat No	Insecticide applications at				Green boll damage (%)					
	45 Days after sowing	60 Days after sowing	90 Days after sowing	120 Days after sowing	90 DAS		120 DAS		150 DAS	
					OV	TV*	OV	TV**	OV	TV***
1	A	-	-	-	8.33	3.24	16.67	23.86	26.67	30.95
2	-	B	-	-	0.00	0.71	21.67	27.71	35.00	36.24
3	-	-	C	-	8.33	2.79	11.67	19.89	20.00	26.45
4	-	-	-	D	10.00	3.59	28.33	32.14	43.33	41.16
5	A	B	-	-	0.00	0.71	11.67	19.89	23.33	28.86
6	A	-	C	-	0.00	0.71	11.67	19.89	18.33	25.31
7	A	-	-	D	8.33	2.79	13.33	21.34	23.33	28.86
8	A	B	C	-	0.00	0.71	1.67	4.31	3.33	8.61
9	A	-	C	D	1.67	0.71	1.67	4.31	5.00	10.45
10	-	B	C	-	0.00	0.71	3.33	8.61	3.33	8.61
11	-	B	-	D	3.33	1.53	15.00	22.60	21.67	27.52
12	-	B	C	D	0.00	0.71	5.00	12.92	5.00	12.92
13	-	-	C	D	8.33	3.24	15.00	22.60	25.00	29.93
14	A	B	C	D	0.00	0.71	1.67	4.31	1.67	4.31
15	Control				13.33	3.59	31.67	34.15	48.33	44.03
SE (M$\pm$)						0.293		2.810		2.986
CD (P=0.05)						0.849		8.139		8.648
CV%						28.57		26.22		21.30

*square root (x+0.5), **Square root values, ***Arc sine values

A= Azadirachtin 3000 ppm@ 40ml 10 Lit.$^{-1}$, B= Thiodicarb 75WP@ 20g 10 Lit.$^{-1}$, C= Chlorpyriphos 20EC @ 25ml 10 Lit.$^{-1}$, D= Lambda-Cyhalothrin 4.9 CS @ 10 ml 10 Lit.$^{-1}$

which consist of azadirachtin 3000 ppm spraying at 45 DAS followed by thiodicarb spraying, chloropyriphos spraying and lambda-cyhalothrin at 60, 90 and 120 days after sowing respectively and it was at par with treatment T_{12}, T_{13}, T_7 and T_9. At harvest loculi damage was in the range of 4.96 to 23.95 per cent. Maximum loculi damage (23.95%) due to pink bollworm infestation was observed in unsprayed control treatment.

B) Effect of various insecticidal treatments on the yield of seed cotton :

Highest seed cotton yield (12.76 q ha^{-1}) was obtained from treatment T_{14} which consist of azadirachtin 3000 ppm spraying at 45 DAS followed by thiodicarb spraying at 60 DAS, chloropyriphos spraying at 90 DAS and lambda-cyhalothrin at 120 DAS followed by treatment T_{12} i.e. Thiodicarb spraying at 60 DAS followed by Chloropyriphos spraying at 90 DAS and Lambda-Cyhalothrin at 120 DAS, treatment T_9 (azadirachtin 3000 ppm spraying at 45 DAS followed by chloropyriphos spraying at 90 DAS and lambda-cyhalothrin at 120 DAS) and treatment T_{13} (chloropyriphos spraying at 90 DAS followed by lambda-cyhalothrin at 120 DAS). Lowest seed cotton yield (3.10 q ha^{-1}) was recorded in unsprayed control. .

These results agreed with the previous finding of Patil *et al.*, (2009) who reported significant reduction in population of PBW larvae in the plots treated with thiodicarb 70 SP at 90 DAS and at 125 DAS also, it maintained its superiority with 4.35 larvae 20^{-1} green bolls.

Table 4: Effect of different treatments on pink bollworm infestation in green bolls loculi at different crop stages.

Treat No	Insecticide applications at				Green loculi damage (%)					
	45 Days after sowing	60 Days after sowing	90 Days after sowing	120 Days fter asowing	90 DAS		120 DAS		150 DAS	
					OV	TV**	OV	TV*	OV	TV*
1	**A**	-	-	-	2.07	1.73	4.02	1.98	7.24	2.67
2	-	**B**	-	-	0.00	0.71	5.27	2.29	10.14	3.18
3	-	-	**C**	-	2.07	1.52	2.89	1.69	4.94	2.21
4	-	-	-	**D**	2.51	1.90	6.91	2.63	13.00	3.61
5	**A**	**B**	-	-	0.00	0.71	2.89	1.69	5.78	2.40
6	**A**	-	**C**	-	0.00	0.71	2.83	1.67	4.44	2.10
7	**A**	-	-	**D**	2.07	1.53	3.26	1.80	6.12	2.47
8	**A**	**B**	**C**	-	0.00	0.71	0.41	0.37	0.83	0.74
9	**A**	-	**C**	**D**	0.41	0.71	0.41	0.37	1.66	1.02
10	-	**B**	**C**	-	0.00	0.71	0.82	0.74	0.82	0.74
11	-	**B**	-	**D**	0.83	1.02	3.63	1.89	5.25	2.27
12	-	**B**	**C**	**D**	0.00	0.71	1.22	1.10	1.22	1.10
13	-	-	**C**	**D**	2.07	1.73	3.70	1.90	6.99	2.62
14	**A**	**B**	**C**	**D**	0.00	0.71	0.41	0.37	0.41	0.37
15	Control				3.31	1.89	7.74	2.77	14.68	3.82
SE (M±)						0.122		0.233		0.269
CD (P=0.05)						0.354		0.676		0.779
CV%						18.68		26.05		22.31

* square root values, ** square root (x+0.5)

A= Azadirachtin 3000 ppm@ 40ml/10 Lit., B= Thiodicarb 75WP@ 20g/10 Lit., C= Chlorpyriphos 20EC @ 25ml/10 Lit., D= Lambda-Cyhalothrin 4.9 CS @ 10 ml/10 Lit..

Borkar and Sarode (2012) reported that the treatment schedules comprising four botanicals including azadirachtin followed by spinosad 45 SC have been found effective in reducing the larval population of pink bollworm in green bolls.

Present findings are in corroborative with Ghure *et al.* (2008) and Gosalwad *et al.* (2009) showed that the newer insecticides molecules i.e. (indoxacarb, spinosad, emamectin benzoate, lambda-cyhalothrin and polytrin c) significantly reduced bollworms infestation in cotton. Abdel-Rahman *et al.* (2005) reported that the Azadirachtin Azal formulations applying at higher dose T/S (20 and 25 ppm) were the most effective against *P. gossypiella* also, Sarode *et al.* (2000) and Gupta (2001) who found that Azadirachtin products and formulation of B. thuringiensis were effective against the bollworms and can be used as alternative to chemical insecticides. In addition, Jeyakumar and Gupta (2002) reported azadirachtin and Bacillus thuringiensis treatments alone was not effective against bollworms. But, treatments by neem + *B. thurienginsis* alternatively with synthetic pesticides were more effective in reducing bollworm infestation. Rashid *et al.* (2012) concluded that neem oil at 1.5 per cent and 2 per cent and neem seed water extract at 3 per cent had positive impact on yield of seed cotton. Ismail (2019) reported that all the tested insecticidal sequences resulted in an appreciable reduction in *P. gossypiella* infestation; as compared with

Table 5: Effect of different treatments on pink bollworm infestation in open boll and loculi damage at harvest and yield.

Treat No	Insecticide applications at				Open boll) damage (%) At harvest		Open boll loculi damage (%) At harvest		Yield (q ha^{-1}) at 180 DAS
	45 Days after sowing	60 Days after sowing	90 Days after sowing	120 Days after sowing	OV	TV*	OV	TV**	
1	**A**	-	-	-	75.00	61.65	22.43	4.70	4.16
2	-	**B**	-	-	71.67	58.07	21.70	4.64	4.49
3	-	-	**C**	-	61.67	51.95	17.45	4.15	6.28
4	-	-	-	**D**	66.67	55.07	19.67	4.42	5.37
5	**A**	**B**	-	-	48.33	44.04	13.28	3.60	8.16
6	**A**	-	**C**	-	45.00	42.06	12.38	3.44	6.98
7	**A**	-	-	**D**	36.67	37.09	9.94	3.10	9.32
8	**A**	**B**	**C**	-	38.33	38.19	10.88	3.27	9.47
9	**A**	-	**C**	**D**	28.33	31.74	7.01	2.60	10.70
10	-	**B**	**C**	-	40.00	39.15	11.22	3.32	9.15
11	-	**B**	-	**D**	43.33	41.12	11.73	3.41	8.60
12	-	**B**	**C**	**D**	23.33	28.54	5.85	2.38	11.46
13	-	-	**C**	**D**	35.00	36.24	9.13	3.01	10.60
14	**A**	**B**	**C**	**D**	18.33	24.81	4.96	2.15	12.76
15	Control				81.67	65.19	23.95	4.88	3.10
SE (M±)						4.726		0.337	0.411
CD (P=0.05)						13.690		0.976	1.192
CV%						18.75		16.50	26.59

* Arc sine values, **Square root values

A= Azadirachtin 3000 ppm@ 40ml/10 Lit., **B=** Thiodicarb 75WP@ 20g/10 Lit., **C=** Chlorpyriphos 20EC @ 25ml/10 Lit., **D=** Lambda-Cyhalothrin 4.9 CS @ 10 ml/10 Lit.

control, the infestation reduction percentages were more than 72 per cent during the two seasons.

LITERATURE CITED

Abd El-Mageed, A.E.M., L.R. El-Gohary and H.F. Dahi, 2007. Evaluation of several programs of sequences pesticides application on cotton bollworms and some other sucking pest in cotton field, J. Entomol.,4:93-103

Abdel-Rahman, A.G., A.K. El-Sayed, Laila S. Hamouda and B.A.I. Imam, 2005. Histological deformations in males testes of *Pectinophora gossypiella* (Saund) induced by treating larvae with neem formulations, Egypt. J. Agric. Res. 83(2):

Amin, A. A and M. F. Gergis. Integrated management strategies for control of cotton key pests in middle Egypt, Agron. Res. 2006; 4 : 121- 128.

Borkar S. L. and S. V. Sarode, 2012. Efficacy of botanicals and bio-pesticides on population dynamics of bollworm complex and their safety to the predators in non-Bt cotton, J. Bio. Control. 26(2) : 165-172.

Ghure, S.T., B.S. Kharbde and D.S. Patil, 2008. Bioefficacy of new pesticides against bollworm complex of cotton (*Gossypium* spp.), International J. Plant Protection 1(2): 106-109.

Gosalwad, S.S., S.K. Kamble, D.W. Wadnerkar and K.B. Awaz, 2009. Efficacy of some newer insecticides for control of cotton bollworms, J. Cotton Res. and Develop., 23(2) : 282-285.

Gupta, G. P., 2001. Role of neem in sustainable cotton pest management, National J. Plant Improve, 3: 37-43.

Ismail, S. M., 2019. Influence of some insecticide sequences on the injurious insect- pests of cotton plants, Bull Natl. Res. Cent., 43 : 149.

Jeyakumar, P. and G.P. Gupta, 2002. Utilization of neem and Bt for managing bollworms in cotton, Indian J. Entomol. 64(4): 424-433.

Kranthi, K. R. Pink bollworm strikes Bt cotton, Cotton Statistics News, 2015; 35: 1-6.

Naik, V. C., B. Jothi Dhara , P. L. Dabhade and S. Kranthi, 2014. Pink bollworm (Saunders) infestation on Bt and non-Bt hybrids in India in 2011-2012, Cotton Res. J., 6(1): 37-40.

Patil S B, S.S. Udikari, R. B. Hirekurubar, G. S. Guruprasad and C. Abhilash, 2009. Thiodicarb and Profenophos: Promising insecticides for Pink Bollworm *(Pectinophora gossypiella)* Saunders in cotton, Indian J. Entomol., 71 : 183-185.

Rashid M. M., M. K. Khattak and K. Abdullah, 2012. Evaluation of botanical and synthetic insecticides for the management of cotton pest insects, Pakistan J. Zoology, 44(5) : 1317-1324.

Sarode, S.V., A.E. Chaudhary and V.U. Sonalkar, 2000. Evaluation of neem products against cotton bollworm complex, J. Entomol. Res. 24(4): 319-324.

Received on : 15.3.2020

* * *

Effect of Potassium Management through Gliricidia Green Leaf Manuring on Yield and Nutrient Uptake by Cotton in Vertisols

V.V. Gabhane[1], K. Rajesh Naik[2], Ashwini Chandel[3], M. M. Ganvir[4] and B. A. Sonune[5]

ABSTRACT

A field experiment was conducted to assess the effect of gliricidia green leaf manuring as a source of potassium on yield and nutrient uptake by cotton on Vertisols. The experiment was conducted during *kharif* 2015-16 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment comprised of nine treatments and three replications, laid out in Randomized Block Design. The treatments comprised of control, 100 per cent RDF (60:30:30 NPK kg ha^{-1}), 100 per cent ,75 per cent and 50 per cent N and 100 per cent P through chemical fertilizers and the combinations of 15, 20 and 30 kg K ha^{-1} through gliricidia green leaf manure at 30 DAS and remaining recommended dose of potassium as basal dose through inorganic fertilizers. The results revealed that application of 100 per cent NP +10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia green leaf manure at 30 DAS recorded higher yield (1172.84 & 3223.59 kg ha^{-1} seed cotton and cotton stalk, respectively) and nutrient uptake by cotton grown in Vertisols under rainfed conditions.

Increase in cotton production and productivity can be achieved only through enhanced soil fertility which can be sustained if the nutrients removed from soil are replenished by way of addition. Supplying the entire quantity of nutrients required for cotton through chemical fertilizers may not be possible due to continues increase in prices of chemical fertilizers. Hence, the nutrient requirement through chemical and organic sources may be useful for sustaining cotton productivity and soil health.

Potassium is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. It is considered second only to nitrogen, when it comes to nutrients needed by plants, and is commonly considered as the "quality nutrient." It affects the plant shape, size, colour, taste and other measurements attributed to healthy produce. It plays a major role in the regulation of water in plants (osmo regulation). Both uptake of water through plant roots and its loss through the stomata are affected as well as it improves drought resistance. Potassium is essential at almost every step of the protein synthesis and in starch synthesis the enzyme responsible for the process is activated by potassium. It has an important role in the activation of many growth related enzymes in plants.

Gliricidia sepium belongs to leguminous family with sub family Papilionoideae. It is a leguminous multipurpose tree and adopts very well in a wide range of soils and adds plant nutrients and organic matter to the soil and increases crop productivity. The leaves decompose relatively fast, providing nitrogen and potassium. Gliricidia as green leaf manure plays important role in increasing the fertility status of soils and helps in conserving soil through reduced soil erosion also. Patil (1989) stated that 1 tonne dry weight of leaves was equivalent to 27 kg N while Kang and Mulongoy (1987) reported that up to 15 t ha^{-1} year^{-1} of gliricidia leaf biomass could be produced on good soils in Nigeria providing the equivalent of 40 kg N ha^{-1}year^{-1}.

Due to energy crises, the fertilizer production around the world is very much affected and fertilizers are becoming very expensive. So it becomes necessary to minimize the expenses on fertilizers and at the same time sustain the crop yields and soil fertility by using organic manure, crop residues, green manuring and tillage practices.

However, such information is limited on rainfed cotton on Vertisol under semi-arid climatic conditions of Maharashtra. Therefore, the present study was carried out to assess the effect the integrated plant nutrient

1. Associate Professor, 2.P.G. student, 3. Ph.D. Scholar and 4&5. Assistant Professor, AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola -444 104(M.S.)

strategies through green leaf manuring, along with chemical fertilizers on nutrient uptake and cotton productivity in Vertisols of Vidrabha region of Maharashtra.

MATERIAL AND METHODS

Field experiment on cotton was conducted during *kharif* 2015-16 at research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment comprised of nine treatments and three replications laid out in Randomized Block Design. The treatments comprised of control, 100 per cent RDF (60:30:30 NPK kg ha^{-1}), 100 per cent ,75 per cent and 50 per cent N and 100 per cent P through chemical fertilizers and the combinations of 15, 20 and 30 kg K ha^{-1} through gliricidia green leaf manure.

The treatment wise plant samples were selected randomly from each net plot at harvesting stage. The plant samples were collected, dried in shade and then placed in oven at 65 ^{0}C and these plant samples were ground in electrically operated stainless steel blade grinder (Willey mill) up to maximum fineness.

Finely ground and well mixed known quantity of plant samples were analysed for N, P and K by standard procedures (Piper, 1966 and Jackson, 1973).

RESULTS AND DISCUSSION

Effect of gliricidia green leaf manuring on yield of cotton

The significantly higher seed cotton yield (1172.84 kg ha^{-1}) was observed (Table 1) with application of 100 per cent NP + 10 kg K ha^{-1} (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and it was on par with the application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3), application of 75 per cent N +100 per cent P+15 kg K ha^{-1}(inorganic) +15 kg K ha^{-1} through gliricidia (T_6), application of 75 per cent N +100 per cent P+30 kg K ha^{-1} through gliricidia (T_7) and treatment receiving 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5). Integrated use of potassium in a 50:50 ration through inorganic and organic along with 100 per cent NP from inorganic enhanced the seed cotton yield by 15.7 and 27.6 per cent compared to 100 per cent K from organic and inorganic, respectively. This clearly suggest that instead of using green manure alone (Gliricidia) or chemical fertilizers alone for 100 per cent K, their integration in a 50:50 proportion is agronomically more effective and also helps in saving of chemical fertilizers to the extent of 50 per cent and also helps in improving the effectiveness of the individual source when applied in association. Similar enhancement in rice yield with integrated application of nutrients in a 50:50 proportion was also reported by Shilpa Babar (2013).

Higher cotton yield with conjunctive application of gliricidia green leaf manure along with chemical fertilizers may be due to balanced supply of nutrients to the crops throughout the crop growth period. Green leaf manure undergo decomposition during which series of nutrient transformation takes place which helps in their higher availability to the crops and higher uptake of nutrients by the crops will result in higher yield.

Overall, higher values of seed cotton yield with integrated use of organics (gliricidia) and inorganics could be inferred from higher availability of nutrients from chemical fertilizers, early decomposition of gliricidia, N-fixed and mobilized and P solubilized by PSB, in addition to other benefits of aggregation of soil facilitating higher infiltration and retention of rainwater in the soil profile (Dass *et al.,* 2013).

This clearly indicated that the balanced nutrition through only chemical fertilizers did not sustain the cotton yield on long run compared with conjunctive use of organic and inorganic fertilizers. The lowest seed cotton yield (669.41 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control. Similar increase in crop yield with gliricidia loppings compared to crop residue was also noted by Sharma *et al.* (2009 &2016).

The significantly higher cotton stalk yield (3429.36 kg ha^{-1}) was observed with the application of 100 per cent NP + 15 kg K ha^{-1} (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and it was found to be on par with application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4), application of 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5) and treatment receiving 75 per cent N +100 per cent P+15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_6). It was also observed that 72.41 per cent and 25 per cent increase in yield of cotton stalk was recorded in treatment T_3 as compared to control and 100 per cent RDF (60:30:30 NPK kg ha^{-1}) respectively. The lowest (1989.03 kg ha^{-1}) cotton stalk yield was recorded in treatment T_1 *i.e.* control.

Table 1: Effect of gliricidia green leaf manuring on yield of cotton

Treatments		Cotton yield (kg ha^{-1})	
		Seed cotton	Cotton stalk
T_1	Control	669.41	1989.03
T_2	100 % RDF (60:30:30 NPK kg ha^{-1})	916.32	2743.48
T_3	100 % NP + 15 kg K (inorganic) +15 kg K through gliricidia	1169.41	3429.36
T_4	100 % NP + 10 kg K (inorganic) +20 kg K through gliricidia	1172.84	3223.59
T_5	100 % NP + 30 kg K through gliricidia.	1010.97	3155.01
T_6	75 % N +100% P+15 kg K (inorganic) +15 kg K through gliricidia	1061.04	2949.25
T_7	75 % N +100 % P+30 kg K through gliricidia	1012.35	2674.90
T_8	50 % N +100 % P+30 kg K through gliricidia	879.29	2400.55
T_9	100 % K through gliricidia	688.61	2126.20
	SE (m) $\pm$	66.25	212.32
	CD at 5 %	198.64	636.58

The results are in conformity with the findings of Raskar (2004), Kamble *et al.*(2009) and Doli *et al.* (2015).

Effect of gliricidia green leaf manuring on nutrient uptake by cotton

Nitrogen uptake

The data (Table 2) indicated that significantly higher N uptake (36.36 kg ha^{-1}) by cotton seed was observed with the application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and it was found to be on par with application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and treatment receiving 75 per cent N +100 per cent P+15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_6). Similar higher N uptake was also observed with the integrated use of nutrient through organics and mineral fertilizers. The lowest N uptake by cotton seed (15.28 kg ha^{-1}) was observed in treatment T_1 *i.e.* control.

The significantly higher N uptake (29.46 kg ha^{-1}) by cotton stalk was observed with the application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and it was also found to be on par with the application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and treatment receiving 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5).

Higher removal of N and K in the above treatments as compared to crop receiving only RDF was perhaps due to continuous supply of nitrogen throughout the crop growth period as the nutrients from inorganic sources were available to the crop in the early stages and in the later stages of the crop growth, the slow and continuous release of nutrients from the organic sources. The lowest N uptake (12.6 kg ha^{-1}) by stalk was observed in treatment T_1 *i.e.* control.

The significantly highest total N uptake (65.82 kg ha^{-1}) by cotton was observed with application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and it was found to be on par with the treatment T_3 *i.e.* 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia. The application of 10 kg K through inorganic and 20 kg K through organic (gliricidia) along with 100 per cent NP (inorganic) recorded 36.5 and 37 per cent higher total N uptake over 100 per cent K (inorganic) and 100 per cent K (organic), respectively. The lowest total N uptake (27.88 kg $ha^{-1)}$ by cotton was observed in treatment T_1 *i.e.* control.

The uptake of N increased due to the combined application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia which increased the concentration of N in seed and stalk. This may be due to addition of gliricidia green leaf manuring which contains larger amount of N in their leaves and that facilitates higher rate of mineralization process. Thus, results in higher uptake of nitrogen by the plant as compared to the inorganic fertilizers alone.

The results are in conformity with the finding of Jayasundara *et al.* (1997), Rao and Janawade (2009), Ghalav *et al.* (2009) and Thimmareddy *et al.* (2013).

Phosphorus uptake

The data (Table 3) indicated that the significantly higher P uptake (5.05 kg ha^{-1}) by cotton seed was observed with the application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and it was on par with the application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and treatment with application of 100 per cent RDF (60:30:30 NPK kg ha^{-1}) (T_2). The lowest P uptake by cotton seed (2.34 kg ha^{-1}) was observed in treatment T_1 *i.e.* control.

The significantly higher P uptake (11.66 kg ha^{-1}) by cotton stalk was observed with the application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and it was also found to be on par with application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4), application of 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5) and treatment receiving 100 per cent RDF (60:30:30 NPK kg ha^{-1})(T_2).The lowest P uptake by (5.14 kg ha^{-1}) stalk was observed in treatment T_1 *i.e.* control.

The significantly higher total P uptake (16.71 kg ha^{-1}) by cotton was observed with the application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and it was found to be on par with application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and treatment T_2 *i.e.* 100 per cent RDF (60:30:30 NPK kg ha^{-1}). The total P uptake enhancement due to application of K in the proportion of 50:50 through inorganic and organic was 18.8 and 21.4 per cent more over 100 per cent K from inorganic and organic sources, respectively. Significantly higher amount of P uptake by plant might be due to application of potash through gliricidia green leaf manuring which increases the availability of phosphorus in the soil. This includes production of organic acids through decomposition of organic matter and a consequent release of phosphate ions, production of hydrous oxides which reduces soil P fixation. The lowest P uptake by cotton was observed in treatment T_1 *i.e.* control (7.47 kg ha^{-1}).

Potassium uptake

The data (Table 4) in respect of K uptake by cotton seed, stalk and total K uptake by cotton were significantly influenced by various treatments and presented in Table 4. The data indicated that the significantly higher K uptake (9.36 kg ha^{-1}) by cotton seed was observed with the application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4) and it was found to be on par with application of 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3), application of 75 per cent N +100 per cent P+15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_6) and treatment receiving 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5). The lowest K uptake (4.66 kg ha^{-1}) by cotton seed was observed in treatment T_1 *i.e.* control.

Table 2: Effect of gliricidia green leaf manuring on nitrogen uptake by cotton

Treatments		Nitrogen uptake (kg ha^{-1})		
		Seed	Stalk	Total
T_1	Control	15.28	12.60	27.88
T_2	100 % RDF (60:30:30 NPK kg ha^{-1})	27.32	20.89	48.21
T_3	100 % NP + 15 kg K (inorganic) +15 kg K through gliricidia	35.65	28.19	63.84
T_4	100 % NP + 10 kg K (inorganic) +20 kg K through gliricidia	36.36	29.46	65.82
T_5	100 % NP + 30 kg K through gliricidia	29.98	27.12	57.10
T_6	75 % N +100% P+15 kg K (inorganic) +15 kg K through gliricidia	30.96	22.70	53.66
T_7	75 % N +100% P+30 kg K through gliricidia	28.93	18.90	47.82
T_8	50 % N +100% P+30 kg K through gliricidia	24.69	16.48	41.16
T_9	100 % K through gliricidia.	19.17	14.02	33.19
	SE (m) $\pm$	2.09	1.70	2.85
	CD at 5%	6.26	5.11	8.55

Table 3: Effect of gliricidia green leaf manuring on phosphorus uptake by cotton

	Treatments	Phosphorus uptake (kg ha^{-1})		
		Seed	Stalk	Total
T_1	Control	2.34	5.14	7.47
T_2	100 % RDF (60:30:30 NPK kg ha^{-1})	4.41	9.65	14.06
T_3	100 % NP + 15 kg K (inorganic) +15 kg K through gliricidia	5.05	11.66	16.71
T_4	100 % NP + 10 kg K (inorganic) +20 kg K through gliricidia	4.88	10.37	15.24
T_5	100 % NP + 30 kg K through gliricidia	3.97	9.79	13.77
T_6	75 % N +100% P+15 kg K (inorganic) +15 kg K through gliricidia	4.04	8.97	13.02
T_7	75 % N +100% P+30 kg K through gliricidia	3.83	7.60	11.43
T_8	50 % N +100% P+30 kg K through gliricidia	3.22	6.99	10.21
T_9	100 % K through gliricidia	2.49	5.78	8.27
	SE (m) $\pm$	0.25	0.81	0.91
	CD at 5%	0.76	2.44	2.72

The significantly higher K uptake (35.68 kg ha^{-1}) by cotton stalk was observed with the application 100 per cent NP + 15 kg K (inorganic) +15 kg K ha^{-1} through gliricidia (T_3) and it was found to be on par with application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia (T_4), application of 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5) and treatment receiving 100 per cent RDF (60:30:30 NPK kg ha^{-1}) (T_2). The lowest K uptake (16.26 kg ha^{-1}) by cotton stalk was observed in treatment T_1 *i.e.* control.

The significantly higher total K uptake (44.92 kg ha^{-1}) by cotton was observed in treatment T_3 and it was found to be on par with the treatment T_4 *i.e.* 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia and treatment with application of 100 per cent NP + 30 kg K ha^{-1} through gliricidia (T_5). The increase in total K uptake due to this treatment was 19 and 11 per cent over 100 per cent K (inorganic) and 100 per cent K from organic, respectively. The lowest total K uptake (20.92 kg ha^{-1}) by cotton was observed in treatment T_1 *i.e.* control.

Increased K uptake with the application of gliricidia green leaf manuring might be due to the fact that leaves of gliricidia contains larger amount of potassium and on decomposition, release of organic acids that solubilize native K and which may get available to the plant. Similar results were also recorded by Mahavishnan *et al.*(2005), Garrido *et al.* (2009), Rao and Janawade (2009) and Thimmareddy *et al*. (2013).

CONCLUSION

The results indicated that the use of gliricidia green leaf manuring at 30 DAS in conjunction with chemical fertilizers recorded higher cotton yield and nutrient uptake. Hence, it is concluded that integrated application of 100 per cent NP + 10 kg K (inorganic) +20 kg K ha^{-1} through gliricidia green leaf manuring at 30 DAS resulted in improvement in nutrient uptake and yield of cotton grown in Vertisols under rainfed conditions.

LITERATURE CITED

Babar, Shilpa and J.H. Dongale, 2013. Effect of Organic and Inorganic Fertilizers on Soil Fertility and Crop Productivity under Mustard-Cowpea-Rice Cropping Sequence on Lateritic Soil of Konkan, J. Indian Soc. Soil Sci., 61 (1): 7-14.

Dass, Anchal, S. Sudhishri and N. K. Lenka, 2013. Integrated Nutrient Management to Improve Finger Millet Productivity and Soil Conditions in Hilly Region of Eastern India, J. Crop Improve., 27(5): 528-546.

Doli A. N., D. T. Pathrika and P.H. Gourkhede, 2015. Effect of fertility levels and green manuring on Bt cotton, Int. J. Trop. Agric., 33(2):1805-1808.

Garrido M da S, R.S.C. Menezes, E.V. S. B. Sampaio, T.R.R.Marques, 2009. Growth and uptake of nutrients by cotton and castor bean fertilized with gliricidia and manure, Revista Brasileira de Engenharia Agricola eAmbiental,13(5):531 536.

Table 4: Effect of gliricidia green leaf manuring on potassium uptake by cotton

Treatments		Potassium uptake(kg ha^{-1})		
		Seed	Stalk	Total
T_1	Control	4.66	16.26	20.92
T_2	100 % RDF (60:30:30 NPK kg ha^{-1})	7.55	30.07	37.62
T_3	100 % NP + 15 kg K (inorganic) +15 kg K through gliricidia	9.24	35.68	44.92
T_4	100 % NP + 10 kg K (inorganic) +20 kg K through gliricidia	9.36	34.15	43.52
T_5	100 % NP + 30 kg K through gliricidia	8.01	32.30	40.32
T_6	75 % N +100% P+15 kg K (inorganic) +15 kg K through gliricidia	8.11	29.28	37.39
T_7	75 % N +100% P+30 kg K through gliricidia	7.69	25.74	33.43
T_8	50 % N +100% P+30 kg K through gliricidia	6.52	22.09	28.62
T_9	100 % K through gliricidia	5.26	19.60	5.26
	SE (m) $\pm$	0.53	2.00	2.16
	CD at 5%	1.58	6.01	6.47

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

Jayasundara H.P.S., M.D. Dennett and U.R. Sangakkara,1997. Biological nitrogen fixation in *Gliricidia sepium* and *Leucaena leucocephala* and transfer of fixed nitrogen to anassociated grass, Trop. grasslands, 3: 529-537.

Sharma , K. L., J. Kusuma Grace, K. Srinivas , B. Venkateswarlu , G. R. Korwar , G. Maruthi Sankar , Uttam Kumar Mandal , V. Ramesh , V. Hima Bindu , M. Madhavi and Pravin N. Gajbhiye, 2009. Influence of Tillage and Nutrient Sources on Yield Sustainability and Soil Quality under Sorghum–Mung Bean System in Rainfed Semi arid Tropics, Commun, in Soil Sci. & Pl. Anal. , 40:15-16, 2579-2602

Kang, B.T. and K. Mulongoy, 1987. *Gliricidia sepium* as a source of green manure in an alley cropping system, A special Publication 8701,: 4449.

Mahavishanan, K., Mangal Prasad and K. Bhanu Rekha, 2005. Integrated nutrient management in cotton-sunflower cropping system in the sandy loam soil of North Indian, J. Tropical Agric. 43 (1-2): 29-32.

Patil, B.P.,1989. Cut down fertilizer nitrogen need of rice by Gliricidia green manure, Indian Farming,39:34-35.

Piper, C.S., 1966. Soil and Plant Analysis, Asian Reprint, Hans Publication, Asian Ed. : 68- 374.

Rao Satyanarayana and A. D. Janawade, 2009. Nutrients uptake and fiber quality parameters as influenced by integrated nutrient management practices in irrigated hybrid cotton, J. Cotton Res. Dev., 23(2):237 239.

Raskar, B.S., 2004. Effect of irrigation methods, fertilizer level and green manuring on yields and nutrient balance in summer cotton, J. Cotton Res. Dev. 18(2):180-183.

Roy, De., G.K. Sarkar, I. Das, R. Karmakar and T. Saha, 2017. Integrated Use of Inorganic, Biological and Organic Manures on Rice Productivity, Nitrogen Uptake and Soil Health in Gangetic Alluvial Soils of West Bengal, J. Indian Soc. Soil Sci., 65(1): 72-79.

Sharma, K. L., Ch. Srinivasa Rao, D. Suma Chandrika, Munna Lal, K. Srinivas, K. Sammi Reddy and A. K. Indoria, 2016. Effect of 13 Years Long Minimum Tillage Cum Conjunctive Nutrient Management Practices on Soil Fertility and Nitrogen Chemical Fractions under Sorghum (*Sorghum bicolour* (L.) Moench) – Mungbean (*Vigna radiata* (L.)Wilczek) System in Semi-Arid Tropical Alfisol (SAT) in Southern India, Commun, in Soil Sci. & Pl. Anal. 47:18 : 2059-2068.

Thimmareddy, K., .B. K. Desai and S. N. Vinoda Kumar, 2013.Uptake of NPK, availability of NPK and quality parameters of Bt cotton (*Gossypium hirsutum* L.) as influenced by different biofertilizers and *in situ* green manuring under irrigation, Int. J. of Agri. Environ. & Biotechn. 6(4):623-628.

Received on : 15.7.2020

* * *

Impact of Land Configuration and Nutrient Management on Soil Biological Properties and Productivity of Rainfed Cotton in Vertisols

V.V. Gabhane[1], A.R. Kute[2], R.S. Patode[3], M.M. Ganvir[4], B.A. Sonune[5] and P.R. Damre[6]

ABSTRACT

A field experiment to assess the impact of land configuration and nutrient management on soil biological properties and productivity of rainfed cotton in Vertisols was conducted during 2013 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment comprised of two factors involving land configuration and nutrient management. Land configuration comprised of flat bed, ridges and furrows, opening of furrow after two rows and opening of furrow after each row while nutrient management comprised of five treatments involving RDF (50:25:25 kg NPK ha^{-1}) through chemical fertilizers, FYM @ 10 t ha^{-1} + PSB + Azotobacter, 50 per cent RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter, Vermicompost @ 2.5 t ha^{-1} + PSB + Azotobacter and Glyricidia @ 10 t ha^{-1} + PSB + Azotobacter. Twenty treatment combinations were executed in split plot design with three replications. The results indicated that application of 50 per cent RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter along with opening of furrow after each row resulted in improvement in soil biological properties viz., SMBC, Alkaline phosphatase, DHA and CO2evolution with higher seed cotton and stalk yield in Vertisols.

Cotton (*Gossypium* spp.) is one of the most important commercial crops of India. It belongs to malvaceae family. Cotton commonly called as “white gold”, play a vital role in rural, national and international economy. It generates employment opportunity to millions not only at production stage but also in processing, marketing and trade. In India cotton is largely cultivated in Maharashtra, Panjab, Haryana, Rajasthan, Gujrat, Andhra Pradesh, Madhya Pradesh, Karnataka and Tamilnadu. In Vidarbha region of Maharashtra, cotton is grown predominantly as a rainfed crop. As such in Vidarbha region about 89 per cent cultivable land is under rainfed farming.

The burgeoning population, shrinking good quality land resources for crop production and increasing concern for declining soil quality and environmental degradation highlight the urgency for continuously enhancing and sustaining productivity of land. The exhaustive cropping system have hasten the excessive mining of native fertility and leaving hardly any crop residue which is necessary to maintain organic matter content at an optimum level (Ghosh *et al.*, 2004).

Land configuration plays important role in conservation of maximum rainwater in the soil. It is the mechanical measure for better in-situ moisture conservation as the soil profile acts as reservoir for moisture storage and this facility needs to be exploited to the maximum extent.Nutrient requirement of the crop is decided by the rooting behavior and foraging ability of the crops and varieties, the native soil fertility and soil productivity.

Cotton is mostly grown on black cotton soil; swelling and shrinkage processes occur in all soils but Vertisols and associated their integrades show a greater expression on these phenomena. Farm yard manure improves physical, chemical and biological environment, thereby increasing the crop yield.Vermicompost has also been considered as bio-fertilizer, because of its richness in humus forming and nitrogen fixing micro-organism. Green manuring is an age-old concept of soil fertility management and are known to fix atmospheric nitrogen, improve soil structure and recycle nutrients on decomposition of organic manure resulting in liberation of CO_2 which influence on weathering of minerals and ultimate release of plant nutrients. Therefore, for sustaining crop productivity and soil fertility, measures like farmyard manure, vermicompost and green manuring may be useful with minimizing expenses on chemical fertilizers along with suitable land configuration.

1 & 3. Associate Professor, AICRP for Dryland Agriculture 2.P. G. student, 4 & 5. Assistant Professor and 6. SRA, Dr. Panjabrao Deshmukh Krishi Vidyapeeth,Akola-444 104(M.S.)

Therefore, the present study was carried out to assess the effect of land configuration and nutrient management on soil biological properties and productivity of rainfed cotton in Vertisols.

MATERIAL AND METHODS

. The present study was undertaken during 2013 in Vertisols with the cotton crop on the research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was conducted in split plot design and three replications with Main plot: Land configuration treatments *viz.*, L_1: Flat bed, L_2: Ridges and Furrows, L_3: Opening of furrow after every two rows (30-40 DAS) and L_4: Opening of furrow after each row. (30-40 DAS) and Sub plot: Nutrient Management treatments viz., M_1: RDF (50:25:25 NPK kg ha^{-1}) through chemical fertilizer, M_2: FYM @ 10 t ha^{-1} + PSB + Azotobacter, M_3: 50 per cent RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter, M_4: Vermicompost @ 2.5 t ha^{-1} + PSB + Azotobacter, M_5: Glyricidia @ 10 t ha^{-1} + PSB + Azotobacter.

In order to assess the biological properties, soil samples were collected during peak growth stage of cotton. Microbial biomass carbon was determined by chloroform fumigation extraction method as described by Jenkinson and Powlson (1976) and Soil dehydrogenase assay was estimated by incubation with triphenyl tetrazolium chloride (TTC) and calcium carbonate method (Casida *et al.* 1964). The CO_2 evolution was estimated by alkali trap method by adopting methods of Anderson (1982). The seed cotton and stalk yield of cotton was also recorded.

RESULTS AND DISCUSSION

Impact of land configuration and nutrient management on soil biological properties

Soil Microbial Biomass Carbon (SMBC)

Soil microbial biomass carbon represent an important nutrient reservoir in soil, also it act as transformation agent of organic matter in soil. It is a centre of majority of biological activity in soil. The effect of various treatments of land configuration was found to be non significant in respect of soil microbial biomass carbon (Table 1) . The numerically higher value (173.73 mg kg^{-1} soil) was recorded in the treatment opening of furrow after each row followed by (172.85 mg kg^{-1} soil) in ridges and furrow. The lowest value (163.10 mg kg^{-1} soil) was recorded in opening of furrow after every two rows.

The results revealed significant variation in soil microbial biomass carbon as influenced by different nutrient management treatments (Table 1). The application of 50 per cent RDF + FYM@5 t ha^{-1} + PSB + Azotobacter recorded highest soil microbial biomass carbon (189.28 mg kg^{-1} soil) followed by FYM @ 10 t ha^{-1} + PSB + Azotobacter (171.38 mg kg^{-1} soil), however these treatments were found at par with each other. These results clearly indicate that the substitution of recommended fertilizer dose by 50 per cent using FYM @ 5 t ha^{-1} along with biofertilizers resulted in sustaining the soil biological health compared with higher dose of FYM @ 10 t ha^{-1}. This might be due to the supply of additional mineralizable and readily hydrolyzable carbon due to organic manure application which resulted in higher microbial activity and in turn higher MBC content (Mali *et al.,* 2014). Similar significant increase in SMBC with the 50 per cent substitution of chemical fertilizers by FYM was also observed by Sharma and Subehia (2014).

The lowest value of soil microbial biomass carbon (151.31 mg kg^{-1}) was recorded in (RDF 50:25:25 kg NPK ha^{-1}) through chemical fertilizer. These findings are in conformity with earlier findings of Jenkinson and Powlson (1976) and Surekha and Rao (2009).

The interaction of land configuration and nutrient management on soil microbial biomass carbon was found to be non significant during the experimentation.

Dehydrogenase activity (DHA)

The dehydrogenase activity is commonly used as an indicator of biological activity in soils as this enzyme is known to oxidize soil organic matter. Monitoring of dehydrogenases, which are respiratory enzyme and integral part of soil organism, express a measure of biological activity of soil at a given time.

The dehydrogenase activity under various treatments of land configuration was found to be non-significant (Table 1). The higher value (45.62 μg TPF g^{-1} soil 24 hr^{-1}) was recorded in opening of furrow after each

Table 1: Impact of land configuration and nutrient management on soil microbial biomass carbon and Dehydrogenase activity

Treatments		SMBC(mg kg^{-1})	DHA(µg TPF g^{-1} l 24 h^{-1})
A]	**Land configuration**		
L_1	Flat bed	168.30	42.97
L_2	Ridges and Furrows	172.85	44.60
L_3	Opening of furrow after every two rows	163.10	43.84
L_4	Opening of furrow after each row	173.73	45.62
	S.E (m) ±	3.59	1.15
	C.D at 5%	-	-
B]	**Nutrient Management**		
M_1	RDF 50:25:25 kg NPK ha^{-1} through chemical fertilizer	151.31	39.51
M_2	FYM @ 10 t ha^{-1} + PSB + Azotobacter	171.38	44.70
M_3	50% RDF + FYM@5 t ha^{-1} + PSB + Azotobacter	189.28	50.77
M_4	Vermicompost @ 2.5 t ha^{-1} +PSB + Azotobacter	167.41	43.07
M_5	Glyricidia @10 t ha^{-1} + PSB + Azotobacter	168.11	43.24
	S.E (m) ±	6.22	2.17
	C.D at 5%	17.96	6.27
C]	**Interaction**		
	S.E (m) ±	12.44	4.35
	C.D at 5%	-	-

row followed by 44.60 µg TPF g^{-1} soil 24 hr^{-1} in ridges and furrow. The lowest value (42.97 µg TPF g^{-1} soil 24 hr^{-1}) was recorded in the treatment of flat bed.

The effect of different nutrient management treatments on dehydrogenase activity was significant (Table 1). The application of 50 per cent RDF + FYM@5 t ha^{-1} + PSB + Azotobacter recorded significantly highest dehydrogenase activity (50.77 µg TPF g^{-1} soil 24 hr^{-1}) followed by FYM @ 10 t ha^{-1} + PSB + Azotobacter (44.70 µg TPF g^{-1} soil 24 hr^{-1}), which were found to be at par with each other. The increase in DHA was to the extent of 28.5 per cent under INM (M3) over 100 per cent NPK (M1). Higher dehydrogenase activity in integrated use of nutrient through fertilizers, FYM , Azotobacter and PSB might be due to increased availability of substrate for dehydrogenase activity under this treatment (Sharma and Subehia, 2014).

The lowest value of dehydrogenase activity was recorded in RDF (50:25:25 kg NPK ha^{-1}) through chemical fertilizer (39.51 µg TPF g^{-1} soil 24 hr^{-1}). The results are in close conformity with the findings by Manna *et al*. (1996) and Mandal *et al*. (2007). The interaction effect of land configuration and nutrient management on dehydrogenase activity of soil was found to be non significant during the experimentation.

CO_2 evolution

Soil respiration is an evolution of soil biological activity and extent of organic matter decomposition. The data presented on soil respiration (CO_2 evolution) as influenced by different land configuration and nutrient management treatments in Vertisols under rainfed cotton are presented in Table 2.

The data on CO_2 evolution under various treatments of land configuration was found to be non significant. The numerically higher value (27.02 mg 100 g^{-1} soil 24 hr^{-1}) was recorded in opening of furrow after each row. The lower respiration rate of soil (26.13 mg 100 g^{-1} soil 24 hr^{-1}) was recorded in opening of furrow after every two rows.

The results further revealed that, CO_2 evolution as influenced by different nutrient management treatments was found to be significant. The application of 50 per cent RDF+FYM@5 t ha^{-1} + PSB + Azotobacter recorded highest CO_2 evolution value (31.21 mg 100 g^{-1} soil 24 hr^{-1}) followed by FYM @ 10 t ha^{-1} + PSB + Azotobacter (27.68 mg 100 g^{-1} soil 24 hr^{-1}) which were found at par with each other. The increase in soil respiration was to the extent of 35 per cent under INM (M_3) over 100 per cent NPK (M1). Significantly superior CO_2 evolution was observed with the substitution of 50 per cent N through FYM in a long term fertilization experiment on sorghum -wheat cropping sequence in a semi-arid climatic conditions (Mali *et al.*, 2014), this is clear indication of the nutrient turnover at higher carbon expenses met through added organic carbon and the increased metabolically active microbial biomass could have resulted in increased soil respiration rate.

The CO_2 evolution rate with application of FYM was high, as compared to different nutrient management treatments. These may be attributed to the fact that the FYM is a humified organic material. FYM preserve carbon as soil organic matter. Surekha and Rao (2009) also reported that organic sources improved soil respiration over fertilizers alone in rice-rice system on a Vertisol (Typic Pellustert). The lowest value of CO_2 evolution was recorded in RDF (50:25:25 kg NPK ha^{-1}) through chemical fertilizer (23.10 mg 100 g^{-1} soil 24 hr^{-1}).

The interaction effect of land configuration and nutrient management on CO_2 evolution of soil was found to be non significant during the experimentation.

Alkaline phosphatase

The general name phosphatase has been used to describe a broad group of enzymes that catalyze the hydrolysis of both esters and unhydrides of H_3PO_4 involving five major groups. The enzymes are classified as acid and alkaline phosphomonoesterases because they show optimum activity in acid and alkaline ranges. Alkaline phosphomonoesterases activity is derived from microorganism only. The data with respect to alkaline

Table 2: Impact of land configuration and nutrient management on CO_2 evolution and Alkaline Phosphatase

Treatments		CO_2 evolution (mg 100 g^{-1} soil 24 hr^{-1})	Alkaline Phosphatase (µg PNP g^{-1} 24 h^{-1})
A]	**Land configuration**		
L_1	Flat bed	26.87	243.99
L_2	Ridges and Furrows	26.89	246.36
L_3	Opening of furrow after every two rows	26.13	244.16
L_4	Opening of furrow after each row	27.02	253.37
	S.E (m) ±	1.20	3.92
	C.D at 5%	NS	NS
B]	**Nutrient Management**		
M_1	RDF 50:25:25 kg NPK ha^{-1} through chemical fertilizer	23.10	227.19
M_2	FYM @ 10 t ha^{-1} + PSB + Azotobacter	27.68	247.02
M_3	50% RDF + FYM@5 t ha^{-1} + PSB + Azotobacter	31.21	269.21
M_4	Vermicompost @ 2.5 t ha^{-1} +PSB + Azotobacter	25.61	244.28
M_5	Glyricidia @10 t ha^{-1} + PSB + Azotobacter	26.03	247.17
	S.E (m) ±	1.51	8.00
	C.D at 5%	4.35	23.11
C]	**Interaction**		
	S.E (m) ±	3.02	16.01
	C.D at 5%	-	-

phosphatase as influenced by various treatments are presented in Table 2.

The alkaline phosphatase activity of soil was not significantly differed due to land configuration. However, numerically higher value (253.37 µg *p*-nitrophenol g^{-1} 24 hr^{-1}) was recorded in opening of furrow after each row while the lowest value of alkaline phosphatase (243.99 µg *p*-nitrophenol g^{-1} 24 hr^{-1}) was recorded in flat bed.

The data further revealed that, alkaline phosphatase as influenced by different nutrient management treatments was found to be significant. The application of 50 per cent RDF + FYM@5 t ha^{-1} + PSB + Azotobacter recorded highest alkaline phosphatase value (269.21 µg *p*-nitrophenol g^{-1} 24 hr^{-1}) followed by FYM @ 10 t ha^{-1} + PSB + Azotobacter (247.02 µg *p*-nitrophenol g^{-1} 24 hr^{-1}), which were found to be at par with each other. The lowest value of alkaline phosphatase was recorded in RDF (50:25:25 kg NPK ha^{-1}) through chemical fertilizer (227.19 µg *p*-nitrophenol g^{-1} 24 hr^{-1}). The application of different nutrient management treatments showed a significant impact on alkaline phosphatase of soil.

The significantly higher activities of phosphatases in the integrated use of chemical fertilizers and FYM along with biofertilizers might be attributed to enhanced microbial activity due to manure input and perhaps the diversity of P solubilizing bacteria due to manuring over the years (Mandal *et al.,* 2007; Saha *et al.,* 2008) besides application of PSB.

The significantly higher activities of alkaline phosphatase in organically treated soils may be due to the enhanced microbial activity and diversity of PSB due to manure input over the year. These findings are in confirmation with Mandal *et al*. (2007) and Kumari *et al.* (2017). The interaction effect of land configuration and nutrient management on alkaline phosphatase of soil was found to be non significant during the experimentation.

Seed cotton yield

The data in respect of seed cotton yield as influenced by land configuration was found to be significant. The significantly higher seed cotton yield (11.49 q ha^{-1}) was recorded in land treatment opening of furrow after each row followed by ridges and furrows (11.40 q ha^{-1}) which were found to be at par with each other. The lowest seed cotton yield (9.05 q ha^{-1}) was recorded in land configuration treatment flat bed. The opening of furrow after each row recorded 26.9 per cent increase in seed cotton yield compared to flat bed system (Rewatkar *et al*., 2001).

The effect of nutrient management on seed cotton yield was found to be significant. The significantly higher seed cotton yield (12.03 q ha^{-1}) was recorded with the application of 50: 25: 25 kg NPK ha^{-1} through chemical fertilizer (RDF) followed by 50 per cent RDF + FYM @ 5 ha^{-1} + PSB + Azotobacter (11.28 q ha^{-1}) which were found to be at par with each other. The lowest seed cotton yield (9.34 q ha^{-1}) was recorded with application of vermicompost @ 2.5 t ha^{-1} + PSB + Azotobacter. Higher productivity of seed cotton in INM treatments could be attributed to efficient utilization of nutrients from combined sources compared to a single source. Moreover, organics like FYM supplies some micronutrients besides major nutrients and Azotobacter and PSB secretes some beneficial growth promoting substances which might have helped in higher boll retention and improved boll weight (Das *et al.,* 2006). After 8 years, equivalent seed cotton yield was noted in treatment receiving substitution of 50 per cent N through FYM with that of 100 per cent RDF through chemical fertilizers in rainfed Vertisols (Venugopalan and Pundarikakshudu, 1999). These results clearly indicate that substitution of 50 per cent N through FYM could be a viable option with reducing chemical fertilizer. Similar significantly highest seed cotton yield with 100 per cent chemical fertilizers was statistically on par with 50 per cent substitution of RDF with FYM in a Vertisols (Pawar *et al.,* 2013).

Interaction effect of land configuration and nutrient management on seed cotton yield was found to be non significant.

Cotton stalk yield

The effect of land configuration on cotton stalk yield was found to be significant. The significantly higher cotton stalk yield (25.62 q ha^{-1}) was noticed in land treatment opening of furrow after each row followed by

Table 3: Impact of land configuration and nutrient management on yield of cotton

Treatment		Cotton Yield (q ha^{-1})	
A]	**Land configuration**	**Seed cotton**	**Cotton stalk**
L_1	Flat bed	9.05	18.52
L_2	Ridges and Furrows	11.40	23.01
L_3	Opening of furrow after every two rows	9.38	23.44
L_4	Opening of furrow after each row	11.49	25.62
	SE (m) ±	0.22	1.03
	CD at 5%	0.76	3.58
B]	**Nutrient Management**		
M_1	RDF 50:25:25 kg NPK ha^{-1} through chemical fertilizer	12.03	25.97
M_2	FYM @ 10 t ha^{-1} + PSB + Azotobacter	9.51	20.82
M_3	50% RDF + FYM@5 t ha^{-1} + PSB + Azotobacter	11.28	24.80
M_4	Vermicompost @ 2.5 t ha^{-1} +PSB + Azotobacter	9.34	20.70
M_5	Glyricidia @10 t ha^{-1} + PSB + Azotobacter	9.50	20.94
	SE (m) ±	0.41	1.45
	CD at 5%	1.19	4.19
C]	**Interaction**		
	SE (m) ±	0.83	2.90
	CD at 5%	-	-

land treatment opening of furrow after every two rows (23.44 q ha^{-1}) and land treatment ridges and furrows (23.01 q ha^{-1}) which were found to be on par with each other. The lowest stalk yield (18.52 q ha^{-1}) was recorded in land treatment flat bed.

The effect of nutrient management on cotton stalk yield was found to be significant. The significantly higher cotton stalk yield (25.97 q ha^{-1}) was recorded with the application of (50: 25: 25 kg NPK ha^{-1}) through chemical fertilizer (RDF) followed by 50 per cent RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter (24.80 q ha^{-1}) which were found to be on par with each other. The lowest cotton stalk yield (20.70 q ha^{-1}) was recorded with the application of vermicompost @ 2.5 t ha^{-1} + PSB + Azotobacter. Similar findings were also reported by Padole *et al.* (1998) and Badole and More (2000). Interaction effect of land configuration and nutrient module on cotton stalk yield was found to be non significant.

CONCLUSION

The results indicated that application of 50 per cent RDF + FYM @ 5 t ha^{-1} + PSB + Azotobacter along with opening of furrow after each row resulted in improvement of soil biological properties *viz.,* SMBC, Alkaline phosphatase, DHA and CO_2 evolution with higher yield of rainfed cotton in Vertisols.

LITERATURE CITED

Anderson J. P. E. 1982. Soil respiration. In Page A L, Miller R H Keeney D R (Eds). *Methods of Soil Analysis*, Part 2. *Chemical and Microbiological Properties*, pp 831–71, Agronomy Monograph No. 9, ASA-SSSA Publisher, Madison, Wisconsin, USA.

Badole S.B. and S.D. More, 2000. Yield and nutrient uptake as influenced by integrated nutrient supply system in cotton, J. Indian Soc. Cotton improvement.161-165.

Casida L. E., D. A. Klein. and T. Santoro T. 1964. Soil dehydrogenase activity, *Soil Sci.* 98 (6) : 371–6.

Das, Anup, M. Prasad, R. C. Gautam and Y. S. Shivay, 2006. Productivity of cotton (*Gossypium hirsutum*) as influenced by organic and inorganic sources of nitrogen, Indian J. Agric. Sci. 76 (6): 354-7.

Ghosh P.K., K.K. Bandopadyaya, A.K. Mishra and A. Subba Rao, 2004. Balanced fertilization for maintaining soil health and sustainable agriculture, J. Fert. News.49 (4): 13-24.

Jenkinson D.S. and D. S. Powlson, 1976. The effect of Biocides treatments on metabolism in soil, soil Biol. Biochem, 8 : 209-213.

Kumari, S., N. Chattopadhyaya, J. Mandal and M. Singh, 2017. Integrated nutrient management boost the soil biological properties in rice rhizosphere, J. Crop and Weed, 13(1) : 116-124.

Mali, D.V., V. K. Kharche, S. D. Jadhao, S.M. Jadhao, P.A. Gite and A.B. Age, 2014.Soil Biological Health under Long-term Fertilization in Sorghum- Wheat Sequence on Swell-Shrink Soils of Central India, J. Indian Soc. Soil Sci. 63(4): 423-428.

Mandal, A., A.K. Patra, Dhyan Singh, Anand Swarup and R. Ebhin Masto, 2007. Effect of long-term application of manure and fertilizer on biological and biochemical activities in soil during crop development stages. Bioresour, Technol. 98, 3585–3592.

Manna M.C., S. Kundu, M. Singh and P.N.Takkar,1996. Influence of FYM on dynamics of microbial biomass and its turnover and activity of enzymes under soybean-wheat system on Typic Haplustert, J. Indian Soc. Soil Sci.,44: 409-412.

Padole V.R., P.W. Deshmukh, R.J. Nikesar and N.V.Bansode,1998. Effect of organics and inorganics on yield and quality of cotton grown on Vertisol, PKV Res. J. 22(1): 6-8.

Pawar, Y.D., B.A. Sonune, V.V. Gabhane and S.S. Rewatkar, 2013. Effect of Tillage and Integrated Plant Nutrient Supply Strategies for Enhancing Seed Cotton Yield and Soil Quality Indicators of Vertisol in Semi Arid Region of Maharashtra, Madras Agric. J., 100 (4-6): 350-356.

Rewatkar S.S., B.N. Sagare and V.P. Babhulkar, 2001. Effect of land configuration and gypsum levels on dynamics of soil properties and productivity of cotton grown in sodic vertisols, J. Indian Soc. Soil Sci., 49(2): 377-379.

Saha, S., V. Prakash, S. Kundu, N. Kumar,and B. L. Mina, 2008. Soil enzymatic activity as affected by long term application of farm yard manure and mineral fertilizer under a rainfed soybean–wheat system in N-W Himalaya, Eur. J. Soil Biol. 44, 309–315.

Sharma, Upinder and S. K. Subehia, 2014. Integrated Nutrient Management on Rice (Oryza sativa L.) - Wheat (Triticum aestivum L.) Productivity and Soil Properties in North-Western Himalaya, J. Indian Soc. Soil Sci. 62 (3): 248-254.

Surekha K.M. and K.V. Rao, 2009. Direct and residual effects of organic sources on rice productivity and soil quality of Vertisol, J. Indian Soc. Soil. Sci., 57 (1): 53-57.

Venugopalan, M.V. and R. Pundarikakshudu, 1999. Long-term effect of nutrient management and cropping system on cotton yield and soil fertility in rainfed Vertisols, Nutrient Cycling in Agroecosystems 55: 159–164, 1999.

Received on : 15.2.2020

* * *

Effect of Different Levels of Gypsum and Phosphogypsum on Yield and Quality of Groundnut Grown on Inceptisol

S. S. Ransing[1], P. R. Kadu[2], R. N. Katkar[3] and V. K. Kharche[4]

ABSTRACT

The present investigation was conducted during 2017-18 and 2018-19 on Inceptisol with a view to study the "Effect of different levels of gypsum and phosphogypsum on yield and quality of groundnut grown on Inceptisol" at Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The experiment was laid out in randomized block design with three replications and nine treatments. There were nine treatments including absolute control, RDF (DAP, urea, MOP) sulphur free, RDF through urea, SSP, MOP, RDF (S free) with soil application of gypsum @ 200, 300 and 400 kg ha^{-1} and RDF (S free) with soil application of phosphogypsum @ 200, 300 and 400 kg ha^{-1}. The experimental results indicated that the application of phosphogypsum @ 400 kg ha^{-1} along with RDF (S free) recorded significantly higher yield and quality parameters of groundnut variety TAG-24 during the year 2017-18, 2018-19 and pooled mean.

In India, groundnut is known as poor mans almond. Among the oil seed crops, groundnut (*Arachis hypogaea* L.) is an important crop both for oil and food. Groundnut is called as the "King of oilseeds. It is one of the most important food and cash crops of our country. The low groundnut productivity of Indian soils could be attributed to several production constraints, which include poor and imbalanced nutrition of crop and growing crop on marginal lands. Therefore, it is most essential to pay greater attention to the nutrition of the groundnut to enhance its productivity. Sulphur and calcium are recognized as fourth and fifth major essential plant nutrients, respectively for growth and development of plants. Calcium and sulphur must be available in adequate amounts in pod formation zone. Among the secondary nutrients, calcium deficiency causes groundnut pegs and pods to abort, hence, reduced yield (Meena *et al.*, 2007). The sulphur deficiency appeared in some intensively cultivated areas and currently 41 per cent of the soil samples in the country (about 250 districts) are deficit in sulphur (Biswas and Sharma, 2008). S is required for the synthesis of three sulphur containing amino acids which are methionine (21 % S), cysteine (26 % S) and cystine (27 % S). Cystine is formed by the oxidation of two molecules of cysteine. Sulphur application can increase the oil production by increasing seed yield or oil contain in seeds or both. Sulphur is needed for development of cell and it also increases cold resistance and drought hardness of plant (Patel *et al.*, 1992). In view of above, a field experiment was conducted to study the "Effect of different levels of gypsum and phosphogypsum on yield and quality of groundnut grown on Inceptisol".

MATERIAL AND METHODS

The experiment was carried out during the summer 2017-18 and 2018-19 at Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with nine treatments replicated thrice in a randomized block design (RBD).

Soil of experimental site was Inceptisol, slightly alkaline in reaction, free from soluble salts particularly montmorillonitie type, hyperthermic family of Typic Haplustepts. In order to study the physical and chemical properties of soil, initial composite soil sample were taken from 0-20 cm depth from randomly selected spots over the experimental field before sowing. The physical and chemical properties of initial composite soil sample were determined in laboratory during 2017-18. The soil was clayey in texture with bulk density (1.40 Mg m^{-3}) and hydraulic conductivity (1.15 cm hr^{-1}). The soil was slightly alkaline (7.74), non-saline (0.195 dSm^{-1}), moderately calcareous (4.62 %) and moderate in organic carbon (0.565 %).The available nitrogen was low (181.26 kg ha^{-1}), medium in available phosphorus (17.30 kg ha^{-1}) and high in

1. Ph.D. Scholar, 2. Head, 3. Professor, Department of Soil Sci. and Agril. Chemistry, Dr. PDKV,Akola and 4. Director of Research, Dr. PDKV, Akola

available potassium (332.19 kg ha^{-1}) while available sulphur was (10.45 mg kg^{-1}). The experimental soil was sufficient in DTPA – Fe, Mn, Zn and Cu. The nutrient contents of gypsum and phosphogypsum were as under.

Gypsum contains Ca- 23.30 per cent, S- 18.50 per cent. Phosphogypsum contains Ca- 22.30 per cent, S- 15.42 per cent, Mn- 4.00 per cent, Zn- 2.80 per cent, Mg- 3.90 per cent, Na- 0.27 per cent, Total N- 0.51 per cent, Total P- 0.46 per cent, Available P_2O_5- 1.33 per cent, Pb- 0.10 ppm, Cd- 0.21 ppm, Cr- 0.10 ppm, Co- 0.46 ppm, Ni-0.66 ppm

The results obtained ststically analysed as per procedure described by Gormez and Gomez, 1983. The experiment was laid out in RBD with nine treatments replicated thrice. Treatments comprised of (T_1): absolute control, (T_2): RDF (DAP, urea, MOP) sulphur free, (T_3): RDF through urea, SSP, MOP, (T_4): T_2 + Soil application of Gypsum @ 200 kg ha^{-1}, (T_5): T_2 + Soil application of Gypsum @ 300 kg ha^{-1}, (T_6): T_2 + Soil application of Gypsum @ 400 kg ha^{-1} (T_7): T_2 + Soil application of Phosphogypsum @ 200 kg ha^{-1} (T_8): T_2 + Soil application of Phosphogypsum @ 300 kg ha^{-1} (T_9): T_2 + Soil application of Phosphogypsum @ 400 kg ha^{-1}. Groundnut variety TAG-24 was used for the experiment. The crop was sown at the spacing of 30 x 10 cm distance. The gross plot size was 1.8 m x 5 m and net plot size was 1.2 m x 4.8 m. Soil application of gypsum and phosphogypsum at 45 days after sowing. RDF- 25:50:30 N, P_2O_5, K_2O kg ha^{-1} basal dose at sowing except absolute control (T_1) and 5 t FYM ha^{-1} for all treatments. At maturity, the net plots were harvested and yield was recorded. Quality parameters was determined as per standard procedure.

RESULTS AND DISCUSSION

Effect of different levels of gypsum and phosphogypsum on pod and haulm yield of groundnut

In general, the pod yield varied between 1350 to 2036 kg ha^{-1} and 1568 to 2138 kg ha^{-1}, respectively during 2017-18 and 2018-19. Whereas, the haulm yield ranged between 1452 to 2471 kg ha^{-1} and 1889 to 2688 kg ha^{-1} during 2017-18 and 2018-19, respectively (Table 1). The application of phosphogypsum @ 400 kg ha^{-1} along with RDF (DAP, urea and MOP) sulphur free recorded significantly higher pod yield of groundnut during the year 2017-18 2018-19 and pooled mean (2036.00, 2138.00 and 2087.00 kg ha^{-1}, respectively). However, it was statistically on par with all the treatments except absolute control, RDF (S free) and RDF (T_3) during the year 2017-18 and it was at par with all treatments except absolute control, RDF (S free) during the year 2018-19. In case of pooled mean it was statistically on par with all the treatments except absolute control, RDF (S free), RDF and RDF (S free) along with soil application of gypsum @ 200 kg ha^{-1}. The results revealed that the soil application of gypsum and phosphogypsum @ 200, 300 kg ha^{-1} along with RDF (S free) are found equally beneficial for getting higher pod yield of groundnut. Therefore, the lower doses of gypsum and phosphogypsum are also useful for harvesting good economical yield of groundnut. The pod yield of groundnut was numerically the highest in treatment RDF (S free) with phosphogypsum @ 400 kg ha^{-1} during the year 2017-18, 2018-19 and pooled mean (2036.00, 2138 and 2087 kg ha^{-1}, respectively) and closely followed by RDF (S free) with gypsum @ 400 kg ha^{-1} (1998, 2056 and 2027 kg ha^{-1}, respectively) indicating beneficial effect of both gypsum and phosphogypsum in regulating soil properties, which ultimately resulted to harvest yield to higher level. This might be associated with both gypsum and phosphogypsum which contains sufficient amount of calcium required in groundnut for proper shell formation, calcium also improves the workability of soil by which there might be easy to penetration of pegs into soil forms the more number of pods and ultimately reflected in higher yield of groundnut. These observations are in conformity of Meena *et al.* (2007), Naresha *et al.* (2014).

The gypsum and phosphogypsum both are also act as soil amendments and improves the soil physical, chemical and biological condition ultimately helps to improves the nutrient availability by regulating in soil. The phosphogypsum is the byproduct of synthesis of single super phosphate which consists of sulphur in addition to calcium and small amount of magnesium. The sulphur and magnesium help to enhance the chlorophyll synthesis in groundnut. The enhanced chlorophyll increased photosynthesis activity in groundnut and assimilate the organic constituents in plant. These organic constituents increased the yield of groundnut. These observations are in conformity of Brigden *et al.* (2002), Naresha *et al.* (2014).

Table 1. Effect of different levels of gypsum and phosphogypsum on pod and haulm yield of groundnut

Treatment	Pod yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean
T_1 : Absolute control	1350	1568	1459	1452	1889	1670
T_2 : RDF (DAP, urea and MOP) sulphur free	1539	1830	1684	1803	2380	2091
T_3 : RDF through urea, SSP, MOP	1597	1880	1738	2110	2430	2270
T_4 : T_2 + Soil application of Gypsum @ 200 kg ha^{-1}	1790	1951	1870	2238	2501	2369
T_5 : T_2 + Soil application of Gypsum @ 300 kg ha^{-1}	1881	2020	1950	2297	2570	2433
T_6 : T_2 + Soil application of Gypsum @ 400 kg ha^{-1}	1998	2056	2027	2446	2606	2526
T_7 : T_2 + Soil application of Phosphogypsum @ 200 kg ha^{-1}	1752	1940	1846	2141	2490	2315
T_8 : T_2 + Soil application of Phosphogypsum @ 300 kg ha^{-1}	1979	2034	2006	2421	2584	2502
T_9 : T_2 + Soil application of Phosphogypsum @ 400 kg ha^{-1}	2036	2138	2087	2471	2688	2579
SE (m) ±	135	96	43	127	139	67
CD at 5 %	407	287	142	380	418	219
CV (%)	13.29	8.59	3.34	10.22	9.82	4.13

Table 2. Effect of different levels of gypsum and phosphogypsum on oil and protein content of groundnut

Treatment	Oil content (%)			Protein content (%)		
	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean
T_1 : Absolute control	49.96	49.64	49.80	27.99	27.63	27.74
T_2 : RDF (DAP, urea and MOP) sulphur free	49.93	49.98	49.96	28.69	27.94	28.18
T_3 : RDF through urea, SSP, MOP	50.25	50.29	50.27	28.69	28.06	28.26
T_4 : T_2 + Soil application of Gypsum @ 200 kg ha^{-1}	49.98	50.52	50.25	28.75	28.25	28.41
T_5 : T_2 + Soil application of Gypsum @ 300 kg ha^{-1}	50.19	50.36	50.28	28.75	29.25	29.09
T_6 : T_2 + Soil application of Gypsum @ 400 kg ha^{-1}	50.45	50.84	50.65	28.81	29.94	29.58
T_7 : T_2 + Soil application of Phosphogypsum @ 200 kg ha^{-1}	50.16	50.28	50.22	28.81	29.00	28.94
T_8 : T_2 + Soil application of Phosphogypsum @ 300 kg ha^{-1}	50.60	50.78	50.69	28.88	29.56	29.34
T_9 : T_2 + Soil application of Phosphogypsum @ 400 kg ha^{-1}	51.07	51.05	51.06	28.88	30.06	29.68
SE (m) ±	0.23	0.12	0.12	0.13	0.09	0.35
CD at 5 %	0.69	0.37	0.40	0.39	0.26	1.14

The haulm yield of groundnut as influenced by RDF (S free), RDF (urea, SSP and MOP) and levels of gypsum and phosphogypsum @ 200, 300 and 400 kg ha^{-1} showed the similar trend during the year 2017-18, 2018-19 and pooled mean as that of in pod yield of groundnut.

The pooled mean indicated that, different fertilizer treatments significantly increased the haulm yield of groundnut. The application of RDF (S free) along with phosphogypsum @ 400 kg ha^{-1} recorded significantly higher haulm yield (2579 kg ha^{-1}) followed by RDF (S free) along with gypsum @ 400 kg ha^{-1} (2526 kg ha^{-1}). However, absence of any additive (gypsum and phosphogypsum) in the fertilizer schedule resulted drastic reduction in the haulm yield of groundnut. The higher haulm yield of groundnut with combined fertilizer treatments might be due to improvement in soil physical, chemical and biological properties due to added amendments in soil. The results are in close conformity with the earlier findings of Naresha *et al.* (2014)

Effect of different levels of gypsum and phosphogypsum on oil and protein content of groundnut

The significantly higher oil content was recorded in RDF (S free) with the application of phosphogypsum @ 400 kg ha^{-1} (51.07, 51.05 %) during the year 2017-18 and 2018-19 (Table 2). However, it was statistically on par with soil application of RDF (S free) along with gypsum @ 400 kg ha^{-1} and along with phosphogypsum @ 300 kg ha^{-1} during both the years. The results are in conformity with the findings of Sahu *et al.* (2001) and Jena *et al.* (2006).

The oilseeds require more amount of sulphur for its growth and development than other crops. Sulphur requirement of oilseeds can be met through a number of sulphur containing materials such as gypsum, elemental sulphur, pyrites (Patel *et al.*, 2019). The application of sulphur @ 30-40 kg ha^{-1} to groundnut was beneficial (Kale, 1993) which ultimately improve oil recovery of groundnut. In the present study the sources of sulphur improve oil content in comparison with the RDF devoid of sulphur. Similarly, in the oilseed crops various sources viz. gypsum, phosphogypsum and SSP involved in the formation of glucosides or glucosinolates which on hydrolysis increase the oil content (Patel *et al.*, 2019).

The significantly higher value of protein content was recorded in RDF (S free) with soil application of phosphogypsum @ 300, 400 kg ha^{-1} (28.88 %) during the year 2017-18 and The significantly higher value of protein content was recorded in RDF (S free) along with application of phosphogypsum @ 400 kg ha^{-1} (30.06 %) during the year 2018-19. However, it was statistically on par with all the treatments except absolute control during the year 2017-18 (Table 2). The results are in conformity with the findings of Jena *et al.* (2006). The percent increase in protein content was noted to 3.18, 8.80 and 6.99 per cent higher with the application of RDF (S free) along with phoshogypsum @ 400 kg ha^{-1} over absolute control during 2017-18, 2018-19 and pooled mean, respectively. This emphasizes the role of sulphur as oilseed require more amount of sulphur for its growth and development than other crops. The crops require sulphur to make specific amino acids and various metabolites contain sulphur, protein synthesis and process required for efficiency from other inputs (Patel *et al.,* 2019). The role of sulphur being a constituent of sulphur containing amino acids cystine, cysteine and methionine and in the nutrition of oilseed crops has been reported by many workers (Parmar *et al*., 2018 and Gangadhara, 1990). They considered that the oilseed require more sulphur than other crops.

CONCLUSION

On the basis of two years experimentation it is concluded that the pod yield and haulm yield of groundnut also oil and protein content of groundnut was recorded significantly higher in RDF (S free) with soil application of phosphogypsum @ 400 kg ha^{-1}.

LITERATURE CITED

Biswas, P.P. and P.D. Sharma, 2008. Phosphogypsum a potential source of sulphur and calcium to crops, Indian J. Fert. 4(8):49-52.

Brigden, K., R. Stringer and D. Santillo, 2002 in Greenpeace Research Laboratory Technical Note 13/2002 Department of Biological Sciences, Univ. of Exeter, UK.

Gangadhara, G.A., H.M. Manjunathaiah and T. Satyanarayana, 1990. Effect of sulphur on yield, oil of sunflower and uptake of micronutrients by plants, J. Indian Soc. Soil Sci. 38 : 692-695.

Gomez, K. A. and A. A. Gomez, 1983. Stastical Procedure for agricultural Research Jhon Wiely and Sons, Newyork.

Jena, D., Sarani Sahoo and M.V. Singh, 2006. Effect of different sources and levels of sulphur on yield and nutrient uptake by groundnut-Rice cropping system in an inceptisol of Orrisa, J. Indian Soc. Soil Sci. 54(1) : 126-129.

Kale, M. R., 1993. Effect of sulphur on growth and yield of groundnut, Indian J. Agron., 38(3) : 504-505.

Meena S., M. Malarkodi and P. Senthilvalvan 2007. Secondary and micronutrients for groundnut – A review, Agric. Rev. 28(4) : 295-300.

Naresha, R., P. Laxminarayana, K.B. Suneetha Devi and V. Sailaja, 2014. Yield and yield attributes of rabi groundnut as influenced by moisture regimes and phosphogypsum levels, J. Res. ANGRAU. 42(2) : 58-62.

Parmar, N.N., A.P. Patel and M. Chaudhary, 2018. Effect of sources and levels of sulphur on growth, yield and quality of summer sesame under south Gujarat condition (*Sesamum indicum* L.) IJCMAS, 7(2) : 2600-2605

Patel, L.P., N. R. Patel and R. H. Patel,1992. Effect of nitrogen, phosphorus and sulphur on seed yield and quality of mustard, J. Oilseeds Res. 9(2) : 333-334.

Patel, P.K., V.A.H. Kadivala and V.N. Patel, 2019. Role of sulphur in oilseed crops : A review, J. Plant Dev. Sci. 11(3) : 109-114

Sahu, S.K., S.C. Nayak, R.K. Nayak and J.K. Dhal, 2001. Integrated management of sulphur for groundnut on lateritic soil in Orissa, India, Int. Arachis Newsletter, 21 : 49-50.

Received on : 03.06.2020

* * *

Performence of Pre-Released Kharif Grain Sorghum Genotypes to Different Fertility Levels

G. V. Thakare[1], R. B. Ghorade[2], V. U. Sonalkar[3], D. V. Lunge[4], V. V. Kalpande[5], S. D. Hiwale[6]and A. R. Gulhane[7]

ABSTRACT

Field experiment was conducted on *kharif* sorghum at Sorghum Research Unit, Dr. PDKV, Akola, Maharashtra during 2018 and 2019 under rainfed condition to find out the performance of promising *Kharif* sorghum hybrids to fertilizers interaction. The experiment was laid out in factorial randomized block design with three replications. The different test and check entries were tested with three different fertilizer levels (F_1 - 75 % RDF, F_2 - 100 % RDF and F_3 - 125 % RDF). The performance of test and check hybrids showed significant response to the different three fertilizer levels under rainfed condition. Among the different test and check genotype, significantly highest plant height (cm), grain weight per panicle (g), grain number per panicle and length of panicle (cm) were recorded with the test hybrid SPH-1846 (2018) and SPH-1886 (2019). The growth and yield contributing character were found significantly maximum with application of fertility level F_3 - 125 per cent RDF. The fertilizer application with F_2 : 100 per cent RDF recorded the second highest grain, fodder and biomass yield, which was on par with application of 125 per cent RDF (F_3). Interaction effect found significant for grain, fodder and biomass yield. Significantly highest monetary advantage and B:C ratio was found with the test genotype SPH-1846, 1886 and fertility level 125 per cent RDF.

Sorghum (*Sorghum bicolor* L.), is one of the most important cereal crops in India. It is the fourth most important cereal crop of the world. It occupies a major niche in the many semi-arid subtropical farming systems due to its low cost of production and better response to favorable conditions with high yield. In addition, it is a double purpose crop; as a fodder and grains. The low productivity of sorghum is primarily because it is often grown on marginal lands with low N, P, K by resource poor farmers. The availability of high yielding and fertilizer responsive cultivars of sorghum has injected new enthusiasm in fertilizer research. Therefore, it is important to assess the magnitude of their response to fertility levels and simultaneously find out the production potential. This encouraged us to investigate the response of promising sorghum cultivars to split application of nitrogen. Nutrient uptake of sorghum was higher at optimum N, P, K in the root zone depth which enhances the better crop yield and its components and chemical contents. Similar results were reported by Akdeniz *et al.* (2000) and Mokashi *et al.* (2008).

Low productivity of sorghum is one of the major constraints. Reasons for which are identified as lack of improved high yielding cultivars, delayed sowing, low fertilizer use and improper adoption of management techniques. The production can be increased by adopting improved package including suitable genotype, optimum plant geometry and appropriate fertilization. Hence, there is dire need to identify high yielding cultivars suitable for the region with optimum fertilizer dose. Sorghum cultivars are known to vary in their response to fertilizers. Productivity of sorghum is limited by soil fertility. Kumar *et al.*, (2010) reported that the increase in productivity of sorghum could be brought out both by genetic improvement as well as associated nutrient management intervention in a rainfed environment. The development of elite genotype is a continuous process and currently many genotypes of different maturity groups have been evolved. Hence, there is a need to explore and evaluate the interaction of sorghum cultivars and fertilizers application in rainfed sorghum.

MATERIAL AND METHODS

The field experiments were carried out at the Sorghum Research Unit Farm, Dr. PDKV, Akola, Maharashtra. The experiments were carried out during two successive *Kharif* seasons of 2018 and 2019 to study the response of sorghum cultivars SPH-1846, SPH-1849, CSH-

1, 3 & 7 Assistant Professor, 2. Senior Research Scientist, 4. P.G. Student, 5.Associate Professor and 6. Ph.D. Scholar, Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

16, CSH-25 CSH-30 (2018) and SPH-1883, SPH-1886, CSH-25 and CSH-30 (2019) to the three different fertilizer levels (F_1:75 % RDF, F_2:100 % RDF and F_3:125 % RDF) under rainfed conditions. Among the cultivars SPH-1846, SPH-1849, SPH-1883, SPH-1886 were the test hybrids and CSH-16, CSH-25 and CSH-30 were the check inbred lines. The different genotype and three different fertilizer levels were laid out in a factorial randomised block design with three replications. Soil samples collected before cultivation and analyzed for physical and chemical properties whereas, soil pH of experimental site was found to be vary from 8.27 to 8.31, available nitrogen 181 to 189 kg ha^{-1}, Available Phosphorus 20.00 to 22.30 kg ha^{-1} and available potassium 317 to 331 kg ha^{-1} in the first and second seasons respectively. Soil samples analyzed was found to be of clayey loam in texture.

Seed of sorghum cultivars were used for sowing which is obtained from Indian Institute of Millets Research, Hyderabad. General cultural practices for sorghum were applied as recommended till harvest. The recommended dose of fertilizer was applied 80:40:40 N : P: K kg ha^{-1}. Seed rate was 10 kg ha^{-1}. The seed was sown manually by labourers on 30.06.2018 and 01.07.2019 with a spacing of 45cm between rows and 15 cm between plants. The data were analysed statistically by using analysis of variance according to factorial randomised block design.

RESULTS AND DISCUSSION

Effect of cultivars on growths and yields contributing components of *Sorghum bicolor*:

During 2018-19, among the different two test and three check genotype, significantly highest plant height (cm), grain weight per panicle (g), grain No. per panicle and length of panicle (cm) were recorded with the test hybrid SPH-1846 and it was found at par with the test hybrid SPH-1849 and check hybrid CSH-25 for plant height and grain weight per panicle. However, days to 50 per cent flowering and 100 seed weight differ significantly due to the check hybrid CSH-30 and found at par with test hybrid SPH-1849. Days to 50 per cent flowering were significantly varied with test and check hybrid genotypes, among all the check CSH-30 recorded lowest days to 50 per cent flowering and in test hybrid SPH-1849 recorded minimum days to 50 per cent flowering. Whereas weight of cob (g) recorded highest with SPH-1846, but did not differ significantly with the performance of test and check genotype. Among all the genotype, test hybrid SPH-1846 recorded significantly superior values for length of panicle (Length) over all other genotype.

Table 01:- Main effect of genotype on yield components of *Sorghum bicolor* in the two growing seasons

Genotypes	Plant Height (cm)	Days to 50 % Flow.	100 Seed Wt. (g)	Grain Wt. Panicle^{-1} (g)	Wt. of Cob (g)	Grain No. Panicle^{-1}	Length of Panicle (cm)
				2018-19			
SPH-1846	178.96	71.56	2.08	40.02	82.11	1918	29.73
SPH-1849	173.83	70.44	2.35	38.57	76.96	1646	24.81
CSH-16	171.67	71.56	2.23	37.97	59.29	1712	26.18
CSH-25	176.83	74.67	2.23	39.04	68.82	1757	26.84
CSH-30	167.67	69.00	2.38	33.00	61.09	1393	22.98
SE (m) ±	2.48	0.53	0.05	1.04	8.38	52	0.67
CD at 5 %	7.18	1.55	0.15	3.00	-	150	1.94
				2019-20			
SPH-1883	166.30	66.28	2.49	29.02	80.13	1160	25.89
SPH-1886	191.10	69.22	2.81	33.52	77.90	1191	25.29
CSH-25	189.00	73.00	2.90	22.34	61.33	771	19.22
CSH-30	179.15	66.27	2.59	30.58	67.80	1173	21.31
SE (m) ±	3.27	1.07	0.05	1.00	7.49	35	0.78
CD at 5 %	9.54	3.11	0.14	2.91	-	-	-

During 2019-20, among the different two tests and two check genotypes, significantly highest plant height (cm), grain weight per panicle (g) and grain no. per panicle were found significantly highest with the test hybrid SPH-1886. Plant height values were found at par with the check hybrid CSH-25, in case of grain no. per panicle was found at par with check hybrid CSH-30 and test hybrid SPH- 1883 but, grain weight per panicle; it was found significantly superior over all other genotypes. However, Days to 50 per cent flowering differ significantly due to the check hybrid CSH-30 and test hybrid SPH – 1883 and recorded minimum days to 50 per cent flowering. The 100 seed weight was found significantly highest with check genotype CSH-25 and it was found at par with test genotype SPH-1886. Whereas, length of panicle and harvest index recorded significantly highest with SPH-1883 and it was found at par with SPH- 1886. Among all the genotype, test hybrid SPH-1886 recorded significantly superior values for grain weight panicle^{-1} over all other genotype.

In general, genotype SPH- 1846 (2018-19) and SPH-1886 (2019) recorded maximum plant height of 178.96 cm and 191.10 cm, respectively compared to other test and check genotype. The variation in plant height in sorghum varieties at different levels of fertilizer application was also earlier reported by George Yakubu Mahama (2012). Among the all genotype there was variation in plant height, grain weight Panicle^{-1} (g), grain No. panicle^{-1} and length of panicle (cm).

Effect of different Fertility Levels on growths and yields contributing components of *Sorghum bicolor*

During two growing seasons, the yield of sorghum and its attributes; exhibited significant differences for different fertility levels (Table 2) in 2018-19, plant height (cm), 100 seed weight (g), grain weight Panicle^{-1} (g), grain No. panicle^{-1} and harvest index (%) were found significantly maximum with F_3 fertility levels (125 % RDF). However, it was found at par with the application of 100 per cent recommended dose of fertilizer (F_2). Among all the fertility levels, F_3 fertility levels recorded significantly superior values for grain weight per panicle. The significantly minimum days to 50 per cent flowering was recorded with F_3 (75 % RDF) and found at par with F_2 (100 % RDF). However, length of panicle was found highest with F_3 (125 % RDF) level but did not differ significantly due to the different fertility levels.

During 2019-20, plant height (cm), grain weight panicle^{-1} (g), grain No. panicle^{-1} and length of panicle (cm) were found significantly maximum with F_3 fertility levels (125 % RDF). However in case of grain weight panicle^{-1} (g), grain No. Panicle^{-1} and length of panicle, fertility level F_3 was found at par with the application of 100 per cent recommended dose of fertilizer (F_2). Whereas, 100 seed

Table 2: Main effect of fertility levels on yield components of *Sorghum bicolor* in the two growing seasons

Genotypes	Plant Height (cm)	Days to 50 % Flow.	100 Seed Wt. (g)	Grain Wt. Panicle^{-1} (g)	Wt. of Cob (g)	Grain No. Panicle^{-1}	Panicle Length (cm)
				2018-19			
F1 -75 % RDF	168.64	72.20	2.22	33.20	57.39	1510	24.87
F2 -100 % RDF	173.00	71.33	2.22	38.92	73.25	1762	26.37
F3 -125 % RDF	179.73	70.80	2.32	41.05	78.32	1783	27.09
SE (m) ±	1.92	0.41	0.04	0.80	6.49	40	0.52
CD at 5 %	5.56	1.20	NS	2.32	-	117	1.51
				2019-20			
F1 -75 % RDF	174	70.19	2.60	24.51	54.10	944	22.43
F2 -100 % RDF	184	68.86	2.69	29.68	58.11	1110	22.80
F3 -125 % RDF	186	67.03	2.80	**32.40**	59.22	1168	23.55
SE (m) ±	2.83	0.92	0.04	0.86	5.22	30	0.68
CD at 5 %	8.27	2.69	0.12	2.52	-	89	NS

weight and Wet of Cob (g) were not affected significantly due to the different fertility levels. Interaction had significant effect on all the growth parameter except 100 seed weight (g) and cob weight (g). Similarly there was increase in all growth parameters were observed with increased levels of fertilizer application. This could be attributed to soil enrichment with higher level of nutrients which owing to provide sufficient nutrients that are essentially required to various metabolic processes and finally resulting in plant growth. The result of present findings tally with the findings of Thakre *et al.* (1989) and Mahakulkar *et al.* (1992).

Effect of cultivars on yields and economics of *Sorghum bicolor*

The yields obtained in this experiment was ranged in between 32.72 to 50.28 q ha^{-1} for grain, 107.0 to 131.0 q ha^{-1} for fodder and 149 to 181 q ha^{-1} for biomass (Table 3).

The results of 2018-19 showed that , among the different two test and three check genotype , test hybrid SPH-1846 recorded the significantly highest grain yield (36.94 q ha^{-1}), fodder yield (123.00 q ha^{-1}) and biological yield (160.00 q ha^{-1}). However, in case of grain yield test hybrid SPH-1846 found at par with test hybrid SPH-1849 and check hybrid CSH-25 and CSH-16. The test genotypes SPH-1849 and CSH-30 was found at par with SPH-1846 for fodder and biomass yield. The lowest grain yield recorded with check genotype CSH-30 and lowest fodder and biomass yield were recorded with check genotype CSH-16. During 2019-20 results showed that, among the different two test and two check genotype, test hybrid SPH-1886, recorded the significantly superior grain yield (50.28 q ha^{-1}), fodder yield (131.00 q ha^{-1}) and biological yield (181.00 q ha^{-1}), However, in case of fodder yield test hybrid SPH-1886 found at par check hybrid CSH-25. The lowest grain yield recorded with check genotype CSH-25, lowest fodder and biomass yield were recorded with test genotype SPH-1883

The economics analysis of study of 2018-19 revealed that, significantly highest monetary advantage in terms of gross monetary returns was found with the test genotype SPH-1846 and closely followed by test genotype SPH-1849 and check genotype CSH-25. Similarly, test hybrid SPH-1846 and 1849 recorded highest B:C Ratio. The economics analysis of study during 2019-20 revealed that, significantly highest monetary advantage in terms of gross monetary returns was found with the test genotype SPH-1886 and followed by check genotype CSH-30 (Table 3).

Effect of fertility levels on yields and economics of *Sorghum bicolor*

The results of first year data showed that, among three different fertility levels, application of 125 per cent RDF (F_3), recorded the significantly highest grain yield (37.07 q ha^{-1}), fodder yield (117.00 q ha^{-1}) and biological yield (154.00 q ha^{-1}) over the 75 per cent RDF (F_1). The fertilizer application with F_2: 100 per cent RDF recorded the second highest grain, fodder and biomass yield, which was on par with application of 125 per cent RDF (F_3). The lowest grain, fodder and biomass yield recorded with application of 75 per cent RDF (F_1). Interaction effect found significant for grain, fodder and biomass yield (Table 4).

During the 2019-20, among the three different fertility levels, application of 125 per cent RDF (F_3), also recorded the significantly highest grain yield (47.81 q ha^{-1}), fodder yield (126.00 q ha^{-1}) and biological yield (173.00 q ha^{-1}) over 75 per cent RDF (F_1). The fertilizer application with 100 per cent RDF recorded the second highest grain, fodder and biomass yield, which was on par with application of 125 per cent RDF (F_3) for fodder and biomass yield. The lowest grain, fodder and biomass yield recorded with application of 75 per cent RDF (F_1). This might be due to higher sink at higher level of nutrition manifested yield attributes to the maximum. The results are corroborating the work of Mahakulkar *et al*. (1992). Such improvements with increasing fertilizer levels were also reported by Chouhan and Dighe, 1999, Wani *et al*. (2004), Buah and Mwinkaara (2009), Uchino *et al*. (2013) and Sami *et al*.(2014).

The economics analysis study for the 2018-19 revealed that, significantly highest monetary advantage in terms of gross monetary returns was found with application 125 per cent RDF and closely followed by application 100 per cent RDF. Also Net Monetary Returns found significantly highest with 125 per cent RDF which

Table 03:-Main effect of cultivars on yield and economics of *Sorghum bicolor* in the two growing seasons

Genotypes	Grain Yield q ha^{-1}	Fodder Yield q ha^{-1}	Biomass Yield q ha^{-1}	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	Benefit Cost Ratio
2018-19						
SPH-1846	36.94	123	160	91100	67630	2.88
SPH-1849	35.36	119	154	87363	63893	2.72
CSH-16	34.22	95	129	80540	57070	2.43
CSH-25	35.20	103	138	83962	60492	2.57
CSH-30	29.08	110	139	74273	50803	2.15
SE (m) ±	1.37	5.98	5.99	2614	2614	
CD at 5 %	3.96	17.32	17.34	7573	7573	
2019-20						
SPH-1883	42.70	107	149	96072	70352	3.71
SPH-1886	50.28	131	181	113620	87900	4.40
CSH-25	32.72	125	157	77905	52185	3.04
CSH-30	45.18	117	163	102106	76386	3.96
SE (m) ±	1.41	3.5	3.7	2837	2837	
CD at 5 %	4.11	10.1	10.9	8282	8282	

Table 04 . Main effect of fertility levels on yield and economics of *Sorghum bicolor* in the two growing season

Genotypes	Grain Yield q ha^{-1}	Fodder Yield q ha^{-1}	Biomass Yield q ha^{-1}	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	Benefit Cost Ratio
			2018-19			
F1 -75 % RDF	29.87	100	130	73711	51701	2.35
F2 -100 % RDF	35.55	112	148	86441	62971	2.68
F3 -125 % RDF	37.07	117	154	90190	65260	2.62
SE (m) ±	1.06	4.6	4.64	2025	2025	0.09
CD at 5 %	3.06	13.4	13.43	5866	5866	0.25
			2019-20			
F1 -75 % RDF	36.34	113	149	83978	59468	3.43
F2 -100 % RDF	44.02	121	165	100118	74398	3.89
F3 -125 % RDF	47.81	126	173	108182	81252	4.02
SE (m) ±	1.22	3.01	3.24	2457	2457	
CD at 5 %	3.56	8.78	9.47	7173	7173	

was recorded at par values with 100 per cent RDF (Table 4). Application of 100 per cent RDF fertility levels recorded highest B:C Ratio. During 2019-20, among three different fertility levels, highest GMR were recorded with application 125 per cent *RDF* and subsequently followed by application 100 per cent RDF. The fertility level F_3 - recorded the highest value of NMR, which was at par with F_2 and also fertility level F_3 recorded the highest B:C Ratio. The results were confirmed with the findings of Mishra *et al.* (2009).

CONCLUSION

It could be concluded that sowing of sorghum crop (*Sorghum bicolor* L.) genotype SPH-1846 (2018-19), SPH – 1886 (2019-20) and fertilized with 125 per cent RDF in order to raise a healthy and good sorghum crop and ultimately get the highest yield and monetary returns under dry land conditions. The application of 125 per cent RDF recorded significantly higher grain yield and fodder yield as compared to rest of the fertilizer levels. Among the genotypes SPH-1846 (2018-19) and SPH – 1886 (2019-20) produced more grain, fodder yield, GMR and NMR as compared to other genotypes.

LITERATURE CITED

Akdeniz, H., I. Yilmaz, B. Keskin and O. Arvas, 2000.The Effects of Different Nitrogen Levels on Yield and Yield Components of Some Silage Sorghum (*Sorghum vulgare* L.) Varieties, Turk J. field crops. 7, 52.

Buah S S J and S Mwinkaara, 2009. Response of sorghum to nitrogen fertilizer and plant density in the Guinea Savanna zone, J. Agron. 8: 124-130.

Chouhan S S and J. M. Dighe, 1999. Chemical composition, yield and yield attribute of sorghum genotypes under different fertility levels in Malwa region, Crop Res.17: 149- 152.

George Yakubu Mahama, 2012. Variation among grain sorghum genotypes in response to nitrogen fertilizer. M. Sc. Thesis (Unpub.), submitted to Department of Agronomy, College of Agriculture, Kansas State University, Manhatton, Kansas.

Kumar S R, Ramanjaneyulu A V and A. Krishna, 2010. A decadal analysis of improved sorghum (*Sorghum bicolor*) cultivar response to fertilizer application in rainy season and hypothetical grain production model, Indian J. Agric. Sci. 80(9): 786-90

Mishra J. S., M. S. Raut, V. S. Khubsad and Z. N. Patel, 2009. Sorghum Agronomy – *Kharif* 2001. Agronomy Report. DOR (ICAR), Rajendranagar, Hyderabad, AP.

Mokashi, D. D., J. D. Jadhav, S.V. Khadatare and A.N. Deshpande, 2008. Crop weather relationship in *rabi* sorghum, Int. J. Agric. Sci., 4(1): 138- 141.

Mahakulkar, B.V., 1992. Nutrient Management in Kharif Sorghum, Indian J. Agric. Sci. 62 : 247-248.

Sami M N, Gabir, Manoj Khanna, Man Singh, S. S. Parihar, Indra Mani and T K Das, 2014. Effect of conservation practices and fertilizer on sorghum (*Sorghum bicolor*) yield under rainfed conditions of northern India, Indian J. Agron. 59(2): 301-305

Uchino H., T. Watanabe, K. Ramu, K.L. Sahrawat, S. Marimuthu and S. P. Wani, 2013. Effects of nitrogen application on sweet sorghum in the semi-arid tropical Zone of India, Jarq. 47 : 65-73.

Wani A. G., B. N. Narkhede and D. P. Pachane, 2004. Performance of *rabi* sorghum (*Sorghum bicolor* L.) genotypes under rainfed conditions at varying fertility levels. Indian J. Dryland Agric. Res. Dev. 19(1): 61-63.

Received on : 20.7.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Organic Sources on Yield and Nutrient Uptake by Wheat

Bijoy Das[1], R.N. Katkar[2], S.D. Jadhao[3], B.D. Gite[4] and Swati Bharad[5]

ABSTRACT

An experiment was conducted during *Rabi* 2020-21 to study the Effect of organic sources on yield and nutrient uptake by wheat on Inceptisols. The study comprised of 10 treatments including application of different combination of organics like compost, potassium humate, humic acid, fulvic acid and sea weed extract along with foliar sprays of different leaf extracts, cow urine, compost extracts and gibberellic acid replicated three times in randomised block design. Observations were recorded at the time of harvesting and plant samples from all the treatments were collected and analysed for N, P, K, S and micronutrient uptake. Application of 100 per cent RDF recorded the highest yield and nutrient uptake as compared to other treatments. Among all the organic treatments the highest yield and nutrient uptake were recorded with compost @ 2.5 t ha^{-1}, fulvic acid @ 10 per cent, humic acid @ 20 per cent and sea weed extracts @ 5 per cent + compost extract @ 5 per cent as foliar spray at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS.

Wheat (*Triticum aestivum* L.) is one of the world's most important food crop. After rice, it is India's second most important staple crop. India has the largest wheat growing region in the world and it ranks second in terms of production after China. In 2019-20 area, production and productivity under wheat in India was estimated as 30 million ha, 102.19 million tonnes and 3.57 t ha^{-1}, respectively (Anonymous, 2019-20). Major wheat growing states in India are Uttar Pradesh, Punjab, Haryana, Rajasthan, Madhya Pradesh, Gujarat, Maharashtra and Bihar.

In Maharashtra, wheat covers 0.9 million ha of area with productivity of 1.4 t ha^{-1}. Maharashtra contributes about 1.51 and 3.06 per cent of the total wheat production and area of the country (Anonymous, 2018-19). It is the most important staple food crop next only to rice in Maharashtra. The imbalance use of chemical fertilizers can lead to soil acidification because of a decrease in organic matter in the soil.

Nitrogen applied through chemical fertilizers on field in large quantity over time damages top soil, resulting in reduced crop yields. Continuous use of chemical fertilizers on soil depletes the soil of essential nutrients. As a result, the food produced by the use of chemical fertilizers contains less vitamins and minerals. According to the data by U.S. Department of Agriculture Nutrient Data Laboratory, foods grown in soils with chemical fertilizers have less magnesium, potassium and calcium content.

So to counter the above mentioned problems and improve the soil properties, supply of nutrients for the growing crops can be done by applying different combination of organics.

MATERIAL AND METHODS

The experiment was conducted in *Rabi* season of 2020-21 on Wheat Research Unit, Dr PDKV, Akola, Maharashtra. The initial soil properties were slightly alkaline in reaction (8.01), non-saline (0.24 dS m^{-1}), medium in organic carbon (4.21 g kg^{-1}), moderately calcareous in nature (7.83 %), low in available nitrogen (180.6 kg ha^{-1}), and available phosphorus (14.73 kg ha^{-1}), medium in available potassium (296.45 kg ha^{-1}) and marginal in available sulphur (11.26 mg kg^{-1}).

Experiment consisted of 10 treatments, *viz* Control, 100 per cent RDF at sowing (T_2), Compost @ 2.5 t ha $^{-1}$+ spraying of Compost extract @ 5 per cent + Cow urine @ 2 per cent at 30-35 and 60-65 DAS, Compost @ 2.5 t ha^{-1} + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS(T_4), Compost @ 2.5 t ha^{-1} + spraying of Gibberllic acid (2.5 ml) at 30-35 and 60-65 DAS(T_5), Compost @ 2.5 t ha^{-1} + spraying of Compost extract @ 5 per cent

1. PG Student, 2. Professor (SSAC), 3 &5. Associate Professor, 4. Assistant Professor, Department of Soil Science & Agril. Chemistry, Dr. PDKV, Akola

and Moringa leaf extract @ 5 per cent at 30-35 and 60-65 DAS(T_6), Compost @ 2.5 t ha^{-1} + spraying of Compost extract @ 5 per cent + Lantana camara leaf extract @ 5 per cent + Pomegranate leaf extract @ 5 per cent at 30-35 and 60-65 DAS(T_7), Compost @ 2.5 t ha^{-1} + spraying of Compost extract @ 5 per cent + Gibberllic acid 2.5 ml at 30-35 and 60-65 DAS(T_8), Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS, Compost @ 2.5 t/ha + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. It was laid out in randomized block design replicated three times. Wheat was sown on 15th Dec, 2020 and harvested on 30th Mar, 2021.

Plot-wise grain and plant samples were collected after harvest of wheat, samples were air dried and then oven dried at 65^{0}C. Grain and straw yield of wheat was recorded treatment wise and per ha yield was determined. The plant samples were analysed for total N by micro Kjeldhal method (AOAC, 1995), total P by (Vanado-molybdate yellow colour method using diacid extract (Jackson, 1973), total K by Flame photometrically from diacid extract (Piper, 1966), total S by turbidity method (Chesnin and Yein, 1951), total Zn, Mn, Fe, and Cu by Diacid extract using atomic absorption spectrophotometer (Issac and Kerber ,1971).

RESULTS AND DISCUSSION

The significantly higher grain yield (38.75 q ha^{-1}) of wheat (Table 1) was recorded with the application of 100 per cent RDF (T_2) and it was found to be on par with treatment Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS (T_{10}) and Compost @ 2.5 t ha^{-1} + potassium humate @ 80 per cent + sea wood extract spraying of Compost extract @ 5 per cent at 30-35 and 60-

Table 1. Yield of wheat as influenced by various organic nutrient sources

Treatments		Wheat yield(q ha^{-1})	
		Grain	Straw
T_1	Control	25.53	39.41
T_2	100% RDF	38.75	54.35
T_3	Compost @ 2.5 t/ha + spraying of compost extract @ 5% + Cow urine @ 2% at 30-35 and 60-65 DAS.	29.97	41.63
T_4	Compost @ 2.5 t/ha + spraying of Compost extract @ 5% at 30-35 and 60-65 DAS.	30.42	42.58
T_5	Compost @ 2.5 t/ha + spraying of Gibberllic acid (2.5 ml) at 30-35 and 60-65 DAS.	28.93	41.50
T_6	Compost @ 2.5 t/ha + spraying of Compost extract @ 5% and Moringa leaf extract @ 5% at 30-35 and 60-65 DAS.	27.92	41.08
T_7	Compost @ 2.5 t/ha + spraying of Compost extract @ 5% + Lantana camara leaf extract @ 5% + pomegranate leaf extract @ 5% at 30-35 and 60-65 DAS.	29.68	42.55
T_8	Compost @ 2.5 t/ha + spraying of Compost extract @ 5% + Gibberllic acid 2.5 ml at 30-35 and 60-65 DAS.	29.23	42.58
T_9	Compost @ 2.5 t/ha + Potassium humate @ 80% + sea weed extract Spraying of Compost extract @ 5% at 30-35 and 60-65 DAS.	33.28	46.89
T_{10}	Compost @ 2.5 t/ha + Fulvic acid @ 10% + Humic acid @ 20% + @ 5% + spraying of Compost extract @ 5% at 30-35 and 60-65 DAS	33.97	47.56
	SE (m) ±	2.21	2.55
	CD at 5%	6.58	7.59
	CV (%)	12.46	10.06

65 DAS(T_9). Among all the organic sources, application of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS recorded the highest grain yield and they were found to give 33.06 and 30.36 per cent higher grain yield as compared to control, respectively.

Significantly highest straw yield (54.35 q ha^{-1}) of wheat was recorded with 100 per cent RDF (T_2) and it was found to be on par with treatment of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS (T_{10})and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS (T_9) recorded straw yield 20.68 per cent over control.

Among all the organic sources application of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS registered the highest yield. This might be due to the application of compost which increases the available nutrients in soil which became available to plants. Humic acid contains plant growth hormones which ensure increase in yield and addition of fulvic acid can improve nutrient availability in soils and potassium humate increases the nutrient content in soils. Similar results have been also reported by Atiyeh *et al*. (2002), Sarwar *et al*. (2008) and Kumar *et al*. (2019).

Uptake of major nutrients

The highest nutrient uptake in grain and straw of wheat (Table 2) were observed with the application of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 pr cent at 30-35 and 60-65 DAS. The N uptake was increased in grain by 52.09 and 39.14 per cent over control by application of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS, respectively. The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total nitrogen uptake by 43.24 per cent and application of Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total nitrogen uptake by 33.16 per cent over control, respectively. The P uptake was increased in grain by 63.23 and 69.32 per cent and in straw by 32.42 and 28.52 per cent more over control by Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS, respectively. The treatments of Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total phosphorus uptake of wheat by 50.63 and 48.99 per cent as compared to control respectively. The K uptake was increased in grain by 51.97 and 47.44 per cent and in straw by 50.75 and 46.62 per cent as compared to control by Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS, respectively. The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent

Table 2. Effect of organic sources on Nitrogen, phosphorus, potassium and Sulphur uptake by wheat(kg/ha)

	Treatments	N			P			K			S		
		Grain	Straw	Total uptake	Grain	Straw	Total uptake	Grain	Straw	Total uptake	Grain	Straw	Total uptake
T_1	Control	41.24	26.73	67.97	8.05	6.91	14.96	8.41	49.87	58.28	6.46	4.42	10.88
T_2	100% RDF	70.80	37.67	108.47	14.61	9.96	24.57	14.22	74.38	88.60	10.49	6.95	17.44
T_3	Compost 2.5 t/ha + spraying of compost extract 5% + Cow urine 2% at 30-35 and 60-65 DAS.	55.08	30.28	85.36	11.60	8.06	19.66	11.24	63.51	74.74	8.42	5.97	14.40
T_4	Compost 2.5 t/ha + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	51.69	29.34	81.04	11.00	7.93	18.93	10.48	62.54	73.02	7.66	5.42	13.07
T_5	Compost 2.5 t/ha + spraying of Gibberllic acid (2.5 ml) at 30-35 and 60-65 DAS.	49.02	30.22	79.24	10.65	7.51	18.16	9.86	57.88	67.74	7.39	5.11	12.50
T_6	Compost 2.5 t/ha + spraying of Compost extract 5% and Moringa leaf extract 5% at 30-35 and 60-65 DAS.	47.79	29.37	77.16	10.38	7.83	18.21	10.03	60.15	70.19	7.22	5.16	12.38
T_7	Compost 2.5 t/ha + spraying of Compost extract 5% + Lantana camara leaf extract 5% + pomegranate leaf extract 5% at 30-35 and 60-65 DAS.	50.00	29.36	79.36	10.63	7.46	18.09	11.03	65.02	76.05	7.30	5.19	12.49
T_8	Compost 2.5 t/ha + spraying of Compost extract 5% + Gibberllic acid 2.5 ml at 30-35 and 60-65 DAS.	50.08	29.01	79.09	10.43	7.75	18.17	10.40	63.40	73.80	7.58	5.15	12.73
T_9	Compost 2.5 t/ha + Potassium humate 80% + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	57.38	33.13	90.51	13.63	8.88	22.52	12.40	73.12	85.52	8.64	6.24	14.88
T_{10}	Compost 2.5 t/ha + Fulvic acid 10% + Humic acid 20% + sea weed extract 5% + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	62.72	34.64	97.36	13.14	9.15	22.29	12.78	75.18	87.96	8.86	6.52	15.38
	SE (m) ±	3.61	2.54	5.84	0.99	0.56	1.50	0.88	4.11	4.89	0.64	0.52	1.08

Table 3. Effect of organic sources Zn, Fe, Mn and Cu uptake by wheat (kg/ha)

	Treatments	Zn			Fe			Mn			Cu		
		Grain	Straw	Total uptake	Grain	Straw	Total uptake	Grain	Straw	Total uptake	Grain	Straw	Total uptake
T_1	Control	73.46	46.99	120.46	111.64	249.64	361.28	64.42	67.43	131.86	10.59	61.21	71.79
T_2	100% RDF	119.86	73.37	193.23	179.44	361.21	540.65	101.52	102.48	204.00	17.92	91.85	109.78
T_3	Compost 2.5 t/ha + spraying of compost extract 5% + Cow urine 2% at 30-35 and 60-65 DAS.	91.63	54.60	146.24	145.08	291.89	436.97	81.04	79.84	160.88	14.80	75.34	90.14
T_4	Compost 2.5 t/ha + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	86.60	54.29	140.89	138.12	275.58	413.69	76.54	75.82	152.36	12.79	70.46	83.25
T_5	Compost 2.5 t/ha + spraying of Gibberllic acid (2.5 ml) at 30-35 and 60-65 DAS.	82.58	50.31	132.88	128.50	266.09	394.59	72.98	73.86	146.84	12.91	68.08	80.98
T_6	Compost 2.5 t/ha + spraying of Compost extract 5% and Moringa leaf extract 5% at 30-35 and 60-65 DAS.	79.76	50.43	130.20	125.20	266.25	391.45	71.02	73.83	144.85	12.48	69.53	82.01
T_7	Compost 2.5 t/ha + spraying of Compost extract 5% + Lantana camara leaf extract 5% + pomegranate leaf extract 5% at 30-35 and 60-65 DAS.	85.44	51.37	136.81	132.57	275.25	407.83	76.15	76.33	152.48	13.38	70.78	84.17
T_8	Compost 2.5 t/ha + spraying of Compost extract 5% + Gibberllic acid 2.5 ml at 30-35 and 60-65 DAS.	83.87	52.05	135.92	131.84	279.99	411.83	74.45	75.13	149.58	13.09	71.61	84.70
T_9	Compost 2.5 t/ha + Potassium humate 80% + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	96.24	64.45	160.70	150.87	306.48	457.35	85.37	86.97	172.34	15.08	79.57	94.65
T_{10}	Compost 2.5 t/ha + Fulvic acid 10% + Humic acid 20% + sea weed extract 5% + spraying of Compost extract 5% at 30-35 and 60-65 DAS.	102.88	66.23	169.10	155.24	314.78	470.01	87.27	89.46	176.73	16.00	82.86	98.86
	SE (m) ±	7.13	3.82	10.35	10.91	19.15	29.05	5.51	5.26	9.99	1.14	5.24	6.16
	CD at 5%	21.19	11.35	30.76	32.42	56.90	86.31	16.37	15.62	29.68	3.39	15.57	18.29

at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased 50.93 and 46.74 per cent total potassium uptake as compared to control. The increase in NPK uptake by grain and straw of wheat might be due to application of fulvic acid which increases the nitrogen content due to enhancement in root activity of plants. Similar findings were reported by Raina and Goswami (1988), Rizk *et al*. (2008). Tahir *et al*. (2011) reported that potassium humate and humic acid increases the nitrogen content in plants through promoting growth and activity of nitrogen mineralizing organism in soil. Application of potassium humate increases the available phosphorus in soil. These findings are in accordance with the results reported by Ali and Elbordiny (2009).The compost extract contains macro and micro nutrients in available form for plants which when applied as foliar spray reflects on nutrient content of plants. Similar findings were reported by El-Gohary *et al.* (2010) and Meena *et al*. (2010) reported that uptake of P and K increases due to better root penetration leading to better absorption due to greater availability of nutrients and improved soil physical condition with the addition of organics. Among all the organic sources treatment of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS has the highest total potassium uptake by wheat. This might be attributed to the improvement of soil fertility status. Presence of humic acid induced a decrease in soil pH and increased the macro and micronutrients availabilities and consequently increased nutrients uptake by crops. The results are in agreement with El-Kouny (2007), Antoun *et al* (2010) and Ragab *et al*. (2010).

The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5per cent at 30-35 and 60-65 DAS increased sulphur uptake by 37.15 and 33.75 per cent as compared to control.

Uptake of micro nutrient

Among all the organic sources the highest uptake of zinc (102.88 g ha^{-1}) by grain and (66.23 g ha^{-1}) by straw was observed in Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent+ spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS followed by Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total zinc uptake by 40.38 per cent and application of Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total zinc uptake by 33.41 per cent over control. The highest uptake of iron (155.24 g ha^{-1}) by grain and (314.78 g ha^{-1}) by straw was recorded in treatment of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total iron uptake by 30.10 per cent and application of Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total iron uptake by 26.59 per cent over control. In case of Mn significantly highest uptake of grain (87.27 g ha^{-1}) and straw (89.46 g ha^{-1}) was recorded in Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS followed by treatment of Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. The highest uptake of copper (16.00 g ha^{-1}) by wheat grain and (82.86 g ha^{-1}) by wheat straw was observed in treatment Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS. The application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total copper uptake by 37.71 per cent and application of Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS increased the total copper uptake by 31.84 per cent over control.

The increase in Zn, Fe, Mn and Cu uptake by grain and straw with treatment of Compost @ 2.5 t ha^{-1} + Fulvic acid @ 10 per cent + Humic acid @ 20 per cent + sea weed extract @ 5 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS and Compost @ 2.5 t ha^{-1} + Potassium humate @ 80 per cent + spraying of Compost extract @ 5 per cent at 30-35 and 60-65 DAS might be attributed due to the organic matter content of the soil which increases with the application of organic sources and this leads to increase in the useful Zn, Fe, Mn and Cu content and ultimately uptake. Humic substances which have both hydrophobic and hydrophilic surfaces and they can interact with the phospholipid structures of cell membranes and act as a nutrient carrier. This characteristic of humic substances is related to the uptake of micro elements such as Zn, Fe, Mn and Cu. Similar findings was reported by Chen *et al.* (2001) and Dincsoy *et al. (2019).*

CONCLUSION

It is inferred that, application of Compost 2.5 t ha^{-1} + Fulvic acid 10 per cent + Humic acid 20 per cent + sea weed extract 5 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS and Compost 2.5 t ha^{-1} + Potassium humate 80 per cent + spraying of Compost extract 5 per cent at 30-35 and 60-65 DAS were found beneficial for yield of and nutrient uptake by wheat.

LITERATURE CITED

Ali L.K.M. and M.M. Elbordiny, 2009. Response of wheat plants to potassium humate application, J. Applied Sci. Res., 5: 1202-1209.

Anonymous, 2018-19. http:// www.intechopen.com, area, production and productivity of wheat in Maharashtra.

Anonymous, 2019-20. ICAR-IIWBR (Wheat) Annual Report (2019-20), Karnal, Haryana, India-132 001.

Antoun, L. W., S.M. Zakaria and H.H Rafla, 2010. Influence of compost, N-mineral and humic acid on yield and chemical composition of wheat plants, J. Soil Sci. Agril.Engg. *1*(11): 1131-1143.

AOAC, 1995, Official Methods of Analysis. 16th Edn., AOAC International, Gaithersburg, MD, Sec. 33.2.11, Method. 991.20.

Atiyeh, R. M., S. Lee, C.A. Edwards, N.Q. Arancon and J.D Metzger, 2002. The influence of humic acids derived from earthworm-processed organic wastes on plant growth, Bioresource Tech., 84:7-14.

Chen, Y., H. Magen, and C. E. Clapp, 2001. Plant growth stimulation by humic substances and their complexes with iron. Proceedings of International Fertiliser Society : 14. Israel: International Fertiliser Society.

Chesnin, L. and C.H. Yein, 1951. Turbidimetric determination of available sulphur, Soil Science Soc. of America Proceeding, 15: 149-151.

Dincsoy, M. and S. Ferit, 2019. The effect of potassium and humic acid applications on yield and nutrient contents of wheat (*Triticum-aestivum* L. var. Delfii) with same soil properties, J. Plant Nutrition, 42(20): 2757-2772.

El-Gohary, A.A., E.A.M. Osman and K.A. Khatab, 2010. Effect of nitrogen fertilization, humic acid and compost extract on yield and quality of rice plants, J. Soil Sci. Agril.Engg, 1(1): 77-91.

El-Kouny, H. M., 2007. Effect organic manure and bio-fertilizers on wheat grown in lacustrine soil as compared with mineral fertilizes, Egypt. J. Soil Sci., 3: 263-280.

Issac, R.A. and J.D.Kerber, 1971. Atomic absorption and flame Photometry: technique and use in soil, plant and water analysis. In Walsh L.M. (Ed). Instrumental Method of Soils and Plant Tissue, Soil Science Society of American J., Madison, wiscon. 18-37.

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

Kumar S.M., X. Zeng, S. Su, Y. Wang, L. Bai, Y. Zhang, T. Li and X. Zhang, 2019. The effect of fulvic acids derived from different materials on changing properties of albic black soil in the North east Plain of China, Molecules*,* 24(8): 1535.

Meena, R.N., S.P. Singh and K. Singh, 2010. Effect of organic nitrogen nutrition on yield, quality, nutrient uptake and economics of rice-pea-onion cropping sequence, Indian J. of Agril. *Sci.,* 80(11): 1003-6.

Piper,C.S., 1966. Soil and Plant Analysis (Ed) Indian Edition, Hans. Publ. Bombay.

Ragab, A.A.M., A.H. El-Sayed, K.A. Shaban and S.M.A. El-Rasoul, 2010. Effect of bio-fertilizer, humic acid and N-mineral on productivity of wheat grown on a saline soil. Egypt. *Appl. Sci*., 20(2): 115-134.

Raina, J.N. and K.P. Goswami, 1988. Effect of fulvic acid *a*nd fulvates on growth and nutrient uptake by Maize plant, J. Indian Soc. Soil Sci., 36: 264-268.

Rizk, A.H., and A.M.A. Mashhour, 2008. Effect of foliar application with potassium humate on growth and uptake of some nutrients by wheat and broad bean plants, Egyptian J. of Soil Sci., 48: 457-465.

Sarwar, G., H. Schmeisky, N. Hussain, S. Muhammad, M. Ibrahim and E. Safdar, 2008. Improvement of soil physical and chemical properties with compost application in the rice-wheat cropping system, Pakistan J. of Botany, 40(1): 275-282.

Tahir, M. M., M. Khurshid, M. Z. Khan, M. K. Abbasi and M. H. Kazmi, 2011. Lignite-derived humic acid effect on growth of wheat plants in different soils, Pedosphere, 21(1): 124-131.

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Foliar Application of Gibberellic Acid on Growth and Yield of Chickpea (*Cicer arietinum* L.)

V. K. Range[1] and M. D. Giri[2]

ABSTRACT

A field experiment was carried out at the research farm of Pulse Research Unit, Washim Road Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the winter season of 2018-19 on a vertisol soil, to study the response of chickpea (*Cicer arietinum*L.) to foliar application of gibberellic acid under rainfed conditions. In chickpea, 11 treatments comprising gibberellic acid–management practices (application of water spray, 15, 30, 45 ppm GA3 at flowering, pod development stages and control) were tested. Results indicated that Single application of 45ppm GA_3 at flower initiation recorded significantly higher plant height, two applications of 30 ppm GA_3 at flower and pod initiation stages recorded significantly higher dry matter accumulation in chickpea crop. The yield attributing parameters like number pods/ plant, grain yield plant^{-1} and seed index were found significantly higher in foliar application of 30 ppm GA_3 at flower and pod initiation stages. This treatment also recorded significantly highest grain yield kg/ ha than the control and water spray but it was at par with all other gibberellic acid management treatments.

India is the largest producer of pulses in the world with 24 per cent share in the global production; it is also a big consumer and exporter of pulses in the world. Being economical source of protein, high fiber content, vitamins and minerals along with unique ability to restore soil health, pulses have assumed the role of universal remedy for sustainable production (Deol *et. al*, 2018). Pulses are the major source of protein and carbohydrate in Indian diet and for being resource conserving and environmentally friendly, the increase in pulse production will act as a panacea for problems like nutritional security and deficiency disorders (Mazid and Naqvi 2014).The major pulse crops of the India are chickpea (48%), pigeonpea (15%), mungbean (7%), urdbean (7%), lentil (5%) and field pea (5%) (Anonymous, 2018[b]).

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop in the world. In India, chickpea is a premier pulse crop occupying 8.17 million ha and contributing 7.47 million tonnes to pulse basket. It accounts for 20 per cent of the world pulses production. India is the largest producer, with about 8 million tons, accounting of about 70 per cent of total world production. In India, chickpea is grown almost in all parts of the country mainly as a rainfed crop (68 % area). In the dry and rainfed area the productivity is 911 kg ha^{-1} which is much lower than those of the developed countries of world, such as 2833 kg ha^{-1} of China, 1668 kg ha^{-1} of Canada and 1488 kg ha^{-1} of USA. During 2017-18, chickpea production has been estimated to be about 11.16 million tones, which is about 45 per cent of the total pulses production (24.51 million tonnes) in India. Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Chhattisgarh, Bihar and Jharkhand contribute more than 95 per cent to the total chickpea production in the country (Anonymous, 2018[a]).

Plant growth regulators may be defined as any organic compounds, which are active at low concentrations in promoting, inhibiting or modifying growth and development. The naturally occurring (endogenous) growth substances are commonly known as plant hormones, while the synthetic ones are called growth regulator. The impact of PGRs in manipulating physiological processes in crop production include germination, vigour, nutrient uptake from soil, photosynthesis, respiration, partitioning of assimilate, growth suppression, defoliation and post-harvest ripening can be observed (Rahman and Nath, 1993) and Hossain *et al.* (2015) .

MATERIAL AND METHODS

A field experiment to study the effect of foliar application of gibberellic acid on growth and yield of

1. P.G. Student and 2.Assistant Professor, Pulses Research Unit, Dr. PDKV, Akola

chickpea (*Cicer arietinum* L.) was conducted at the research farm of Pulse Research Unit, Washim Road, Dr. Panjabao Deshmukh Krishi Vidyapeeth, Akola during winter season of 2018-19. The soil of experimental plot was clayey and slightly alkaline (pH 8.0), with available nitrogen (174kg ha^{-1}), phosphorus (22 kg ha^{-1}) and potassium (568 kg ha^{-1}) content. The treatments consisted of : T_1- control; T_2- foliar application of water spray at flower + pod initiation; T_3- foliar application of 15 ppm GA_3 at flower initiation; T_4- foliar application of 30 ppm GA_3 at flower initiation; T_5- foliar application of 45 ppm GA_3 at flower initiation; T_6- foliar application of 15 ppm GA_3 at pod initiation; T_7- foliar application of 30 ppm GA_3 at pod initiation; T_8- foliar application of 45 ppm GA_3 at pod initiation; T_9- foliar application of 15 ppm GA_3 at flower + pod initiation; T_{10}- foliar application of 30 ppm GA_3 at flower + pod initiation and T_{11}- foliar application of 45 ppm GA_3 at flower + pod initiation. In all, there were eleven treatments replicated three times under RBD. The experimental field was laid out in 33-unit plots, each plot measuring 10.80 m2 (3.6m x 3.0m).

Seeds of chickpea variety JAKI- 9218 were sown @ 30 kg ha^{-1} (33 plant/m^2) with the spacing of 30 cm between rows and 10cm between plants on 5th November 2018. A fertilizer dose of 25 kg N, 50 kg P_2O_5 and 25 kg K_2O ha^{-1} through urea, single super phosphate and muriate of potash was applied at the time of sowing (basal application) to all the plots. Foliar application of gibberellic acid was done as per the treatments. For the foliar application of gibberellic acid a stock solution of 1000 ppm was prepared and from this stock solution required amount of the gibberellic acid as per the treatments was utilized for foliar application. The first spray of gibberellic acid was taken at flower initiation stage (42 DAS) and second spray was taken at pod initiation stage (61 DAS). The data on various parameters recorded from experimental plots were statistically analyzed as suggested by Panse and Sukhatme (1995) by using 'F' test at P=0.05.

RESULTS AND DISCUSSION

Growth studies

Plant height and number of branches plant^{-1}

Single applications of 45 ppm gibberellic acid at flower initiation recorded significantly higher plant height (53.72 cm) than control treatment (Table 1). However, it was at par with single application of 45ppm gibberellic acid at pod initiation stage, two applications of 15, 30 and 45 ppm gibberellic acid at flower and pod initiation stages. The lowest plant height was observed in control treatment (38.35 cm). Single application of 45 ppm gibberellic acid at flower initiation stage recorded 40% taller plants than the control treatment. The plant height is an important growth factor, which had a direct effect on crop productivity. Growth in the plant occurs mainly by multiplication of cells and formation of plant parts. Tiwari and Eugenia (2018) and Manjari *et al.* (2018) also found that application of gibberellic acid resulted in increased plant height.

The effect of various gibberellic acid management treatments on number of branches/ plant of chickpea crop was found to be non-significant.

Number of functional leaves and leaf area

The data regarding number of functional leaves and leaf area plant^{-1} as influenced by different gibberellic management treatments are presented in Table 1. At 49 days after sowing (seven days after the first application of gibberellic acid), treatment single applications of 45ppm gibberellic acid at flower initiation recorded significantly more number of leaves plant^{-1} (76.40 leaves plant^{-1}) and at 68 (seven days after the second application of gibberellic acid) days after sowing, two applications of 45ppm gibberellic acid at flower and pod initiation stages recorded significantly more number of leave/ plant than the control treatment.

At 49 days after, single applications of 45ppm gibberellic acid at flower initiation recorded significantly higher leaf area plant^{-1} (22.10 cm^2) than the control treatment and it was at par with two applications of 30 ppm gibberellic acid at flower and pod initiation stages. The best treatment recorded 28 per cent higher leaf area than the control treatment at 49 days after sowing. At 68 days after sowing two applications of 45 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher leaf area plant^{-1} (39.75 cm^2) than the control treatment and it was at par with single application of 15, 30 and 45 ppm gibberellic acid at flower initiation stage, two applications of 15 and 30 ppm gibberellic acid at flower and pod initiation stages. Leaf area depends on the size and the number of leaves. The best treatment recorded 33 per cent higher leaf area than the control treatment at 68 days after sowing Application of gibberellic acid might have increased the leaf emergence and the development of the leaf due to the rapid cell elongation and the cell division resulted in increased number of leaves with larger leaf area. Similar results were also reported by, Rathod *et al.* (2015) and Dawar (2019).

Chlorophyll content

At 49 days after sowing, single application of 45ppm gibberellic acid at flower initiation stage recorded significantly higher values of chlorophyll 'a' (0.42 mg g^{-1}). Two applications of 30 and 45 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher values of chlorophyll 'b' (0.24 mg g^{-1}). Single application of 45 ppm gibberellic acid at flower initiation stage recorded significantly higher values of 'total chlorophyll' (0.65 mg g^{-1}). Whereas, at 68 days after sowing, two applications of 45ppm gibberellic acid at flower and pod initiation stages recorded significantly higher values of chlorophyll 'a' (0.45 mg g^{-1}). Chlorophyll 'b' was significantly higher in single application of 45 ppm gibberellic acid at flower initiation stage (0.21 mg g^{-1}). Two applications of 45ppm gibberellic acid at flower and pod initiation stages recorded significantly higher total chlorophyll content (0.66 mg g^{-1}). Application of gibberellic acid increases the synthesis of photo pigments either by increasing the activity of chlorophyll synthesizing pigments or by reducing the rate of chlorophyll degradation. Therefore, in the present investigation the chlorophyll content is found increased due to application of gibberellic acid. These findings coincide with the previous findings made by Kumar *et al*. (2017), Baliah *et al.* (2018) and Dawar (2019).

Dry matter accumulation

Dry matter accumulation is considered to be the reliable index of crop growth. The dry matter accumulation was significantly influenced by the gibberellic acid management treatments (Table 2). At 49 days after sowing, two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher total dry matter accumulation by chickpea crop (7.30 g $plant^{-1}$) than the control treatment. However, it was at par with the single application of 15, 30 and 45 ppm gibberellic acid at flower initiation stage and two applications of 15 and 45ppm gibberellic acid at flower and pod initiation stages. At 68 days after sowing and at harvest also two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher dry matter accumulation in chickpea crop (9.39 and 15.19 g $plant^{-1}$ at 68 days after sowing and at harvest, respectively) than the control treatment. However, at harvest it was at par with two applications of 15 ppm gibberellic acid (14.59 g $plant^{-1}$) and 45 ppm gibberellic acid (15.03 g $plant^{-1}$) at flower and pod initiation stages. Improvement in growth parameters of chickpea crop due to foliar application of different concentration of gibberellic acid over untreated control may be because of beneficial effects of gibberellic acid on cell elongation and cell division, increase in photosynthetic activity and supported efficient translocation of photosynthates from source to sink resulted in higher dry matter accumulation in chickpea crop. The results are supported by the findings of Sarwar *et al.* (2017) and Tiwari and Dawar (2019).

Yield attributing characters

Number of pods and seed yield

Two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher number of pods $plant^{-1}$ (43.07 pods $plant^{-1}$) than the control treatment (Table 2) and it was at par with single application of 30 and 45ppm gibberellic acid at flower initiation stage, two applications of 15 and 45 ppm gibberellic acid at flower and pod initiation stages. Two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded 27 per cent more pods $plant^{-1}$ than the control treatment. Application of gibberellic acid might have retained more number of flowers/ plant and hence these treatments might have resulted into more number of pods $plant^{-1}$. These findings are in the lines of the findings earlier made by Dawar (2019).

Two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher seed yield $plant^{-1}$ (10.32 g $plant^{-1}$) than the control treatment (Table 2). However, it was at par with all other gibberellic acid management treatments. Improvement in leaf area, leaf chlorophyll content, dry matter accumulation

Table 1: Effect of different treatments on plant height , number of branches and leaves, leaf area and chlorophyll content (mg/g) of chickpea.

Treatment	Plant height (cm)	Branches plant^{-1}	Number of leaves plant^{-1}		Leaf area plant^{-1} (cm^2)		Chlorophyll content at 49 DAS (mg/ g)			Chlorophyll content at 68 DAS (mg/ g)		
			49 DAS	68 DAS	49 DAS	68 DAS	a	b	Total	a	b	Total
T_1 : Control (No spray)	38.35^c	12.40^a	71.59^b	139.89^b	17.32^c	29.98^d	0.34^c	0.15^c	0.49^c	0.37^b	0.14^b	0.51^c
T_2 : Water Spray at flower + pod initiation	40.21^b	12.33^a	71.63^b	139.97^b	17.33^c	29.99^d	0.35^c	0.15^c	0.50^c	0.37^b	0.14^b	0.51^c
T_3 : 15 ppm GA_3 at flower initiation	46.01^b	13.47^a	75.97^a	156.35^a	20.47^b	37.96^a	0.38^b	0.20^b	0.58^b	0.42^a	0.19^a	0.61^b
T_4 : 30 ppm GA_3 at flower initiation	45.43^b	14.73^a	76.17^a	160.10^a	20.52^b	38.82^a	0.40^a	0.22^a	0.63^a	0.43^a	0.20^a	0.63^a
T_5 : 45 ppm GA_3 at flower initiation	53.72^b	15.07^a	76.40^a	160.84^a	22.10^a	38.88^a	0.42^a	0.23^a	0.65^a	0.43^a	0.21^a	0.64^a
T_6 : 15 ppm GA_3 at pod initiation	43.56^b	13.47^a	71.60^b	146.54^b	17.32^c	31.31^c	0.34^c	0.16^c	0.50^c	0.41^a	0.15^b	0.56^b
T_7 : 30 ppm GA_3 at pod initiation	45.56^b	14.67^a	71.90^b	148.17^b	17.38^c	31.63^c	0.35^c	0.15^c	0.50^c	0.41^a	0.15^b	0.56^b
T_8 : 45 ppm GA_3 at pod initiation	49.05^a	15.27^a	71.57^b	147.45^b	18.03^c	32.96^c	0.35^c	0.15^c	0.50^c	0.42^a	0.14^b	0.56^b
T_9 : 15 ppm GA_3 at flower + pod initiation	50.04^a	14.00^a	75.03^a	156.34^a	19.51^b	36.39^b	0.39^b	0.23^a	0.62^a	0.44^a	0.20^a	0.64^a
T_{10} : 30 ppm GA_3 at flower + pod initiation	51.31^a	16.13^a	76.03^a	160.54^a	21.26^b	39.69^a	0.38^b	0.24^a	0.62^a	0.44^a	0.21^a	0.65^a
T_{11} : 45 ppm GA_3 at flower + pod initiation	52.33^a	16.87^a	76.10^a	161.20^a	20.49^a	39.75^a	0.39^b	0.24^a	0.63^a	0.45^a	0.21^a	0.66^a
S.E. m$\pm$	2.15	0.96	1.33	3.86	0.31	0.93	0.01	0.01	0.01	0.01	0.01	0.02
CD at 5%	6.29	-	3.88	11.29	0.89	2.71	0.02	0.02	0.03	0.04	0.03	0.04

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

Table 2: Effect of different treatments on pods, seed yield plant^{-1}, seed index and dry matter accumulation of chickpea.

Treatment	No. of pods plant^{-1}	Seed yield plant^{-1} (g)	Seed index (g)	Dry matter accumulation/ plant (g) 49 DAS	68 DAS	At harvest
T_1 : Control (No spray)	33.80^c	8.70b	23.37^b	6.44^b	7.48^c	11.94^c
T_2 : Water Spray at flower + pod initiation	35.00^b	8.88b	23.37^b	6.45^b	7.61^c	12.30^b
T_3 : 15 ppm GA_3 at flower initiation	38.00^b	9.60a	23.90^a	7.09^a	8.41^b	12.79^b
T_4 : 30 ppm GA_3 at flower initiation	40.47^a	10.15a	23.97^a	7.18^a	8.43^b	13.25^b
T_5 : 45 ppm GA_3 at flower initiation	39.67^a	10.05a	24.60^a	7.27^a	8.76^a	13.50^b
T_6 : 15 ppm GA_3 at pod initiation	37.67^b	9.55a	24.37^a	6.44^b	8.39^b	13.42^b
T_7 : 30 ppm GA_3 at pod initiation	37.67^b	9.58a	24.43^a	6.40^b	8.23^b	13.62^b
T_8 : 45 ppm GA_3 at pod initiation	38.07^b	9.62a	24.50^a	6.43^b	8.39^b	13.38^b
T_9 : 15 ppm GA_3 at flower + pod initiation	40.53^a	10.18a	24.50^a	7.02^a	9.28^a	14.59^a
T_{10} : 30 ppm GA_3 at flower + pod initiation	43.07^a	10.32a	24.80^a	7.30^a	9.39^a	15.19^a
T_{11} : 45 ppm GA_3 at flower + pod initiation	42.73^a	10.25a	24.80^a	7.21^a	9.30^a	15.03^a
S.E. m$\pm$	1.34	0.33	0.31	0.22	0.23	0.53
CD at 5%	3.91	0.96	0.90	0.65	0.67	1.56

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

Table 3: Effect of different treatments on seed, straw yield and harvest index

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1 : Control (No spray)	2360^b	2683^a	46.81^a
T_2 : Water Spray at flower + pod initiation	2372^b	2706^a	46.70^a
T_3 : 15 ppm GA_3 at flower initiation	2599^a	2929^a	47.02^a
T_4 : 30 ppm GA_3 at flower initiation	2723^a	3017^a	47.48^a
T_5 : 45 ppm GA_3 at flower initiation	2576^a	2819^a	47.74^a
T_6 : 15 ppm GA_3 at pod initiation	2560^a	2887^a	47.03^a
T_7 : 30 ppm GA_3 at pod initiation	2548^a	2930^a	46.51^a
T_8 : 45 ppm GA_3 at pod initiation	2599^a	2963^a	46.73^a
T_9 : 15 ppm GA_3 at flower + pod initiation	2829^a	3068^a	47.95^a
T_{10} : 30 ppm GA_3 at flower + pod initiation	2857^a	3083^a	48.12^a
T_{11} : 45 ppm GA_3 at flower + pod initiation	2783^a	3087^a	47.36^a
S.E. m$\pm$	106	123	0.41
CD at 5%	311	-	-

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

and number of pods plant^{-1} due to the application of gibberellic acid cumulatively resulted in higher seed yield plant^{-1}. Two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded 19 per cent more seed yield plant^{-1} than the untreated control treatment. The results of the present experiment are in agreement with the results of Matwa *et al.* (2017) and Kumar *et al.* (2017).

Seed index

Two applications of 30 ppm gibberellic acid at flower and pod initiation stages recorded significantly higher seed index (24.80 g) than the control (Table 2). However, it was at par with all other the gibberellic acid management treatments. The lowest value for seed index of chickpea crop was observed in control treatment (23.37 g). The best treatments recorded 6 per cent heavier seeds than the control treatment.

Seed, straw yield (kg ha^{-1}) and harvest index (%)

Seed yield was significantly improved due to various gibberellic acid management treatments (Table 3). Two applications of 30ppm gibberellic acid at flower and pod initiation stages recorded significantly highest seed yield (2857 kg ha^{-1}) than the control treatment. However, it was at par with all other gibberellic acid management treatments. Two applications of 30 ppm gibberellic acid at flower and pod initiation stages registered 21per cent seed yield than the control treatment. The seed yield of chickpea crop was increased due to cumulative effect of improvement in yield attributing characters, enhanced photosynthetic efficiency and improvement in the capacity of the reproductive sinks to utilize the incoming assimilates due to the foliar application of GA_3. The results of the present experiment were supported by the findings of Kumar *et al.* (2017), Giri *et al.* (2018) and Dawar (2019).

The effect of various treatments on straw yield was found to be non-significant. Numerically the highest value of straw yield was observed with the treatment two applications of 45 ppm gibberellic acid at flower and pod initiation stages (3087 kg ha^{-1}). The lowest value of the straw yield was observed with the control treatment (2683 kg ha^{-1}).

The effect of various treatments on harvest index of chickpea crop was found to be non- significant. Numerically the highest value of harvest index was observed with the treatment two applications of 30ppm GA_3 at flower and pod initiation stages (48.12 %). The lowest value of the harvest index was observed with the single application of 30 ppm gibberellic acid at pod initiation stage (46.51%).

LITERATURE CITED

Anonymous, 2018[a]. Annual Report 2017-2018. All India Coordinated Research Project on Chickpea.

Anonymous, 2018[b]. Data retrieved from //http//dpd.gov.in/strategy/preamble.htm.

Baliah, N. T., C.P. Sheeba and S. Mallika, 2018. Encouraging effect of gibberellic acid on the growth and biochemical characters of green gram, J. Global Biosciences, 7(8) 5522-5529.

Dawar, R., 2019. Effect of exogenous application of gibberellic acid on blackgram (*Vigna mungo* L.). M.Sc. (Agri.). thesis (Unpub) submitted to the Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola.

Deol, J.S., Shyam, Chandrima, R. Sharma, R. Kaur and S.I. Meena, 2018. Improving productivity of pulses using plant growth regulators: a review, International Journal of Microbiology Research. 10 (6):1259-1263.

Giri, M.D., C.P. Jaybhaye, D.G. Kanwade and A.N. Patil, 2018. Effect of foliar application of gibbrellic acid on pigeonpea (*Cajanus cajan* L.) under rainfed conditions, PKV Res. J., 42(2): 72-78.

Hossain, M.I., M.A. Mannam and M.A. Kareem, 2015. Salicylic acid and gibberellic acid ameliorate the adverse effect of salinity on chickpea, Bangladesh Agron. J.,18(1): 81-88.

Kumar, S., S. Jangde, T. Priya and B.R. Yashu, 2017. Effect of GABA on morphology, yield and yield attributes in blackgram (*Vigna mungo* L. Hepper) under salt stress condition, International J. Pure and Applied Bioscience, 5 (5):1223-1228.

Manjari, A., S.D. Singh, R. Gupta and A.K. Singh, 2018. Responses of black gram to foliar applied plant growth regulators, International J. Current Micro. and Applied Sci., 7: 4058-4064.

Matwa, D., K.P. Rao, J.S. Dhewa and Rajveer,2017. Effect of plant growth regulators and micronutrients on flowering and yield parameters of greengram, International J. Current Micro. and Applied Sci., 7: 2350-2356.

Mazid, M. and N. Naqvi, 2014. Key approach of plant growth regulator application in searching of best time for enhancing nitrogen fixation capacity of chickpea cultivar DCP 92-3, UJAHM.2(05): 8-18

Panse, V.G. and P.V. Sukhatme, 1995. Statistical Methods for Agricultural workers, Indian Council of Agricultural Research, New Delhi : 145-–152.

Rahman, M.A. and K.K. Nath, 1993. Effect of seed treatment of IAA and GA3 on sex expression, fruit character and yield of bottle gourd, Bangladesh J. Sci., 5(2):57-63.

Rathod, R.R., R.V. Gore and P.A. Bothikar, 2015. Effect of growth regulators on growth and yield of french bean (*Phaseolus vulgaris* L.) var. arkakomal, IOSR J. Agri. and Veter. Scie., 8 (5): 2319-2380.

Sarwar, N. A. , O.F. Rehman, K. M. Farooq, A. Wasaya, W. Nouman, M.Z. Ali and M. Shahzad, 2017. Exogenous application of gibberellic acid improves the maize crop productivity under scarce and sufficient soil moisture condition, Cercetari Agronomice in Moldova. 4(172):65-73.

Tiwari, V. and P.L. Eugenia, 2018. Effect of foliar application of gibberellic acid on growth, yield, physiological and biochemical characteristics of mungbean (*Vigna radiata* L.) under salt stress, Indian J.Chem. Studiesl, 6 (5) : 713-717.

Received on : 15.01.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Tillage and Weed Management Practices on Physico-Chemical Properties of Soil and Yield of Soybean in Inceptisols

N. M. Konde[1], S. N. Ingle[2], S. M. Bhoyar[3], Nilam Kanase[4], J. P. Deshmukh[5], P. R. Kadu[6], D. V. Mali[7] and Jyoti Shirankar[8]

ABSTRACT

An investigation was carried during the year 2018-19 to study the" Effect of tillage and weed management practices on physico-chemical properties of soil and yield of soybean in Inceptisols" at Research Farm of All India Coordinated Research Project (AICRP) on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The study has focused the integrated effect of tillage and weed management practices on physico-chemical properties of soil , yield of soybean and availability of nutrients. Five weed control practices were superimposed in four strips of different tillage practices in strip plot with three replications. The tillage operations consist of conventional tillage, reduced tillage, minimum tillage and zero tillage, while the weed management practices includes application of pre emergence weedicide (diclosulam), post emergence weedicides (propaquizafop + imazethapyr.), integration of pre emergence and post emergence weedicide, hand weeding and weedy check. The soil of the experimental plot was alkaline in reaction and low to medium in organic carbon. the available nitrogen and phosphorus was low and potassium was high to very high. Based on the observation noted, the bulk density of soil was significantly influenced due to tillage and weed management practices. The lowest bulk density was noted with zero tillage (1.46 Mg m^{-3}) followed by reduced tillage (1.45 Mg m^{-3}). The highest MWD (0.75 mm) was enumerated with minimum tillage and hand weeding management practice (0.75 mm). While the interaction of tillage and weed management practices showed non-significant results in respect of soil physical properties. The highest available of nitrogen (207.33 kg ha^{-1}), phosphorus (20.07 kg ha^{-1}) and potassium (346.1 kg ha^{-1}) were recorded with treatment minimum tillage and hand weeding practice.

Soybean (*Glycine max*. L.) is miracle crop and has witnessed phenomenal growth in production. Processing and trade of soybean in last few years in India has revolutionized the rural economy and improved socio-economic status of farmers. Soybean cultivation has placed India on the world map in recent past. Soybean has not only gained the vital importance in Indian agriculture, but also plays a decisive role in oil economy of India.

The area under soybean cultivation in India in 2018 was 23.15 million ha, having production of 42.25 million metric tons with yield of 1.83 MT ha^{-1}. While in Maharashtra the area under cultivation of soybean was 34.48 Lakh ha with production of 29.00 Lakh MT. The soybean production of India in 2018-19 is 11 $MTha^{-1}$. (Annonymous, 2018) Soybean being a very important rainy season crop, suffers severally due to infestation of several weeds resulting in yield losses upto 77 per cent depending on the weeds species, their density and period of weed-crop completion (Tiwari and Kurchania,1990). If weed are not controlled during the first 30 days after sowing, the critical period of weed- crop competitions reduces the yield of soybean up to 31 to 84 percent depending upon the type and intensity of weed infestation (Kachroo *et al.*, 2003).

Tillage has direct and indirect impacts on water, soil and air quality. One expects to find a diversity of tillage equipment, practices and systems, reflecting the variety of agro ecosystems and the degrees of mechanization and industrialization. Even within one tillage system, there can be numerous technical options available to farmers. The tillage experiments are site specific and yield results are often non-repeatable even under the same soil conditions. While tillage changes soil characteristics, the effects are usually not of the magnitude to significantly affect emergence and early plant growth in experimental plots. Most experiments on effects of different tillage systems showd non-significant results or inconsistent data from year to year. Tillage experiment inconsistencies are due to the complexity of changes in

1,4,7. Assistant Professor (SSAC), 2. Retd. Professor (SSAC), 3. Professor (SSAC), 5. Associate Professor (Agronomy), 6. Head (SSAC) and 8. PG Student, Department of Soil Science and Agril. Chemistry, Dr. PDKV, Akola

soil properties caused by tillage. Therefore, the repeated tillage experiments under black-cotton soil conditions would lead to draw a definite conclusion, similarly very little work has been carried out on integration of tillage and use of weedicide on soil properties and yield of soybean. Moreover, the practical feasibility of the tillage practice would also play a major role when it comes to disseminate the technology to farmer's field. Hence, the outcome of present investigation will certainly be beneficial to the researchers and stakeholders of this region and its repetition may provide the solution on sustainable basis

Therefore, considering the intensity of weeds under different tillage operation, its competition with major crops and ultimate influence on soil properties and yield of soybean, the present investigation was defined. The major intention of framing this experiment was to find out the effect of various weedicides on soil and to assess the properties of soil.

MATERIAL AND METHODS

The field experiment was conducted at Research Farm of AICRP on Weed Management, Department of Agronomy, Dr. PDKV, Akola during *Kharif* 2018-19. The experiment was conducted with nine treatments and three replications laid out in a strip plot design.

The pre-emergence herbicide i.e., Diclosulam was sprayed throughout the field at the rate of 0.030 kg a.i. ha^{-1} PE. The Post-emergence herbicide i.e., Propaquizafop + Imazethapyr was applied in the field according to the subplot treatments of 0.125 kg a.i. ha^{-1} POE at 20 DAS. The selected plots of the field with different treatments of weed control were treated with weed free (2H at 15 & 30 DAS + 1HW at 20 DAS) and weed check (unweeded).

The initial soil samples (0-20 cm) were collected from each plot in all the three replications. The treatment wise soil samples were also collected at harvest. Nearly 2.0 kg of representative soil sample from each plot of all the representative treatment were collected for laboratory studies. Soil clods were collected from the plot for determination bulk density and for aggregate analysis. The analysis of physical, chemical and nutrient properties of collected samples were carried out using standard procedures (Black 1965; Jackson 1967) and The test of significance to the experimental data was carried out as per procedure described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of tillage and weed management practices on physical properties of soil

The result indicates that the bulk density (1.44 Mg m^{-3}) under conventional tillage and adoption of hand weeding (1.43 Mg m^{-3}) supported to minimize the bulk density, but it has not influenced significantly (Table 3). This might be because of higher porosity and greater aeration in the soil. Similar findings were observed by Osunbitan *et al*., (2005) who stated that zero tillage has recorded highest bulk density than other tillage practices. The results are also in conformity with the findings of Grant and Lafond (1993). While, the MWD was numerically higher under minimum tillage and hand weeding, but the results were non-significant. Similar results were achieved by Mohanty and Painuly (2003) who reported that the tillage practices contributed in changing the mean weight diameter of the soil. The mean weight diameter was registered higher under minimum tillage. It was significantly lowered in weedy check treatment and the highest in WM2 i.e., application of post emergence weedicide propaquizafop + imazethapyr.

Effect of tillage and weed management practices on chemical properties of soil

The pH was higher in minimum tillage (7.64) followed by zero tillage. While the lowest (7.61) value of pH was registered with conventional tillage. The similar results were observed by the Kahlon and Singh (2014) who noted the highest pH was recorded under conventional tillage followed by no tillage and roto tillage (Table 2). Similarly, the electrical conductivity was assessed and was noted highest (0.33 dSm^{-1}) under minimum tillage. The lowest (0.27 dSm^{-1}) electrical conductivity was registered where conventional tillage was adopted. Similarly, reduced tillage (1 harrowing + 1 rototill) also contributed to minimize the electrical conductivity upto 0.29 dSm^{-1}. The results were confirmed by Kahlon and Singh (2014). Equivalent results were obtained by Gholami *et al.*, (2014). The properties like pH and electrical conductivity have not shown significant

Table 1. Effect of tillage and weed management practices on bulk density and mean weight diameter under soybean

Treatment		**Bulk density** (Mg m^{-3})	**Mean weight diameter**(mm)
a) Tillage practices			
T1	(Conventional tillage)	1.44	0.73
T2	(Reduced tillage)	1.45	0.70
T3	(Minimum tillage)	1.43	0.75
T4	(Zero tillage)	1.46	0.71
	SE(m)±	0.01	0.02
	CD at 5%	NS	NS
b) Weed management practices			
WM1	(Pre emergence weedicide)	1.44	0.71
WM2	(Post emergence weedicide)	1.45	0.73
WM3	(Pre emergence & Post emergence)	1.43	0.71
WM4	(Weed free)	1.45	0.75
WM5	(Weedy check)	1.46	0.70
	SE(m)±	0.01	0.03
	CD at 5%	-	-
Interaction of tillage and weed management (a X b)			
	SE(m)±	0.02	0.06
	CD at 5%	-	-

results, but the values of the same were enhanced under conventional tillage and hand weeding.

The organic carbon and calcium carbonate were assessed, but the results were non-significant. Minimum tillage and hand weeding practices have noted the highest organic carbon (5.28 & 5.44 g kg^{-1}, respectively) as compared to other tillage practices. The calcium carbonate was reduced to 10.77 per cent in conventional tillage. The lower values of calcium carbonate noticed under conventional tillage must be due to leaching adsorbed carbonates on clay particles , formation of humic acids and also due to enhanced aeration in the soil rhizosphere. The results were confirmed by the study of Kahlon and Singh (2014) who stated that conventional tillage has lowest soil organic carbon. Similar findings were obtained by Dick (1983).

Effect of tillage and weed control practices on available nutrients in soil under soybean

The data pertaining to available nutrients influenced by integration of tillage and weed management practices is presented in (Table 3). The available soil nutrients were influenced and mostly observed higher in minimum tillage. However, the soil nutrients were less in conventional tillage. Among weed management practices the nutrients were commonly more in weed free (hand weeding) and weedy check (unweeded) treatment as compared to other management practices.

In respect of residual soil fertility, available nitrogen, phosphorus and potassium was influenced significantly with minimum tillage. The highest available N (207.33 kg ha^{-1}), Phosphorus (20.0 kg ha^{-1}) and potassium (346.17 kg ha^{-1}) observed with minimum tillage. The corresponding observations were noticed by Khakural *et al.,* (1992) and Kahlon and Singh (2014) who revealed that the conventional tillage recorded the lowest soil available nitrogen and phosphorus. Similarly, Dick (1983) reported that there was greater amount of nitrogen under no tilled condition. The soil available potassium and sulphur was showing similar decreasing trend as minimum tillage > zero tillage > reduced tillage> conventional tillage.

Table 2. Effect of tillage and weed management practices on Chemical properties of soils under soybean

Treatment	pH (1:2.5)	Electrical conductivity (dSm^{-1})	Organic Carbon ($g\ kg^{-1}$)	Calcium Carbonate (%)
a) Tillage practices				
T1 (Conventional tillage)	7.61	0.27	4.63	10.77
T2 (Reduced tillage)	7.62	0.29	5.14	11.73
T3 (Minimum tillage)	7.64	0.33	5.28	12.07
T4 (Zero tillage)	7.63	0.30	5.25	12.05
SE(m)±	0.04	0.01	0.15	0.08
CD @ 5%	NS	NS	NS	NS
b) Weed management practices				
WM1 (Preemergence weedicide)	7.64	0.30	4.84	11.69
WM2 (Postemergence weedicide)	7.65	0.29	5.01	11.49
WM3 (Preemergence & Postemergence)	7.64	0.31	4.81	11.75
WM4 (Weed free)	7.60	0.29	5.44	11.75
WM5 (Weedy check)	7.59	0.30	5.27	11.59
SE(m)±	0.05	0.01	0.15	0.12
CD @ 5%	-	-	-	-
Interaction of tillage and weed management (a X b)				
SE(m)±0.11	0.03	0.31	0.24	-
CD @ 5%	-	-	-	-

While , the weed management practices have also influenced the availability of nutrients significantly. The appreciable enhancement in available NPK were noted where hand weeding was followed. The similar observations were noted by Jha *et al*., (2012) they observed that among different herbicides, the highest available potassium in soil was noted with imazethapyr 10 per cent SL @ 100 g a.i. ha^{-1}. Weedy check recorded the least and weed free resulted in the highest values of available potassium in the soil.

Yield of Soybean

The grain (22.96 q ha^{-1}) and straw yield (27.54 q ha^{-1}) was noticed significantly higher in conventional tillage (T_1) followed by reduced tillage (T_2). The lowest (17.30 q ha^{-1}) grain yield was observed in zero tillage (T_4) among all tillage practices (Table 4). The conventional tillage have 24.6 per cent more grain yield than zero tillage. While, in respect of straw yield, the 27.54 q ha^{-1} was recorded to be the highest straw yield under conventional tillage where ploughing and harrowing was allowed every year and which was followed by reduced tillage. The 20.76 q ha^{-1} was the lowest straw yield and was registered under the zero tillage (T_4). The straw yield was 32.65 per cent greater under conventional tillage than in zero tillage. Kahlon and Singh (2014) concluded that lower straw yield was observed under conventional tillage. The similar results were obtained by Webber *et al*., (1986) who observed that conventionally tilled soybean had a greater yield potential due to greater vegetative growth but with less than adequate.

Under weed management practices the grain and straw yield was superior in weed free treatment where hand weeding was operated and found the lowest in weedy check treatment. The highest (24.74 q ha^{-1}) grain yield and straw yield (30.10 q ha^{-1}) was noticed in weed free treatment. It was followed by WM_3 where preemergence and postemergence was applied. In weedy check (WM_5) treatment the lowest grain yield (13.65 q

Table 3. Effect of tillage and weed management practices on available nutrients in soil under soybean

Treatment		Available Nutrients (kg ha^{-1})			Sulphur
		Nitrogen	Phosphorus	Potassium	(Mgkg^{-1})
a) Tillage practices					
T1	(Conventional tillage)	193.30	16.92	332.17	8.96
T2	(Reduced tillage)	201.98	18.47	341.71	9.97
T3	(Minimum tillage)	207.33	20.07	346.17	10.95
T4	(Zero tillage)	205.76	19.89	342.52	10.73
	SE (m)±	1.61	0.20	2.36	0.29
	CD at 5%	5.58	0.67	8.15	1.00
b)	**Weed management practices**				
WM1	(Preemergence weedicide)	199.37	17.72	336.05	9.78
WM2	(Postemergence weedicide)	204.67	18.97	340.39	10.16
WM3	(Preemergence & Postemergence)	198.14	17.77	337.19	9.85
WM4	(Weed free)	205.29	20.03	345.53	10.71
WM5	(Weedy check)	202.99	19.71	344.07	10.28
	SE (m)±	1.89	0.36	1.70	0.28
	CD at 5%	5.44	1.03	5.11	NS
Interaction of tillage and weed management (a X b)					
	SE (m)±	3.77	0.72	10.23	0.55
	CD at 5%	10.87	2.07	NS	1.59

Table 4. Effect of tillage and weed management practices on yield of Soybean

Treatment		Yield (q ha^{-1})	
		Grain	Straw
a)Tillage practices			
T1	(Conventional tillage)	22.96	27.54
T2	(Reduced tillage)	20.67	25.06
T3	(Minimum tillage)	19.52	23.75
T4	(Zero tillage)	17.30	20.76
	SE (m)±	0.12	0.21
	CD at 5%	0.43	0.73
b) Weed management practices			
WM1	(Preemergence weedicide)	17.84	21.36
WM2	(Postemergence weedicide)	20.66	24.43
WM3	(Preemergence & Postemergence)	23.67	29.34
WM4	(Weed free)	24.74	30.10
WM5	(Weedy check)	13.65	16.15
	SE (m)±	0.47	0.71
	CD at 5%	1.35	2.06
Interaction of tillage and weed management (a X b)			
	SE (m)±	0.94	1.43
	CD at 5%	-	-

ha^{-1}) and straw yield (16.15 q ha^{-1}) was recorded. Kumar *et al.,* (2018) observed that the post emergence tank mix combination of propaquizafop + imazethapyr helps in improving growth and yield of soybean.

On the basis of present study, it can be concluded that, the adoption of minimum tillage and hand weeding have registered notable changes in respect of physico-chemical soil properties and residual soil fertility. Therefore, the integration of minimum tillage and hand weeding have found beneficial for maintaining physico-chemical properties of soil, yield and residual soil fertility under soybean in Inceptisols.

LITERATURE CITED

Annonymous, 2018. Soybean production by State Soyean Processor Association of India.

Black C.A., 1965. Methods of Soil Analysis, Part I&2 *American Society of Agronomy*, Madison, Wisconsin USA.

Dick, W.A., 1983. Organic carbon, nitrogen and phosphorous concentration and pH in soil profiles as influenced by tillage intensity, Soil Sci. Soc. Am. J., 47 : 102-107.

Grant, C.A. and G.P. Lafond, 1993. The effects of tillage systems and crop sequences on soil bulk density and penetration resistence on a clay soil in southern Saskatchewan, Canadian J. Soil Sci., 73 (2): 223-232.

Gholami, A., H.R. Asgari, and Z. Saeidifar, 2014. Short-term effect of different tillage systems on soil salinity, density and nutrients in irrigated wheat, Int. J. Adv. Biol. Biom. Res. 2(5): 1513-1524.

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

Jha, B.K., R. Chandra and R. Singh, 2012.Influence of post emergence herbicides on weeds, nodulation and yields of soybean and soil properties, Agricultural research communication centre, Legume Res., 37 (1): 47 - 54.

Kachroo, D., A.K. Dixit and A.S. Bali, 2003. Weed management in oilseed crops, J. Res. SKVAST, 2(1): 1-12.

Kahlon, M.S. and G. Singh, 2014. Effect of tillage practices on soil physico-chemical characteristics and wheat straw yield, Int. J. Agril Sci., 4 (10): 289-293.

Khakural, B.R., G.D. Lemme, T.E. Schumacher and M.J. lindstrom, 1992. Effect of tillage system and landscape on soil, Soil and Tillage Res., 25: 43-52.

Kumar, J., D. Nirmal, A. Pradhan, P. Sharma and G.R. Charry, 2018. Effect of Tillage on Nutrient Dynamics and Physical Condition of Soil under Rainfed Rice Chick Pea Based Cropping System of Bastar, Chhattisgarh, International J.Curr. Microbiology App. Sci., 7(12): 2319-7706.

Mohanty, M. and D.K. Painuly, 2003. Land preparatory tillage effects on soil physical properties and growth and yield of rice in a vertisol, J. Indian Soc. Soil Sci., 51(3) : 217-222.

Osunbitan, J.A., J.D. Oyedele and K.O. Adekalu, 2005. Tillage effects on bulk density,hydraulic conductivity and strength of a loamy sand soil in southwestern Nigeria, Soil and Tillage Res., 82 (1): 57-64.

Panse, V.G. and P.V. Sukhatme, 1985. Statistical methods for agricultural workers, ICAR, NewDelhi

Tiwari, J.P. and S.P. Kurchania, 1990. Survey and management of soybean ecosystem in Madhya Pradesh, Indian J. Agril. Sci., 60: 672-676.

Webber C. L., M.R. Gebhardt and H.D. Kerr, 1986. Effect of Tillage on Soybean Growth and Seed Production, Alliance of Crop, Soil and Environmental Sci. Soc., 79(6): 952-956.

Received on : 5.6.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Natural Zeolite on Dry Matter Accumulation and Nutrient uptake of Cotton in Salt Affected Soils of Purna Valley

Kime Mado[1], A. B. Age[2], S. D. Jadhao[3], P. R. Kadu[4], N. K. Patke[5] and G. S. Laharia[6]

ABSTRACT

The pot culture study was conducted at shed net house Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola, to study the effect of natural zeolite on dry matter accumulation and nutrient uptake of cotton in salt affected soils of Purna valley The experiment was laid out in completely randomized design with eleven treatments consisting of 75 per cent RDF (90:45:45 NPK kg ha^{-1}) and 100 per cent RDF (120:60:60 kg ha^{-1}) for bt cotton in separate treatment combinations with FYM, gypsum and three zeolite levels with three replications.The results indicated that,the application of various levels of zeolite significantly improved the dry matter accumulation, content and uptake of nutrient and nutrient use efficiency of cotton. Among various zeolite levels the application of 100 per cent RDF+ Zeolite @ 450 kg ha^{-1}recorded significantly highest dry matter accumulation of cotton,total uptake of nutrients and nutrient use efficiency of cotton and was found to on par with application of 100 per cent RDF + Zeolite @ 300 kg ha^{-1} (T_{10}) and 100 per cent RDF + Zeolite @ 150 kg ha^{-1} (T_9).

Cotton (*Gossypium* spp.) Known as the "king of fiber",is a valuable fiber and cash crop andis plays an important role in the economy of farmers as well as the world. Originated in India, this fiber crop accounts for approximately 25 per cent of total global fiber supply.It is also known as "white gold" and provides direct livelihood to 6 million farmers and 40-50 million people are employed in cotton trade and its processing. India accounts for roughly one-third of the world's cotton area. Two-thirds of cotton produced in India is grown in the central cotton growing region, which includes the states of Maharashtra, Madhya Pradesh, Gujarat, and Odisha. Approximately 62 percent of India's cotton is grown under rainfed condition, while 38 percent is grown on irrigated land.Among the various cotton varieties, *Gossypium hirsutum* and *Gossypium arboreum* are widely grown in Maharashtra and used in textile industries to make fabric. Vidarbha is the largest cotton growing region in Maharashtra, accounting for 15.81 lakh ha^{-1} acreage and producing 35.5 lakh bales with a productivity of 388.0 kg lint ha^{-1} (Anonymous, 2020). Purna valley's black hard clay soils have a high potential for crop production. However, there is significant potential for improving these salt affected soils by implementing proper management methods based on thorough research for diagnosing their issues.There is a clear need to enhance the nutrient use efficiency particularly in valuable cash crops like cotton to improve crop productivity in a sustainable way. In this regard inclusion of natural zeolite in agricultural fertilizer management is a relatively recent approach to improve the soil fertility and nutrient uptake and thereby maximizing the crop yield.Zeolites improves the nutrient use efficiency by increasing the availability of N with capture, storage and utilization of N-NH_4^+ and N-NO_3^- and reduce losses by leaching of exchangeable cations.Zeolite promotes better plant growth by improving the value of fertilizers due to its relatively high adsorption rate, cation exchange, and catalysis and dehydration capacity.The use of different rates of chemical fertilizers amended with zeolite can improve soil fertility and enhance crop production.

MATERIAL AND METHODS

A pot culture experiment was conducted at shade net located at Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season 2020-2021. The soil samples were collected from the farmer's field of salt affected soils of Purna valley (Waki, Anakwadi, Ghusar). The experimental soil comprised of clayey, montmorillonitic, hyperthermic family of Typic Haplusterts.The test crop

1. P.G. Student, 2. Assistant Professor, SSAC, 3.Associate Professor, SSAC, 4. Head, SSAC, 5.Associate Professor, Agronomy,6.Associate Professor, Department of SSAC, Dr. PDKV, Akola.

used in this experiment wasbt cotton (Ajeet-199).The experiment was arranged as a complete randomized design with eleven treatments and three replications. Different treatment combinations of 75 per cent and 100 per cent nitrogen (urea), phosphorus (P_2O_5) and potassium (K_2O) @ 90:45:45 kg ha^{-1} (1.50:2.25:0.60 g pot^{-1}) and 120:60:60 kg ha^{-1} (2.25:3.0:0.90 g pot^{-1}), respectively with FYM (5 t ha^{-1} *i.e.,* 22.32 g pot^{-1}), gypsum (2.5 t ha^{-1} *i.e.,* 11.20 g pot^{-1}) and 3 levels of zeolite (150, 300, 450 kg ha^{-1} *i.e*., 1.20, 2.40, 3.40 g pot^{-1}) were applied as per treatments. The cotton plants were maintained till harvest at 95 DAS.The weight of dry matter accumulated in plant is an index of plant growth. The cotton plant harvested were air dried under shade for five days and subsequently dried in the thermostatic oven at 65 ^{0}C, till constant weight. The final constant dry weight was recorded as total dry matter accumulation plant^{-1}.

The digestion of plant samples for estimation of total nitrogen content was carried out with concentrated sulphuric acid and salt mixture ($CuSO_4$, K_2SO_4 and selenium powder). For determination ofphosphorus, potassiumand micronutrients (Zn, Fe, Cu and Mn)the digestion was done with di-acid mixtureof nitric acid (HNO_3) and perchloric acid ($HClO_4$) in 9:4 ratio. The plant samples (0.5 g) were digested in a micro processer based block digestion unit. The digested plant samples were distilled using micro-processor based automatic distillation unit and the liberated ammonia was trapped in boric acid containing mixed indicator and titrated against 0.01 N H_2SO_4 for determination of total nitrogen in plant(A.O.A.C. 1995). Vanado-molybdate yellow colour method was used to determine the phosphorus content in the di-acid digested plant samples. The intensity of colour was read at 420 nm wavelength using spectrophotometer (Jackson, 1973). Potassium content in the di-acid digested plant sample was estimated by atomizing the diluted plant extract in the flame photometer as described by Piper (1966). Uptake of nutrients *viz*., N, P and Kwas calculated by considering dry matter yield at harvest in the particular pot in relation to concentration of the particular nutrient in respective treatment using the formula

Uptake of nutrient (g pot^{-1}) = Nutrient content (%) x Dry matter yield of shoot or roots (g pot^{-1}).

RESULTS AND DISCUSSION

Dry matter accumulation

The application of 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_{11}) (Table 1) recorded significantly highest dry matter accumulation in leaves of cotton (12.70 g plant^{-1}) which was found on par with 100 per cent RDF+ Zeolite @ 300 kg ha^{-1} (T_{10}), 100 per cent RDF+ Zeolite @ 150 kg ha^{-1} (T_9), 75 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_8) and 75 per cent RDF + Zeolite @ 300 kg ha^{-1} (T_7) while lowest dry matter accumulation in leaves was observed in absolute control (5.68 g plant^{-1}).The dry matter yield of shoot of cotton showed non-significant effect among various treatments.The highest dry matter accumulation in cotton shoot was noticed with application of treatment 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_{11}) followed by 100 per cent RDF+ Zeolite @ 300 kg ha^{-1} (T_{10}) and 75 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_8). The root dry matter yield of cotton recorded maximum value (11.05 g plant^{-1}) with the application of 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_{11}) followed by 10.58 g plant^{-1}of root dry matter obtained with the application of 100 per cent RDF+ Zeolite @ 300 kg ha^{-1} (T_{10}) which wereon par with each other. The lowest dry matter yield of root was recorded in control (4.41 g plant^{-1}).

Further more, the total dry matter accumulation of cotton was recorded significantly highest (27.38 g plant^{-1}) with the application of 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} (T_{11}) which was found on par with the treatments T_{10}, T_9,T_8andT_7*viz*., 100 per cent RDF+ Zeolite @ 300 kg ha^{-1} ,100 per cent RDF+ Zeolite 150 @ kg ha^{-1}, 75 per cent RDF+ Zeolite @ 450 kg ha^{-1} and 100 per cent RDF + Zeolite @ 300 kg ha^{-1} found superior over rest of the treatments and control. The absolute control recorded the lowest total dry matter accumulation (13.86 g plant^{-1}) of cotton.The increase in dry matter accumulation may be attributed to enhanced nutrient availability due to reduced loss of major nutrients especially N, P and K as a result of zeolite application which play an important role in slow release of nutrients.The results are consistent with the findings of Malekian *et al*. (2011), who discovered a significant increase in maize stover dry matter in soil treated with surfactant modified zeolite and zeolite clinoptilolite. Manikandan *et al*. (2016) similarly concluded that nanozeourea-treated soil yielded the greatest dry matter of maize.

Uptake of nutrients

Total uptake of nitrogen

TheNitrogen uptake was significantly increased with the various levels of zeolite (Table 2). The treatment T_{11} (100 per cent RDF + Zeolite @ 450 kg ha^{-1}) registered significantly higher N uptake by leaves (5.84 g plant^{-1}) which was also significantly higher than N uptake by shoot and roots of cotton (1.12 and 5.30 g plant^{-1} respectively) while the lowest N uptake by cotton leaves, shoot and root was noticed in control (2.10, 0.64, 1.68 g plant^{-1}respectively). The treatment T_{11} was superior over rest of the treatments and control. It was found to be on

Table 1. Dry matter accumulation of cotton at harvest as influenced by various treatments

Treatments		Dry matter accumulation(g plant^{-1})			
		Leaves	Shoot	Root	Total
T_1	Absolute Control	5.68	3.77	4.41	13.86
T_2	75 % RDF + FYM @ 5 tonnes ha^{-1}	8.33	3.95	5.65	17.93
T_3	100 % RDF + FYM @ 5 tonnes ha^{-1}	9.68	4.02	6.13	19.83
T_4	75 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	8.08	3.97	6.29	18.34
T_5	100 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	9.17	3.80	7.07	20.04
T_6	75 % RDF+ Zeolite @ 150 kg ha^{-1}	8.93	2.27	7.27	18.48
T_7	75 % RDF+ Zeolite @ 300 kg ha^{-1}	11.72	4.16	9.31	25.18
T_8	75 % RDF+ Zeolite @ 450 kg ha^{-1}	11.87	4.37	10.16	26.40
T_9	100 % RDF+ Zeolite @150 kg ha^{-1}	11.62	4.26	9.63	25.52
T_{10}	100 % RDF+ Zeolite @ 300 kg ha^{-1}	12.36	4.40	10.58	27.33
T_{11}	100 % RDF+ Zeolite @ 450 kg ha^{-1}	12.70	4.46	11.05	27.38
	SE (m) ±	1.01	0.52	0.17	1.26
	CD at 5 %	3.07	NS	0.51	3.73

Table 2 . Total uptake of nitrogen by cotton as influenced by various treatments

Treatments		Total N uptake (g plant^{-1})			
		Leaves	Shoot	Root	Total
T_1	**Absolute Control**	**2.10**	**0.64**	**1.68**	**4.42**
T_2	75 % RDF + FYM @ 5 tonnes ha^{-1}	3.50	0.79	2.60	6.89
T_3	100 % RDF + FYM @ 5 tonnes ha^{-1}	4.26	0.84	3.00	8.11
T_4	75 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	3.15	0.71	2.83	6.70
T_5	100 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	3.58	0.68	2.69	6.95
T_6	75 % RDF+ Zeolite @150 kg ha^{-1}	3.84	0.48	3.42	7.73
T_7	75 % RDF+ Zeolite @ 300 kg ha^{-1}	5.51	0.96	4.66	11.12
T_8	75 % RDF+ Zeolite @ 450 kg ha^{-1}	5.58	1.05	5.18	11.81
T_9	100 % RDF+ Zeolite @ 150 kg ha^{-1}	5.35	0.98	4.72	11.04
T_{10}	100 % RDF+ Zeolite @ 300 kg ha^{-1}	5.81	1.01	4.87	11.69
T_{11}	100 % RDF+ Zeolite @ 450 kg ha^{-1}	5.84	1.12	5.30	12.26
	SE (m) ±	0.45	0.12	0.26	0.78
	CD at 5 %	1.34	0.36	0.77	2.36

par with 100 per cent RDF + Zeolite @ 300 kg ha^{-1} (T_{10}) and 100 per cent RDF + Zeolite @150 kg ha^{-1} (T_9) ,75 per cent RDF + Zeolite @ 450 kg ha^{-1}and 75 per cent RDF + Zeolite @ 300 kg ha^{-1}. Moreover, the total nitrogen uptake by cotton significantly improved from 4.42 g plant^{-1} in absolute control (T_1) to 12.26 g plant^{-1}in T_{11} (100 % RDF + Zeolite @ 450 kg ha^{-1})which was found significantly higher than rest of the treatments and on par with 100 per cent RDF + Zeolite @ 300 kg ha^{-1}(T_{10}), 100 per cent RDF + Zeolite @ 150 kg ha^{-1} (T_9),75 per cent RDF + Zeolite @ 450 kg ha^{-1}and 75 per cent RDF + Zeolite @ 300 kg ha^{-1}. The favorable effect of zeolite on soil CEC enhances NH_4z adsorption and reduces leaching losses, resulting in greater N availability in the plant root zone, might be the reason responsible for higher nitrogen uptake. Similar results were reported by Lija *et al*. (2014)indicating that combining zeolite with compound fertilizer increased N uptake in maize and that applying larger dosages of zeolite together with nitrogen increased N uptake in rice grain and straw (Kavoosi, 2007). Ahmed *et al*. (2008) reported that zeolite boosted N absorption in maize significantly.

Total uptake of Phosphorus

The data (Table 3) on uptake of phosphorus by cotton leaves, shoot and root were significantly influenced by various zeolite levels and comparatively more uptake of P by leaves of cotton was observed than the P uptake by shoot and roots of cotton. The P uptake was recorded significantly highest with the application 100 per cent RDF + Zeolite @ 450 kg ha^{-1}(T_{11}) with 2.16, 0.71 and 3.98 g plant^{-1} values for phosphorus uptake in leaves, shoot and roots respectively while lowest observed value of P uptake *i.e*., 0.51, 0.34 and 1.01 g plant^{-1} for leaves, shoot and root respectively was registered from absolute control.Further, the total phosphorus uptake by cotton was recorded significantly highest with the application of treatment T_{11} i.e., 100 per cent RDF + Zeolite @ 450 kg ha^{-1} (6.85 g plant^{-1}) which was found on par with 100 per cent RDF + Zeolite @ 300 kg ha^{-1}(T_{10}), 100 per cent RDF + Zeolite @ 150 kg ha^{-1} (T_9),75 per cent RDF + Zeolite @ 450 kg ha^{-1}and 75 per cent RDF + Zeolite @ 300 kg ha^{-1}. The inclusion of zeolite increased the P concentration significantly. This might be due to increased availability of P in soil as a result of the zeolite's solubilisation impact on P in the soil and the synergistic impact of N on P, resulting in increased availability of P in soil, and thereby resulting in significantly high P uptake.

The result is in conformity with the findings of Ahmed *et al*. (2010) who reported that the usage of inorganic fertilizers in conjunction with zeolite improves P absorption and use efficiencies in maize cultivation and P absorption in leaves, stems, and roots was higher when opposed to regulation.Similar results were reported by

Table 3. Total uptake of phosphorus by cotton as influenced by various treatments

Treatments		Total P uptake (g plant^{1})			
		Leaves	Shoot	Root	Total
T_1	**Absolute Control**	**0.51**	**0.34**	**1.01**	**1.86**
T_2	75 % RDF + FYM @ 5 tonnes ha^{-1}	0.92	0.51	1.41	2.84
T_3	100 % RDF + FYM @ 5 tonnes ha^{-1}	1.36	0.52	1.66	3.53
T_4	75 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	0.97	0.52	1.64	3.12
T_5	100 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	1.28	0.49	1.98	3.76
T_6	75 % RDF+ Zeolite @ 150 kg ha^{-1}	1.25	0.30	2.04	3.58
T_7	75 % RDF+ Zeolite @ 300 kg ha^{-1}	1.99	0.67	2.89	5.54
T_8	75 % RDF+ Zeolite @ 450 kg ha^{-1}	1.90	0.70	3.25	5.85
T_9	100 % RDF+ Zeolite @ 150 kg ha^{-1}	1.98	0.68	3.37	6.03
T_{10}	100 % RDF+ Zeolite @ 300 kg ha^{-1}	2.10	0.70	3.70	6.51
T_{11}	100 % RDF+ Zeolite @ 450 kg ha^{-1}	2.16	0.71	3.98	6.85
	SE(m)±	0.41	0.02	0.21	0.58
	CD at 5 %	1.22	0.06	0.62	1.74

Table 4. Total uptake of potassium by cotton as influenced by various treatments

Treatments		Total K uptake (g plant $^{-1}$)			
		Leaves	**Shoot**	**Root**	**Total**
T_1	Absolute Control	1.25	2.11	3.09	6.45
T_2	75 % RDF + FYM @ 5 tonnes ha{ ^{1}	2.00	2.33	4.07	8.40
T_3	100 % RDF + FYM @ 5 tonnes ha{ ^{1}	2.42	2.53	4.84	9.80
T_4	75 % RDF +Gypsum @ 2.5 tonnes ha{ ^{1}	1.70	2.06	4.59	8.35
T_5	100 % RDF +Gypsum @ 2.5 tonnes ha{ ^{1}	1.83	1.90	5.02	8.75
T_6	75 % RDF+ Zeolite @ 150 kg ha{ ^{1}	2.14	1.38	5.45	8.98
T_7	75 % RDF+ Zeolite @ 300 kg ha{ ^{1}	3.05	2.70	7.63	13.39
T_8	75 % RDF+ Zeolite @ 450 kg ha{ ^{1}	2.85	2.62	8.13	13.60
T_9	100 % RDF+ Zeolite @150 kg ha{ ^{1}	3.02	2.73	7.90	13.64
T_{10}	100 % RDF+ Zeolite @ 300 kg ha{ ^{1}	3.21	2.82	8.68	14.71
T_{11}	100 % RDF+ Zeolite @ 450 kg ha{ ^{1}	3.30	2.90	9.28	15.48
	SE(m)±	0.26	0.24	0.56	0.61
	CD at 5 %	0.79	0.73	1.67	1.81

Rabai *et al.* (2013) who reported that treatments with clinoptilolite zeolite greatly improved P uptake in all plant sections as compared to soil alone (control). P uptake in stems, leaves and roots was significantly higher in the compound fertilizer treatment mixed with clinoptilolite zeolite.

Total uptake of Potassium

The uptake of potassium by cotton leaves, shoot and roots were significantly influenced by various zeolite levels (Table 4). Among the different treatments, 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} registered significantly highest uptake of potassium by cotton leaves, shoot and roots (3.30, 2.90 and 9.28 kg ha^{-1}respectively) and was found to at par with 100 per cent RDF + Zeolite @ 300 kg ha^{-1}, 100 per cent RDF + Zeolite @ 150 kg ha^{-1}, 75 per cent RDF + Zeolite @ 450 kg ha^{-1}and 75 per cent RDF + Zeolite @ 300 kg ha^{-1}. The total potassium uptake by cotton was recorded significantly highest (15.48 kg ha^{-1}) with the application of 100 per cent RDF + Zeolite @ 450 kg ha^{-1}and was found at par with treatment 100 per cent RDF + Zeolite @ 300 kg ha^{-1}. The increased K uptake in the zeolite treatments might be attributed to decreased potassium leaching. This is due to the fact that when zeolites are combined with soil, they aid in the retention of nutrients from applied fertilizers in the root zone.These results are in line with the findings of Rabai *et al.* (2013), who observed that the compound fertilizer combined with clinoptilolite zeolite significantly increased K uptake in stem, leaves, and roots. Similar results were obtained by Lija *et al.* (2014) who found that the treatment with compound fertiliser + zeolite resulted in significantly higher K absorption in roots, stems and leaves.

Nutrient use efficiency

The nutrient use efficiency of cotton clearly indicated (Table 5) that there was increased nutrient use

Table 5. Effect of various treatments on nutrient use efficiency of cotton

	Treatments	Nutrient Use Efficiency(%)
T_1	**Absolute Control**	-
T_2	75 % RDF + FYM @ 5 tonnes ha^{-1}	24.05
T_3	100 % RDF + FYM @ 5 tonnes ha^{-1}	28.11
T_4	75 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	45.42
T_5	100 % RDF +Gypsum @ 2.5 tonnes ha^{-1}	48.65
T_6	75 % RDF+ Zeolite @ 150 kg ha^{-1}	50.72
T_7	75 % RDF+ Zeolite @ 300 kg ha^{-1}	75.12
T_8	75 % RDF+ Zeolite @ 450 kg ha^{-1}	78.15
T_9	100 % RDF+ Zeolite @150 kg ha^{-1}	76.77
T_{10}	100 % RDF+ Zeolite @ 300 kg ha^{-1}	82.27
T_{11}	100 % RDF+ Zeolite @ 450 kg ha^{-1}	86.47

efficiency of cotton with increased levels of zeolite. The highest nutrient use efficiency (86.47%) was noticed with application of 100 per cent RDF + Zeolite @ 450 kg ha^{-1} followed by 100 per cent RDF + Zeolite @ 300 kg ha^{-1} and 75 per cent RDF + Zeolite @ 450 kg ha^{-1}. The higher nutrient use efficiency of cotton might be attributed to the properties of zeolite such as high cation exchange, larger surface area, dehydration-rehydration and adsorption and slow release of nutrients during the growth of crop.These results are in conformity with those reported by Hua *et al*., (2006), Kavoosi (2007) and Majid *et al*., (2012).

CONCLUSION

It can be concluded that,the application of various levels of zeolite significantly improved the dry matter accumulation, uptake of nutrient and nutrient use efficiency of cotton.Among various zeolite levels the application of 100 per cent RDF+ Zeolite @ 450 kg ha^{-1} recorded significantly highest dry matter accumulation, total uptake of nutrients and nutrient use efficiency of cotton grown in salt affected soils of Purna valley.

LITRATURE CITED

Anonymous, 2020. http://krishi.maharashtra.gov.in, Department of Agriculture, Govt. of Maharashtra.

Ahmed, O.H., A. Hussain, H.M.H. Ahmad, A.A. Rahim and N.M.A. Majid, 2008. Enhancing the Urea-N use efficiency in maize (*Zea mays*) cultivation on acid soils amended with zeolite and TSP, The scientific world journal, 8: 394–399.

Ahmed, O.H., G. Sumalatha and N.M.A. Majid, 2010. Use of zeolite in maize (*Zea mays*) cultivation on nitrogen, potassium and phosphorus uptake and use efficiency, International J.Phy. Sci., 5(15): 2393-2401.

Hua, Q. X., J.M.Zhou, H.Y.Wang, C.W.Du, X.Q.Chen and J.Y.Li, 2006. Effects of modified clinoptilolite on phosphorus mobilisation and potassium or ammonium release in Ferrosols, Australian J. Soil Res., 44:285-290.

Jackson, M.L., 1973. Soil Chemical Analysis (Edn. 2) Prentice Hall of India Pvt.Ltd. New Delhi : 69-182.

Kavoosi, M., 2007. Effects of Zeolite application on rice yield, nitrogen recovery and nitrogen use efficiency, Communications in Soil Science and Plant Analysis, 38(12): 69-76.

Lija, M., O.H. Ahmed and S. Kasim, 2014. Maize (*Zea mays L.*) nutrient use efficiency as affected by formulated fertilizer with Clinoptilolite Zeolite, Emirates J. Food Agri., 26 (3): 284-292.

Majid A., M. Gholamhoseini, A. Dolatabadian, A. KhodaeiJoghan and K. S. Asilan, 2012. Zeolite influences on nitrate leaching, nitrogen-use efficiency, yield and yield components of canola in sandy soil, Archives of Agronomy and Soil Science, 58 (10) : 149-1169.

Malekian, R., J. Abedi-Koupai and S.S. Eslamian, 2011. Influences of clinoptilolite and surfactant-modified clinoptilolite zeolite on nitrate leaching and plant growth, J. Hazardous Materials, 185: 970–976.

Manikandan, A. and K.S. Subramanian, 2016. Evaluation of Zeolite based nitrogen Nanofertilizers on Maize growth, yield and quality on Inceptisols and Alfisols, International J. Pl. & Soil Sci., 94: 1-9.

Piper, C.S., 1966. Soil and Plant Analysis, Hans. Pub. Bombay, Asian Ed. : 368-378.

Rabai, K.A., O.H. Ahmed and S. Kasim, 2013. Use of formulated nitrogen, phosphorus, and potassium compound fertilizer using clinoptilolite zeolite in maize (*Zea mays L.*) cultivation, Emirates J. Food and Agriculture, 25 (9): 713-722.

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Different Planting Geometry on Growth and Yield of Different Bt Cotton Varieties

R. S. Pise[1], S. U. Kakade[2], V. V. Goud[3] and N. D. Parlawar[4]

ABSTRACT

A field investigation under rainfed condition in Inceptisol was carried at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season of 2020-21. Four planting geometry viz. 60 x 15 cm (1,11,111 plants ha^{-1}), 60 x 30 cm (55,555 plants ha^{-1}), 90 x 15 cm (74,074 plants ha^{-1}) and 90 x 60 cm with four varieties viz. Suraj Bt, PKV 081 Bt, Rajat Bt and GJHV 374 Bt, were laid out in split plot design with three replications. Although higher growth attributes viz., leaf area (24.68 dm^2), monopodial branches (1.37), sympodial branches (27.98), dry matter plant^{-1} (67.23 g) and yield attributes viz., number of boll plant^{-1}, boll weight per plant and seed cotton yield plant^{-1} was recorded with wider planting geometry but significantly higher seed cotton yield was recorded with closer spacing of 60 x 15 cm. Among cotton genotype Rajat Bt recorded higher growth, yield and quality attributes viz., higher tenacity, elongation, micronaire value and seed cotton yield (1608 kg ha^{-1}).

Cotton (*Gossypium hirsutum* L.) is one of the most ancient and important component crop next to food grains. Due to its importance in agriculture as well as industrial economy, it is also known "White Gold". In India during 2019-2020 is expected around 360 lakh bales 170 kg from 125.84 lakh hectares with a productivity of 486 kg lint ha^{-1}. During the 2019-20, Maharashtra, Gujarat and Telangana were the major cotton growing states covering around 69.60 per cent (87.59 lakh hectare) in area under cotton cultivation and 63.88 percent (230 lakh bales) of cotton production in India. In Maharashtra total area under cotton is about 43.69 lakh ha and annual production of about 82 bales of 170 kg with productivity 319 kg ha^{-1}, (Project coordinator report: 2019-20). In India, the seed cotton yield unit^{-1} area is still far below than many other cotton growing countries in the world. There is much scope to increase the cotton production in India by increasing the productivity through adoption of appropriate agronomic practices. The current economic climate continues to impact profit margins with production cost on the rise due in part to increased seed cost associated with transgenic technologies, producers are searching for ways to increase efficiency. This has led to changes seeding rates, row spacing and row-configurations such as solid planted, twin-rows, and skip-row patterns with the advent of precision seed drop planters and GPS control systems, producers can manipulate plant populations to optimize yield. There is also a need to find out optimum plant density for recently released cotton hybrids to realize the maximum yield potential. Hence, the need to find out the potentially of cotton genotypes and also to save cotton seeds with different plant densities under rainfed condition. So this study was conducted with the objective to screen out the rational plant density for yield maximization in Bt cotton under the high density planting system.

MATERIAL AND METHODS

A field investigation was carried out at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India during *Kharif* season of 2020-2021. The soil of experimental plot was medium deep black with fairly uniform and levelled topography with slightly alkaline in reaction with medium status of organic carbon content, available nitrogen and phosphorous and fairly rich status of available potassium. Four cotton planting geometry *viz.,* 60 x 15, 60 x 30, 90 x 15 and 90 x 60 cm with four Bt cotton varieties viz., Suraj, PKV 081, Rajat and GJHV 374 were laid out in split plot design with three replications. The cotton crop was sown on June 24, 2020 and harvested in three pickings up to last week of December, 2020.

RESULTS AND DISCUSSION

Growth parameters

The closer planting geometry 60 x 15 cm recorded

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

significantly superior plant height over remaining plant geometry. Maximum plant height was recorded at closer planting geometry might be due the reduction in plant height under wider planting geometry due to suppression of apical dominance as against closer planting geometry which induced more vertical growth due to congestion of plant per unit area (Table 1). Similar result reported by Jagtap and Bhale (2011), Parlawar *et al.* (2017). The planting geometry 90 x 60 cm recorded significantly more leaf area, monopodial and sympodial branches per plant. It might be due to a wider spacing plant enjoyed more space, light, moisture, and nutrient efficiently. These results are in line with finding of Parlawar *et al.* (2017), Kumar and Ramchandra (2019). Dry matter production per plant was increased with wider planting geometry, this might be due to more number of sympodial and monopodial branches due to the larger ground area, more availability of moisture and nutrients, more light interception by more number of leaves and leaf area resulting in higher photosynthetic activity and more biomass accumulation through the process of plant metabolism. These results are in accordance with the finding of Jagtap and Bhale (2011) and Shukla *et al.* (2014).

The varieties Suraj Bt recorded significantly highest plant height than other varieties. The Rajat Bt recorded significantly superior leaf area plant^{-1} over Suraj Bt and GJHV 374 Bt, however, which was at par with PKV 081 Bt, might be due to more number of large size leaves in Rajat Bt than other varieties. Difference in leaf area per plant might be mainly ascribed to difference in genetic makeup of the varieties. The number of monopodial branches plant^{-1} did not differ significantly due to the different varieties. The significantly more number of sympodial branches plant^{-1} was recorded with Rajat Bt over GJHV 374 Bt, PKV 081 Bt and Suraj Bt. Among varieties Rajat Bt recorded significantly higher dry matter accumulation plant^{-1} over GJHV 374 Bt, however, it was at par with PKV 081 Bt and Suraj Bt. This might be due better photosynthetic ability of plant resulting into more dry matter accumulation in leaves, stem and reproductive parts. Similar results was recorded by Ban (2015).

Yield attributes

Planting geometry significantly influenced the number of picked bolls plant^{-1}, at wider planting geometry 90 x 60 cm number of picked bolls plant^{-1} significantly higher than the all other plant geometry, might due to sufficient space available which creates better aeration, less competition and higher photosynthesis, Similar result reported by Reddy and Kumar (2010) and Bhalerao and Gaikwad (2010). The influenced of plant geometry on boll weight plant^{-1} was found non-significant, planting geometry 90 x 60 cm recorded higher boll weight plant^{-1} than the other treatments. Planting geometry had not significant effects on boll weight plant^{-1}, similar result reported by Jagtap and Bhale (2010), Iqbal and Khan (2011). At wider planting geometry 90 x 60 cm seed cotton yield plant^{-1} was significantly superior over remaining spacing. This might be due to overall improvement in growth attributes and its positive effect on number of bolls plant^{-1} at wider geometry. The above result was in conformity with the findings of Parihar *et al.* (2018), Kumar and Ramchandra (2019).

Number of picked boll plant^{-1} was significantly higher in Rajat Bt than Suraj Bt and GJHV 374 Bt, however, it was at par with PKV 081 Bt. The difference in number of bolls plant^{-1} among varieties was directed consequence of difference in sympodial branches plant^{-1}. The significant differences among varieties for number of bolls plant^{-1} had also been reported by Subramanian and Murugan (2011), Singh *et al.* (2012). Boll weight per plant was not influenced significantly across the varieties, however, significantly higher seed cotton yield plant^{-1} was recorded with Rajat Bt followed by PKV 081 Bt.

Yield

The planting geometry 60 x 15 cm recoded significantly maximum seed cotton yield ha^{-1} over 90 x 15 cm and 90 x 60 cm (Table 2), however, it was not significant with 60 x 30 cm, it might be due the higher number of plant unit^{-1} area, similar result reported by Sowmiya and Sakthivel (2018). Cotton stalk and biological yield ha^{-1} was significantly highest in 60 x 15 cm. (Table 2). All the cotton varieties differed from each other for seed cotton yield. Rajat Bt registered significantly superior seed cotton yield than Suraj Bt and GJHV 374 Bt, however, which was at par with the PKV 081 Bt. might be due to the genetic ability and better photosynthetic efficiency through better source sink relations as reflected in harvest index. similar result also reported by Singh *et al.* (2010), Parlawar *et al.*

Table 1. Growth, yield and quality attributes as influenced by different treatments.

Treatment	Growth attributes					Yield attributes			Quality attributes				
	Plant height (cm)	Leaf area (dm^2)	Monopodia branches $plant^{-1}$	Sympodia branches $plant^{-1}$	Dry matter plant(g)	Number of boll $plant^{-1}$	Boll weight $plant^{-1}$	Seed cotton yield $plant^{-1}$ (g)	UHML (mm)	Uniformity Index (%)	Micronair value (µg $inch^{-1}$)	Tenacity 3.2 mm (g tex^{-1})	Elongation (%)
A) Planting Geometry													
S_1 - 60 x 15 cm	95.8	20.4	0.8	23.0	40.7	4.8	3.27	16.9	27.6	81.8	4.4	28.0	5.9
S_2 - 60 x 30 cm	87.9	22.6	1.3	24.2	41.7	7.4	3.29	20.8	28.1	81.8	3.7	27.7	6.0
S_3 - 90 x 15 cm	85.3	20.7	1.0	24.6	45.6	6.2	3.35	24.5	25.8	80.0	4.6	27.0	6.0
S_4 - 90 x 60 cm	84.9	24.7	1.4	27.0	67.2	19.1	3.42	64.6	26.5	80.8	4.3	27.9	6.5
SE (m) ±	2.26	0.60	0.07	0.63	1.07	0.38	0.04	1.21	-	-	-	-	-
C.D. at 5%	7.83	2.08	0.24	2.18	3.70	1.32	NS	4.19	-	-	-	-	-
B) Varieties													
G_1 - Suraj Bt	91.4	21.3	1.0	23.6	48.9	9.0	3.26	30.2	27.1	81.0	4.2	27.0	6.1
G_2 - PKV 081 Bt	90.5	22.9	1.0	24.3	49.0	9.7	3.33	33.2	27.2	81.3	4.3	27.9	6.0
G_3 - Rajat Bt	88.7	23.1	1.0	27.8	51.7	10.1	3.30	36.0	26.9	81.0	4.3	28.0	6.2
G_4 - GJHV 374 Bt	83.2	21.1	1.3	24.1	45.7	8.7	3.43	27.4	26.8	81.0	4.2	27.5	6.1
SE (m) ±	1.89	0.60	0.11	0.82	0.99	0.38	0.04	1.03	-	-	-	-	-
C.D. at 5%	5.52	1.75	NS	2.40	2.90	1.10	NS	3.01	-	-	-	-	-
C) Interaction (PXG)													
SE (m) ±	3.78	1.20	0.82	1.64	1.99	0.75	0.07	2.06	-	-	-	-	-
C.D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Seed cotton, stalk, biological yield, harvest index and economics as influenced by different treatments

Treatment	Yield (kg/ha)			Harvest	Economics (Rs/ha)			
	Seed cotton	Stalk	Biological	Index (%)	Cost of cultivation	GMR	NMR	BCR
A) Plant Geometry								
S_1 - 60 x 15 cm	1589	3530	5119	31.04	40143	91168	51025	2.27
S_2 - 60 x 30 cm	1519	2875	4394	34.56	38368	86664	48296	2.25
S_3 - 90 x 15 cm	1488	3143	4631	32.13	38145	85216	47071	2.23
S_4 - 90 x 60 cm	1456	2545	4001	36.39	36641	82826	46185	2.26
SE (m) ±	20	73	126	-	-	1120	1110	-
C.D. at 5%	68	252	435	-	-	3877	NS	-
B) Varieties								
G_1 - Suraj Bt	1505	3021	4526	33.25	37799	83038	48239	2.27
G_2 - PKV 081 Bt	1562	3073	4636	33.69	38852	89219	50367	2.29
G_3 - Rajat Bt	1608	3127	4735	33.95	38773	91803	53030	2.36
G_4 - GJHV 374 Bt	1377	2871	4248	32.41	37873	78814	40941	2.08
SE (m) ±	18	63	107	-	-	989	989	-
C.D. at 5%	51	184	311	-	-	2889	2889	-
C) Interaction (S x G)								
SE (m) ±	35	126	213	-	-	1978	1979	-
C.D. at 5%	-	-	-	-	-	-	-	-

(2017) and Parihar *et al.* (2018). The cotton Rajat Bt registered higher cotton stalk and biological yield, which were significantly superior over GJHV 374 Bt, however, which was at par with PKV 081 Bt and Suraj Bt. The Cotton genotype Rajat Bt recorded highest harvest index than the PKV 081 Bt followed by Suraj Bt and GJHV 374 Bt.

Quality parameters

Quality parameters viz., higher upper half mean length (UHML), uniformity index and tenacity was recorded with closer spacing, however, more micronaire and elongation value was recorded with wider spacing. The cotton genotype PKV 081 *Bt* showed maximum values of UHML and uniformity index, however, higher tenacity and elongation value was recorded with Rajat Bt, whereas micronaire value was identical with PKV 081 Bt and Rajat Bt.

Economics

The planting geometry of 60 x 15 cm recorded the significantly highest gross monetary return over remaining treatments (Table 2). The next superior treatment 60 x 30 cm recorded maximum gross monetary return, however, it was at par with the 90 x 15 cm and 90 x 60 cm. The influenced of planting geometry on net return was not significant, however, highest return was recorded with 60 x 15 cm, over remaining planting geometry. The net return at closer planting geometry was increased might be due to high plant density, which was responsible for obtaining higher seed cotton yield ha^{-1}. The identical benefit cost ratio (BCR) was recorded across the planting geometry.

Among varieties Rajat Bt recorded significantly maximum gross and net return than Suraj Bt and GJHV 374 Bt, however, it was at par with PKV 081 Bt. Similar result reported by Singh *et al.* (2010), Udikeri and Shashidhara *et al.* (2017). The cotton varieties Rajat Bt recorded the highest BCR followed by PKV 081 Bt, Suraj Bt and GJHV 374 Bt.

CONCLUSION

The yield and quality attributes viz., UHML, uniformity index and tenacity value and seed cotton yield was higher with closer spacing of 60 x 15 cm, however, among varieties Rajat Bt has recorded highest yield and yield attributes viz., tenacity, elongation and micronaire value and seed cotton yield.

LITERATURE CITED

Anonymous., 2019. ICAR-All India Coordinated Research Project on Cotton- annual Report 2019-20. https://aiccip.cicr.org.in/3_A1_A19_PC _report

Ban, Yogesh G., D.P. Nawalkar, B.M. Mote, V. Kumar and A.V. Narwade, 2015. Crop phenology, thermal requirement, yield and fiber properties of cotton (*Gossypium hirsutum*) genotypes as influenced by different environments, Indian J. Plant Physio., 20 (2): 1347-144.

Bhalerao, P.D. and Godavari S. Gaikwad, 2010. Productivity and profitability of Bt cotton (*Gossypium hirsutum*) under various land geometry and fertilizer levels under rainfed condition, Indian J. Agron., 55 (1) : 60-63.

M. Iqbal and R. Khan, 2011. The growing concept and uses of training needs assessment: A review with proposed model, J. European Industrial Training, 35(5):439-466.

Jagtap, D.N. and V.M. Bhale, 2011. Effect of different plant spacing and nitrogen levels of deshi cotton hybrid (*Gossypium arboreum* L.), J. Agric. Sci., 7: 123-125.

Kumar S. and Ramchandra, 2019. Growth and yield of cotton as influenced by planting geometry and genotypes under high density planting system, International J. Curr. Microbiol. App. Sci., 8 (5): 2073-2077.

Parlawar N. D., D.J. Jivtode, V.S. Khawale, K.J. Kubde and P.D. Puri, 2017. Effect of Planting geometry and varieties on morpho-physiological parameter and yield of cotton, J. Soils and Crops, 27(2):152-158.

Parihar, L.B., T.H. Rathod, S.M. Raut and N.S. Kahate, 2018. Impact of genotypes and high density planting on yield and yield attributes and quality parameter in *hisrstum* cotton, J. Pharmacognosy and Phytochemistry, 7(6) **:** 2089-2092.

Reddy, P.R.R. and B.D. Kumar, 2010. Fertilizer response studies in Bt cotton hybrid, J. Cotton Res. Dev., 24 (1):7677.

Shukla, S.P., M.J. Puma and B.I. Cook, 2014. The response of the South Asian Summer Monsoon circulation to intensified irrigation in global climate model simulations, *Clim. Dyn.*, 42 (1-2): 21-36.

Singh, Kulvir, Harmandeep Singh, R.K. Gumber and Pankaj Rathore, 2010. Studies on the Seed Cotton Yield, Growth and Yield Contributing Characters of New Bt. Cotton Hybrids under Varied Agronomic Manipulations, World Cotton Research Conference on Technologies for Prosperity.

Singh, Kulvir, Harmandeep Singh, R.K. Gumber and Pankaj Rathore, 2012. Response of desi cotton (*Gossypium arboreum* L.) genotypes to plant geometries and nutrient levels under irrigated conditions, J. Cotton Res. Dev., 26 (1): 58-61.

Subramanian, A. and S. Murugan, 2011. Assessment of stability over environment in upland cotton, Plant Archives, 11 (2): 1135-1141.

Sowmiya R. and N. Sakthivel, 2018. Effect of Planting Geometry on Growth and yield of cotton, Madras Agriculture J., 105(1-3): 30-32.

Udikeri M. and G.B. Shashidhara, 2017. Performance of compact genotypes under high density planting system at different fertilizer levels, J. Farm Sci., 30 (4): 460-466.

* * *

PKV Res. J. Vol. 44 (1), January 2020

Effect of Packaging Material on Dehydrated Tomato Slices

S. V. Khanezod[1], A. M. Sonkamble[2], D. S. Ravankar[3] and S. R. Patil[4]

ABSTRACT

The present investigation was carried out in Post-harvest technology Laboratory at University, Department of Horticulture, Dr. PanjabraoDeshmukhKrishiVidyapeeth, Akola during 2017-2018. The experiment was laid out in Factorial Completely Randomized Design with three replications. Tomato (*Solanum lycopersicon* L.) slices were dried in solar drier at 60 ^{0}C upto 6 per cent moisture level and packed in 200 gauge polyethylene bags (P_2), 300 gauge polyethylene bags (P_3), aluminated foils (P_4), plastic boxes (P_5) and as control i.e, unpacked samples (P_1) stored upto 180 day from drying. Packaging in aluminated foil found to be good for retaining maximum nutritional contents during storage period. Maximum retention of nutrients likeprotein, total sugars, reducing sugars, non reducing sugars, ascorbic acid, total soluble solids, titrable acidity, crude fibre with minimum moisture was recorded in dehydrated tomato slices packed in aluminated foil as compared to other packaging material.

Tomato (*Solanum lycopersicon*) is the second most important vegetable crop in India, next only to potato. Tomato is good source of minerals, vitamins, organic acids, lycopene, beta-carotene, phenols and flavonoids. Tomato is a warm season vegetable crop belongs to family Solanaceae. The average nutritional value per 100 gm of edible contain of tomato fruit is moisture (93.1%), protein (1.9g), fat (0.1g), minerals (0.5g), carbohydrate (3.6g), vitamin A (320 IU), thiamine (0.07 mg), riboflavin (0.01 mg) ascorbic acid (31 mg), calcium (30 mg), magnesium (15 mg) and iron (1.8 mg) per of edible part (Bose *et al*., 2002).The primary purpose of packaging is to protect the food products and to keep it in good condition and to preserve the products. The packaging must be capable of protecting the product from thermal changes, humidity variation and the hazards of rough handling, infestation and contamination from microbes. The material must be effective in preventing the product from quality deterioration. Considering the above fact an experiment was conducted to assess the effect of packaging materials and storage on nutritional qualities of dehydrated tomato slices.

MATERIAL AND METHODS

The study was conducted in post-harvest technology Laboratory at University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2017-2018. The experiment was laid out in Factorial Completely Randomized Design with three replications.

The selected tomato fruits were cut manually with stainless steel knife and prepared slices of 0.5 cm thickness. Slices were allowed for pre-treatment i.e., dipping insolution of 1 g $CaCl_2$ per 100 g + Potassium metabisulphite (KMS) 0.2 g per 100 g for 10 minutes. At the end of treatment period, the slices were taken out and drained and dried in solar dryer at 60°C upto 6 per cent moisture level.After drying, the dried slices were packed in different packaging materials viz. 200 gauge polyethylene bags (P_2), 300 gauge polyethylene bags (P_3), aluminated foils (P_4), plastic boxes (P_5) and as control (P_1) unpacked samples stored at room temperature upto 180 days from drying (Shams-Ud-Din and Shraji, 2008). Chemical analysis of slices were done at 30 days interval upto 180 day of storage. The chemical parameters like moisture, protein, total sugars, reducing sugars, non reducing sugars, ascorbic acid, total soluble solids, titrable acidity and crude fibre content were determined according to methods given by Ranganna (1979).

Table 1 : Different packaging material details for dehydrated tomato slices.

Treatments	Packaging material details
P_1	Unpacked samples (Control)
P_2	200 gauge polyethylene bags
P_3	300 gauge polyethylene bags
P_4	Aluminated foils
P_5	Plastic boxes

1 & 3. P. G. Student, 2. Head and 4. Associate Professor, Department of Vegetable Science, Dr. P.D.K.V. Akola

RESULTS AND DISCUSSION

The data (Table 2) indicated that, the content of moisture, protein, total sugars, reducing sugars, non reducing sugars, ascorbic acid, total soluble solids, titrable acidity and crude fibre showed non-significant differences on 1st day of storage.

Moisture content increased during storage of dehydrated tomato slices irrespective of packaging material and storage period. The moisture content was significantly low (9.15%) in the dehydrated tomato slices packed in aluminated foil (P_4). The increasing trend might be due to gain of moisture by dried slices from atmosphere. The gain in moisture was highest in control as compared to rest of the treatments. Similar results of increase in moisture content with the advancement of storage period were also reported by Yeboah *et al*. (2016) in tomato powder and Giri *et al*. (2018) for drying of spine gourd slices.

On 180th day of storage, maximum protein content was found in tomato slices whenpacked in aluminated foil (12.33%) and same showed minimum loss in protein content during storage period as compared to rest of the packaging materials. Decreased protein content was recorded with increase in storage duration (Negi and Roy, 2001). The decreasing trend might be due to gain of moisture by dried slices from atmosphere. Denaturation of protein was brought about by heat in presence of moisture (Khurdiya *et al*., 1972).

The total sugars, reducing sugars, non reducing sugars content in tomato slices were found significantly maximum in aluminated foil at 180th day of storage. Increasing trends of all sugars were recorded with advancement of storage period. The increasing trend might be due to activity of invertase or amylase.Similar results were reported by Osunde and MusaMukama (2007) for sun dried tomatoes.

The titrable acidity of tomato slices at 180th day of storage was found maximum when packed in aluminated foil (0.49%). Decreasing titrable acidity was recorded with advancement of storage period. This might be due to higher rate of oxidation at ambient temperature (Aggarwal *et al*., 2016).

The ascorbic acid content was higher in the dehydrated tomato slices packed in aluminated foil (23.14%) on 180th day of storage as compared to control and other packaging materials. The ascorbic acid content of tomato slices was decreased with advancement of storage. This might be due to its oxidation during dehydration which resulted in decreased ascorbic acid content (Dhotre *et al.,* 2012).

Significantly maximum total soluble solids content was observed in aluminated foil (8.57 %) over the rest of the treatments at 180thday of storage (Table 3). The increasing trend in total soluble solids might be due to the hydrolysis of polysaccharides and their subsequent conversion to reducing sugars as evidence by decreasing the starch content of tomato slices (Mane, 2010).While crude fibre showed non-significant effect on tomato slices packed in different packaging materials.The dehydrated

Table.2 Effect of packaging material onchemical parameters of dehydrated tomato slices.

Treatments	Chemical parameters									
	Moisture (%)		Protein (%)		Total sugars (%)		Reducingsugars (%)		Non reducing sugars (%)	
	1st day	180th day	1st day	180th day	1st day	180th day	1st day	180thDay	1st day	180thday
P_1	5.83	12.78	13.20	10.68	17.61	18.95	16.48	17.44	1.13	1.51
P_2	5.80	9.94	13.20	11.92	17.59	20.58	16.48	18.72	1.15	1.74
P_3	5.80	10.39	13.20	11.50	17.60	20.20	16.47	18.47	1.13	1.64
P_4	5.81	9.15	13.20	12.33	17.59	21.16	16.47	19.27	1.12	1.84
P_5	5.80	10.42	13.20	11.28	17.61	19.75	16.48	18.05	1.13	1.56
SE(m) ±	0.013	0.023	0.029	0.006	0.03	0.04	0.03	0.03	0.003	0.009
CD at 5%	-	0.068	-	0.018	-	0.12		0.11	-	0.028

Table.3 Effect of packaging material on chemical parameters of dehydrated tomato slices.

Treatments	Chemical parameters							
	Ascorbic acid (mg/100g)		Total soluble solids (%)		Titrable acidity (%)		Crude fibre (%)	
	1st day	180th day	1st day	180th day	1st day	180th Day	1st day	180th day
P_1	24.325	21.320	7.31	7.84	0.64	0.27	11.23	11.09
P_2	24.325	22.240	7.31	8.36	0.64	0.44	11.20	11.06
P_3	24.325	21.895	7.30	8.14	0.64	0.36	11.18	11.04
P_4	24.325	23.145	7.30	8.57	0.63	0.49	11.21	11.07
P_5	24.320	21.550	7.30	7.97	0.65	0.32	11.20	11.06
SE(m) ±	0.052	0.006	0.016	0.009	0.004	0.003	0.003	0.003
CD at 5%	-	0.017	-	0.027	-	0.009	-	-

tomato slices can be stored for longer duration in aluminated foil with better retention of nutrients. Protein content, total sugars, reducing sugars, non reducing sugars, ascorbic acid, total soluble solids, titrable acidity, crude fibre content were retained maximum in aluminated foil with minimum moisture content. Slices remained in good condition and preserved the nutritive quality throughout storage period.

CONCLUSION

At the end of storage period maximum content of protein, total sugars, reducing sugars, non reducing sugars, ascorbic acid, total soluble solids and titrable acidity were recorded in the dehydrated tomato slices packed in Aluminated foil (P_4) and minimum in control treatment (P_1). Control treatment showed maximum loss of chemical parameters.

LITERATURE CITED

Aggarwal, P., P. Goyal and S. Kapoor, 2016. Effect of drying methods and pre-treatments on phytonutrients of tomato slices, Int. J. Food. Ferment. Technol., 6(2): 421-432.

Bose, T. K., J. Abir, T. K. Maity nd M. G. Som, 2002. Vegetable Crops. Vol. II.

Dhotre, D. R., A.M. Sonkamble and S. R. Patil, 2012. Studies on drying and dehydration of bitter gourd slices, International J. Processing and Post-Harvest Technology.3 (1): 98-100.

Giri, K. S., A. M. Sonkamble and S. R. Patil, 2018. Effect of packaging materials and storage on nutritional qualities of dehydrated spine gourd slices, Int. J. Curr. Microbiol. App. Sci (6): 524-527

Khurdiya, D.S., D. Ambadan, M. Muralikrishna, R. Phal and B. Choudhury, 1972. Varietal trial on dehydration of peas, Indian Food Packer. 26(3): 5-7.

Mane, D. U., 2010. Effect of peeling pre-treatments and drying methods on quality of tomato slices, M.Sc. Thesis (Unpub), Dr. P. D. K.V. , Akola.

Negi, P.S. and S.K. Roy, 2001. Effect of drying conditions on quality of green leaves during long term storage, Food Res. Int. 34:283- 287.

Osunde, Z. D. and A. L. Musa Mukama, 2007. Assessment of changes in nutritional value of locally sun dried vegetables, A. U. J. T. *10*(4):248-253

Rangana, S., 1979. Manual of Analysis of Fruit and Vegetable Products, Mc-Graw Hill Publication.

Shams-Ud-Din and S.M. Shirazi, 2008. Studies on the rehydration properties of dried bitter gourd, Bangladesh J. of.Agril. Sci. 27(2): 257-263.

Yeboah, A. A., K. Q. Emmanuel, B. T. Odai, Y. P. George, and A.Victoria, 2016.Effect of irradiationand storage on the physico-chemical properties of tomato (*Solanum lycopersicon* L.) powder under solar and freeze-dried conditions in Ghana. Food Sci. and Quality Manage, 56 : 79-90.

Received on : 18.7.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Economic Performance of Giriraj Poultry Production on Supplementation of Neem Leaf (*Azadirachta indica*) and Ginger (*Zingiber officinale*) Powders

S. R. Shegokar[1], S. D. Chavan[2], S. P. Nage[3], R. R. Shelke[4], S. J. Manawar[5], R. N. Katkar[6]

ABSTRACT

A economic performance study on production of Giriraja poultry birds was conducted in the Department of Animal Husbandry and Dairy Science ,Akola during the year 2017 with the aim to evaluate the effect of supplementation of neem leaf powder (NLP) and Ginger (GP) with sole and in combination in the feed with T_1(control), T_2(0.5 % NLP) , T_3(1 % NLP), T_4(1 % GP), T_5(1 .5 % GP), T_6(0.5 % NLP + 1% GP), T_7 (1% NLP + 1.5 % GP), T_8 (1 % NLP + 1.0 % GP), & T_9(1 % NLP + 1.5 % GP) in the diet. The level of profit was higher than that of sole feeding of either NLP or GP in the diet when the birds were provided NLP + GP mixture at different levels.The margin of profit was highest (Rs 109.77/-) on feeding 1 per cent NLP + 1.5 per cent GP mixture (T_9) in the diet followed by Rs 80.13 in 1 per cent NLP + 1 per cent GP GP (T_8), Rs 61.63 in 0.5 per cent NLP + 1.5 per cent GP (T_7) and Rs. 70.76 in 0.5 per cent NLP + 1per cent GP (T_6). This trend does indicated that the margin of profit showed an increase with the increase level of NLP and GP in the mixture in the diet

In India poultry enterprise is the most organized sector in animal agriculture, worth rupees one lakh crores. The growth of poultry sector is recorded 6-8 per cent in layers and 10-12 per cent in broilers per year against the growth of agriculture sector as a whole is around 2.5 per cent. Chickens are widely kept in India and total population of chicken in India is estimated to be about 729.21 million with 133.79 million improved layer bird population regard to breed, 70.5 per cent (514.13 million), 18.3 per cent (133.79 million) and 11.1 per cent (81.28 million) of the total poultry were reported to be synthetic/hybrid and exotic, improved layer and indigenous birds, respectively.The term feed additives applied in a broad sense to all products other than these commonly called feed stuffs which could be added to the ration with the purpose of obtaining some special effects. The main objective of adding feed additives is to boost poultry bird performance by increasing their growth rate, better feed conversion efficiency, greater livability and lowered mortality in poultry birds with quality meat and eggs without harmful residue within a short time interval is the major concern to modern poultry farmers. The use of synthetic drugs as antibiotics and growth promoters has high cost implication. Sometimes, with attending adverse side effects on birds health if prolonged withdrawal period and increases risk of accumulation in tissues and eggs which could have harmful effect on human health (Jawad *et al*, 2014). In view of this consumers of poultry product dwellers demanding for drug residue free meat and eggs. This has triggered the search for alternative means to produce birds at reduced cost using natural growth and health promoters.

Herb and spices are most important parts of the human diet in addition to boosting flavor, herb and spices are also known for their preservative and medicinal values (Punita Kumar *et al*, 2014). The neem (*Azadirachta indica*) is a subtropical evergreen tree native to Indo- Pak subcontinent (Anonymous, 1985). Biologically active principles isolated from different parts of the plant include azadirachtin, nimbodin, sodium nimbolide, gedunin, mahmoodin, Gallic acid, salanin, nimbin, valassin and catechi and many other derivatives of these principles. Miliacin forms the bitter principles of its leaves (NRC, 1992). Gingr (*Zingiber officinale*) also have been successfully used as supplement to enhance the health and performance of livestock particularly monogastric animals including poultry (Obun and Ayanwate *et al*, 2008).It has good source of dietary fiber and particularly no fat and cholesterol. Keeping these in mind, the significance of neem and ginger in poultry feed, the present study planned to evaluate economics of poultry production on supplementation with neem leaf and ginger powders.

1,3& 4. Assistant Professor, 2. Head (AHDS), 5. PG Student and 6. Professor (SSAC), Department of Animal Hunsbandary and Dairy Science, Dr. PDKV, Akola

MATERIAL AND METHODS

Procurement of neem leaves

The Neem tree leaves were collected from nearby campus of Department of Animal Husbandry and Dairy Science, Dr. P.D.K.V., Akola. The collected fresh tree leaves were wash with water to clean the dust with view to maintain hygienic condition.

Drying and preparation of neem leaf powder

The fresh clean, succulent green leaves of neem tree were kept into the tray for drying and these fresh leaves were keep into the mechanical tray dryer machine for drying. The temperature for drying was maintained up to 40 ^{0}C for 4 hours at Department of Agriculture Processing Engineering, Dr. P.D.K.V., Akola. The dried neem tree leaves were crushed by mechanical grinder into fine powder. The powder was stored in air tight polythene bag with the aim to keep moisture free and development of fungus during storage until use.

Procurement of Ginger Power :

Procurement and Selection of Experimental chicks:

Total 270 number of days old chicks of Giriraja poultry birds were purchased through private supplier from Government Hatchery, C.P.D.O., Mumbai. On arrival of chicks were weighted and distributed randomly into nine treatment groups viz, T_1(control), T_2(0.5 % NLP) , T_3(1 % NLP), T_4(1 % GP), T_5(1 .5 % GP), T_6(0.5 % NLP + 1% GP), T_7(1 % NLP + 1.5 % GP), T_8(1 % NLP + 1.0 % GP),& T_9(1 % NLP + 1.5 % GP), with 30 chicks in each group on equal weight basis. The birds were randomly divided into three replicate groups of each treatment and the chicks were housed in separate compartment. All the chicks were vaccinated as per the schedule carried out at CPDO, Mumbai. The appropriate statistical method for data analysis used was CRD.

RESULTS AND DISCUSSION

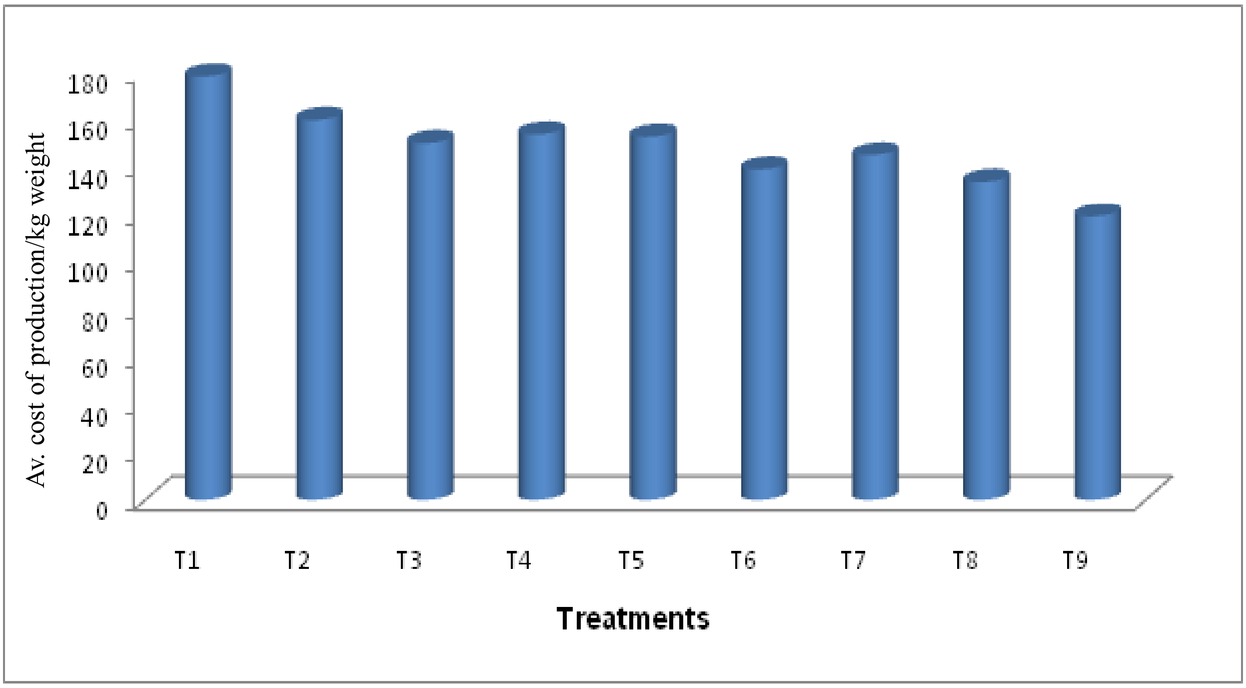
It was noticed that the feed cost in T_2 to T_9 treatment groups increased against T_1 (control) in accordance with the level of addition of NLP and ginger powder in the diet. The increase in feed cost was to the tune of 3.14, 11.42 and 13.46 per cent in sole addition of NLP Ginger and their mixture in diet, respectively. Over that of cost of Rs. 29.40 in T_1 (control). This trend is expected as addition of feed noticed in sole NLP addition (29.65 to 30.50%) was lower in comparison to sole GP and NLP + GP mixture groups. Perhaps the higher cost of ginger as compare to NLP might be the reason to raise the cost of feed. This situation had its reflection on cost of feed consumed per bird where the cost of feed was more in treatment groups in comparison to control, being 82.58 in T_1 control, 81.85 in 0.5 per cent NLP (T_2), 83.41 per cent in 1 per cent NLP (T_3), 84.76/- in 1per cent GP (T_4), 88.12/- in 1.5 per cent GP (T_5) and Rs.86.84/- to 87.83/- in T_6 to T_9 group where the mixture of NLP + GP was fed.

In general the results (Table 1) indicated that, the margin of profit showed an increasing trend from that of control group due to provision of growth promoters in the diet of birds in spite of the fact that, the total cost of production per birds was more in treatment groups in comparison of control group. The production cost per bird was Rs.156.58, 155.85, 157.41, 158.76, 162.12, 160.84, 162.57, 161.67 and 161.83/- under T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9 group, respectively. Probably the higher LBW with less consumption of feed per Kg LBW gain and improved FCR in treatment group might be the reason to emerge out this trend. It is pointed out that the LBW of birds (Kg) exhibited increase from 0.879 in T_1 (control) to 0.975 to 1.048 in sole 0.5 per cent NLP (T_2) and 1 per cent NLP (T_3), 1.032 to 1.061 in 1 per cent GP (T_4) and 1.5 per cent GP (T_5), 1.121 to 1.358 in T_6 to T_9 NLP + GP mixture fed group at 7th week of the trial. The corresponding feed consumption per kg LBW gain was 3.20 to T_1 and 2.80, 2.60, 2.60, 2.54, 2.33, 2.37, 2.22 and 1.91 in T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, and T_9 group, respectively.

Thus, the margin of profit was Rs.39.15 in T_2 and 52.19 in T_3 sole NLP groups against Rs.19.12 in T_1 control which appeared 2 to 2.7 fold more than that of control group when the birds were disposed of in retail sale basis. The level of profit margin gets slightly decrease when birds were disposed of on wholesale basis being Rs.24.25/- and 36.47/- T_2 and T_3, respectively. Considering the cost of production and price realize the cost benefit ratio on retail and wholesale basis was 1.11 and 1.04, 1.25 and 1.16, 1.33 and 1.23 in T_1, T_2, and T_3 group, respectively. Thus, the feeding of sole NLP in the diet was advantageous to raise the level of profit in Giriraja bird rearing. The past worker like Manwar *et al.* (2007) observed more profit from the birds with the incorporation of NLP in diet at 2 g kg^{-1} feed 1.5 to 2.5, 0.3 and 0.3 per cent, respectively, as a result of higher body weight gain and improved FCR in birds.

On the contrary, the margin of profit was found higher than that of control (T_1) and sole NLP (T_2-T_4) on feeding sole 1per cent GP T_4 and 1.5 per cent GP (T_5) in the diet. The margin of profit was Rs.52.19/- and 47.64/- in T_4 and T_5 treatments respectively which was higher by 2.5 to 2.7 times over that of control T_1 groups and 1.2 to 1.3 folds more than sole 0.5 per cent NLP (T_2) when the birds were dispose of on retail basis. The cost benefit ratio on and retail and wholesale basis was 1.33 and 1.23, 1.30 and 1.20 in T_4 & T_5 groups, respectively, indicating that there was decrease in profit level when the birds were sale out on wholesale basis, because of comparatively less price Rs. 185/- kg weight under whole sale as compared to retails rate (Rs.200/- kg weight). Thus the results do indicate sole supplementation of GP at 1 to 1.5 per cent in diet appeared beneficial to increase the profit level in comparison to sole feeding of 0.5 to 1 per cent NLP in diet of birds. The findings are in accordance with Eltazi *et al.* (2014) and Gaikwad *et al.* (2019) who reported highest profit ratio by feeding 1.5 per centginger in diet as compared to supplementation of Ginger at lower level and therefore this level of feeding was most economical in broiler production. While Gaikwad *et al.* (2019) noticed higher profit on feeding 1 per cent ginger powder in diet and there was decrease in profit level with the increase level (2 to 3 %) of ginger in diet.

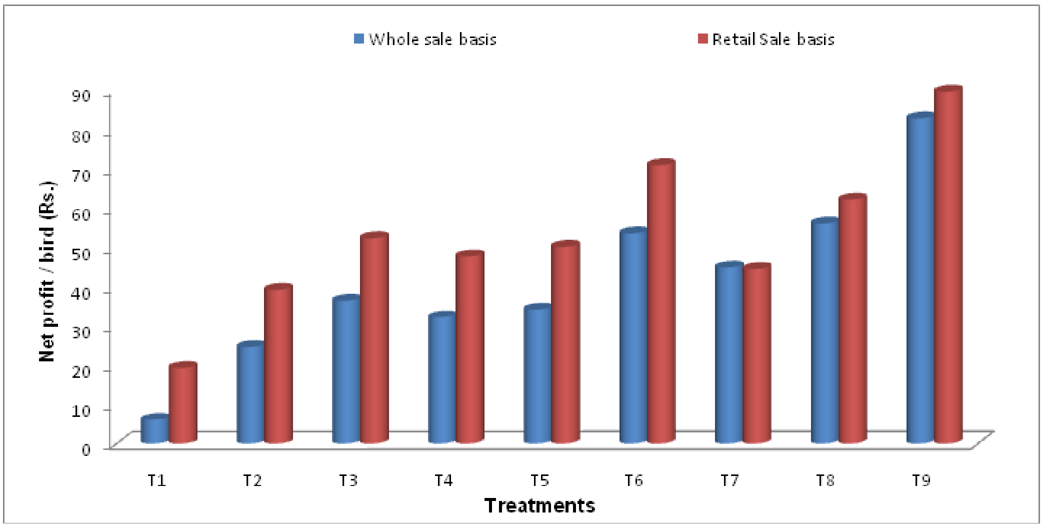
However, the level of profit was higher than that of sole feeding of either NLP or GP in the diet when the birds were provide NLP + GP mixture at different levels. The margin of profit was highest (Rs.109.77/-) on feeding 1 per cent NLP + 1.5 per cent GP mixture (T_9) in the diet followed by Rs.80.13 in 1 per cent NLP + 1 per cent GP (T_8), Rs.61.63 in 0.5 per cent NLP + 1.5 per cent GP (T_7) and Rs.70.76 in 0.5 per cent NLP + 1 per cent GP (T_6). This trend does indicate that the margin of profit showed an increase with the increases levels of NLP and GP in the mixture in the diet.



Graph 1. Economics of production of Giriraja birds fed on NLP, Ginger and their mixtures

Table 1 : Economics of production of Giriraja birds fed on Neem Leaf Powder (NLP), Ginger power(GP) and their Mixtures

SN	Particulars	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
1	Cost of day old chick (Rs.)	24	24	24	24	24	24	24	24	24
2	Cost of feed (Rs/kg)	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40
3	Cost of Neem tree leaves (Rs 1.10/kg green on DM basis)	0	0.55	1.10	-	-	0.55	0.55	1.10	1.10
4	Cost of ginger powder Rs 22.47/kg on DM basis	0	0	0	2.24	3.36	2.24	3.36	2.24	3.36
5	Total cost of feed (Rs/kg)	29.40	29.95	30.50	31.64	32.76	32.19	33.31	32.74	33.86
6	Average total feed consumed per bird (Kg)	2.809	2.733	2.735	2.679	2.690	2.698	2.659	2.678	2.594
7	Cost of feed consumed per bird (Rs.)	82.58	81.85	83.41	84.76	88.12	86.84	88.57	87.67	87.83
8	Average body weight at the end of 7^{th} week (Kg)	0.879	0.975	1.048	1.032	1.061	1.158	1.121	1.209	1.358
9	Feed consumption per kg live weight gain (Kg)	3.20	2.80	2.60	2.60	2.54	2.33	2.37	2.22	1.91
10	Cost of feed per kg live weight gain (Rs.)	93.94	83.95	79.59	82.13	83.05	74.99	79.00	72.51	64.68
11	Rearing Cost per bird (Rs.)	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
12	Total cost of production (Rs.) (1 + 7 +11)**(Cost of Cultivation)**	156.58	155.85	157.41	158.76	162.12	160.84	162.57	161.67	161.83
13	Average cost of Production / Kg weight	178.13	159.85	150.20	153.83	152.80	138.90	145.02	133.72	119.16
14	Average price realized @ **Rs. 185/-** per kg live weight (Rs.) on whole sale basis **(G. M. R. on Whole sale basis)**	162.62	180.38	193.88	190.92	196.29	214.23	207.38	223.66	251.23
15	Average price realized @ **Rs. 200/-** per kg live weight (Rs.) on retail basis **(G. M. R. on Retail basis)**	175.8	195.0	209.6	206.4	212.2	231.6	224.2	241.8	271.6
16	Net profit / bird (Rs.) on Whole sale basis	6.04	24.53	36.47	32.16	34.17	53.39	44.81	55.95	82.61
17	Net profit / bird (Rs.) on Retail Sale basis	19.22	39.15	52.19	47.64	50.08	70.76	44.41	61.99	89.40
18	Cost Benefit Ratio on Whole sale basis	1.04	1.16	1.23	1.20	1.21	1.33	1.28	1.38	1.55
19	Cost Benefit Ratio on Retail sale basis	1.11	1.25	1.33	1.30	1.31	1.44	1.40	1.50	1.68



Graph 2. Economics of production of Giriraja birds fed on NLP, Ginger and their mixtures on wholesale and retail basis

LITERATURE CITED

Eltazi Safa, M.A., 2014. Effect of using ginger powder as natural feed additive on performance and carcass quality of broiler chicks, Assint. Vet. J. Vol. 60(141):87-95.

Gaikwad D. S., Y. G. Fulpagare , U.Y. Bhoite, D.K. Devkar and C.A. Nimbalkar, 2019. Effect of diatery supplementation of Ginger and cinnamon on growth performance and economics of broiler production, International J. Current microbiology and Applied Sciences Vol.(8) Number 03 (2019).

Jawad, Z., M. Younus, M. U. Rehman, R. Munir, A. Maqbool and W. Shahzad, 2014. Effect of *Azadirachta indica* on the hepatorenal functions of broiler chickens, The J. Anim. and Pl. Sci., 24(4):1018-7081.

Manwar S. J., P.Thirumurigan, D. Konwar, Chidandaiah and D. K. Karna, 2007. Effect of *Azadirachtaindica* leaf powder supplementation on broiler performance, Indian Vet. J.,84: 159-

NRC, National Research Council, Neem, 1992. A tree for solving global problem, Washington D.C., National Academic Press

Obun, C.O. and B.A. Ayanwate, 2008. Performance of nutrient digestibility and cost evaluation of raw and roasted *Afzeliaafricane* trees meal fed to finisher broiler chicks, Nigerian J. Anim. Production, 35 : 9-17.

Punita Kumari, Chandramani, Kaushalendra Kumar, Sanjay Kumar, 2014. Effect of dietary supplementation of sugar beet, neem leaf, linseed and coriander on growth performance and carcass trait of Vanaraja Chicken, Veternary World, 7 : 639-643.

Received on : 5.5.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

Constraints in Adaptation of Scientific Management Practices by Dairy Owners under Unnat Bharat Abhiyan

A. K. Varpe[1], K. U. Bidwe[2], R. R. Shelke[3], S. D. Chavan[4] and S. D. More[5]

ABSTRACT

The present investigation entitled "Constraints in adoption of scientific management practices by dairy owners under "Unnat Bharat Abhiyan" conducted under university adopted five village clusters viz. Masa, Chandur, Kaulkhed (Gomase), Kanheri Sarap and Redwa of Akola District. A survey method of data collection was adopted by selecting 60 livestock owners from each village in such a manner total 300 respondents were selected for the study. Findings revels that, in case of financial constraints 93.33 per cent expressed high cost of concentrate. Under situational constraints 78.33 per cent expressed shortage of green fodder. In case of technical constraint 70.66 per cent farmers expressed lack of scientific knowledge. Regarding organizational constraints non availability of agro-industrial byproduct expressed 65.00 per cent by dairy owner. It was followed by animal health constraints 49.00 per cent expressed irregularity in vaccination. In case of personal constraints lack of interest (53.33 %) and low level of education (65.00 %) was quoted by the farmers. In respect of intensity of constraints, financial constraints ranked first with mean value 263.25 followed by situational (218.33), technical (206), organizational (200), animal health (190.33) and personal (177.5) contraints.

Unnat Bharat Abhiyan is a flagship programme of the Ministry of Human Resource Development, Government of India with the intention to enrich Rural India. The knowledge base and resources of the Premier Institutions of the country are to be leveraged to bring in transformation change in the rural developmental process. It also aims to create vibrant relationship between the society and the higher educational institutes, with the latter providing the knowledge and technology support to improve the livelihoods in rural areas and allied enterprises to upgrade the capabilities of both the public and private organizations in the society(Anonymous, 2018). Animal management and milk production is not a separate activity in India but a sub-system within whole farming system. Growing technological facilities expanded the massive production of milk to meet demands of more population. There are different management systems have an impact on both cows as individual and dairy enterprise as a whole. Some dairy farm is working on the production of milk at economic scale while other at small farms, like on the pasture-based farm and less dependent on chemical and pharmaceutical inputs in comparison to a large farm.

Considering same the efforts were taken in the present study to collect the information pertaining to constraints faced by the dairy owners in adoption of scientific management practices in dairy. This will definitely helpful to the researcher to identify solution over the constraints of dairy owners.

MATERIAL AND METHODS

Unnat Bharat Abhiyan is a flagship programme of the Ministry of Human Resource Development, with clear vision to involve the reputed higher educational institutions (technical/ non-technical/ public/ private) of the country in the process of indigenous development of self-sufficient and sustainable village clusters. In accordance with the above-mentioned vision, Dr. Panjabrao Deshmukh KrishiVidyapeeth act as one of the participatory institute in Vidarbha region under which cluster of five villages were selected for study viz. Masa, Chandur,Kanheri Sarap, Kaulkhed (Gomase) and Redwa. The sample consisted of 300 farmers rearing animal for milch purpose and sale of milk from five different villages of Akola district were purposively selected who had adopted dairy farming. Data was collected by personal interview with the help of a structured interview schedule especially designed for the purpose of present study. The question related to the different constraints faced by the dairy owners were also similar to be findings of Amresh, 2012 and Kale, 2012. The collected data on various constraints were subjected to statistical analysis to find

1. PG Student. 2&3. Assistant Professor, 4. Head (AHDS), 5. Assistant Professor (Ext. Edn.), Department of Animal Husbandry and Dairy Sciences, Dr. PDKV, Akola

out all means,standard deviation and coefficient of variation so as to estimate the central value rank of various constraints and extent of variability. The coefficient of variation (CV) was estimated by adopting the standard formula reported by Gupta (1997).

RESULTS AND DISCUSSION

The various constraints faced by the livestock owners have been stratified in to following major groups and discussed under following heads.

I) Financial constraints

II) Situational constraints

III) Technicalconstraints

IV) Organisational constraints

V) Personal constraints

VI) Animal health constraints

I) Financial constraints :

The financial constraints (Table 1) are prominent constraints for non-adoption of various scientific management practices by dairy owners.The major constraints expressed by respondents under this group were high cost of concentrate (90.33 per cent), high cost of green fodder (89.66%), high cost of labour (86.00 %), and high cost of mineral mixture (85.00 %). Patel *et al.* (2013) also observed 90.00 per cent of farmer expressed the constraint of high cost of feed and fodder.

II) Situational constraints

Next to financial constraints, situational constraint group was also responsible for non-adoption of scientific management practices by dairy owners.

In this case it was found that 78.33 per cent of dairy owners expressed shortage of green fodder it was followed by lack of irrigation 80.00 per cent, non-availability of pasture land expressed by 69.33 per cent respondents, lack of machinery with 68.33 per cent intensity, lack of electricity with 77.00 per cent intensity, lack of grazing facility 63.66 per cent intensity were the prominent constraints in this group (Table 2). Patel *et al.* (2013) also reported that 73.75 per cent farmer have non-availability of green fodder through the year.

III) Technical Constraints

In case of technical constraints (Table 3), lack of scientific knowledge regarding management of livestock scientifically was expressed by 70.66 per cent of respondents and lack of technical guidance was the constraints to 66.66 per cent livestock owners.These trends of results were also reported by Sarap *et al.* (2012), Waykar *et al.* (2012) and Prasad *et al.* (2017), which supports the results observed in present study.

IV) Organizational constraints

It was found that non-availability of agro-industrial byproduct in nearby areas with intensity of 65.00

Table 1.Financial constraints faced by livestock owners

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1.	High cost of concentrate	25 (83.33)	54(88.52)	98(95.14)	52 (85.24)	42 (93.33)	271(90.33)
2	High cost of green fodder	23 (76.66)	58 (95.08)	93(90.29)	55(90.16)	40(88.88)	269 (89.66)
3.	High cost of labor	11 (36.66)	55 (90.16)	97 (94.17)	54(88.52)	41 (91.11)	258 (86.00)
4.	High cost of mineral mixture	19 (63.33)	53 (86.88)	93(90.29)	52 (85.24)	38(84.44)	255(85.00)

(LL- landless, M- Marginal, S- Small, Med.- Medium and L- Large)

Table 2.Situational constraints faced by livestock owners

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1.	Lack of irrigation facilities	25(83.33)	48 (78.68)	76 (73.78)	54(88.52)	37(82.22)	240(80.00)
2.	Shortage of green fodder	28(93.33)	54(88.52)	83(80.58)	47(77.04)	23(51.11)	235 (78.33)
3.	Lack of electricity	23(76.66)	54 (88.52)	78(75.72)	48(78.68)	28(62.22)	231 (77.00)
3.	Non-availability of pasture land	19(63.33)	45 (73.77)	83 (80.58)	38(62.29)	23(51.11)	208(69.33)
4.	Lack of Machinery	30(100.00)	54(88.52)	72(69.90)	33(54.09)	16(35.55)	205(68.33)
5.	Lack of grazing facility	18(60.00)	46(75.40)	62(60.19)	39(63.93)	26(57.77)	191(63.66)

per cent (Table 4) and non-availability of fodder tree with 68.33 per cent intensity were the prominent constraints under this group. This group and diary owner was also responsible for non-adoption of scientific management practices by dairy owners.These results were also supported with the results noted by Sarap *et al.* (2012) and Waykar *et al.* (2012).

V) Personal Constraints

The constraints included under personal group (Table 5), were also responsible up to some extent for non-adoption of scientific management practices for rearing of livestock in adopted villages. These are low level of education with 65.00 per cent of intensityand lack of interest with 53.33 per cent intensity were the prominent constraints under this group.

VI) Animal health constraints

The constraints regarding animal health are indicated (Table 6) in which 88.33 per cent of livestock owners have the barrier of high cost of veterinary medicines followed by; unavailability of medicines, veterinary doctor with 53.00 per cent intensity and some livestock owners up to 49.00 per cent intensity faced the problem of irregularity of vaccination. The present results are in conformity with the observations reported by Channappagouda *et.al.* (2016).

Rank order of various constraints:

The data (Table 7) revealed that, the financial constraints were the most serious constraints due to financial crunch of the farmers (263.25) with 3.01 per cent of co-efficient of variation. This might be due to costly availability of concentrate, green fodder and mineral mixture etc.Next in order of intensity were situational constraints, which ranked second (218.33) with 9.02 per cent co-efficient of variation. This group of the constraints included lack of irrigation facilities, shortage in availability of green fodder, lack of electricity supply, non-availability of pasture land, lack of machinery for irrigation and other

Table 3.Technical constraints faced by livestock owners

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1.	Lack of scientific knowledge	26(86.66)	52 (85.24)	71(68.93)	43 (70.49)	20 (44.44)	212 (70.66)
2.	Lack of technical guidance	24 (80.00)	55 (90.16)	66 (64.07)	39(63.93)	16 (35.55)	200(66.66)

Table 4.Organizational constraints faced by livestock owners

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1	Non-availability of fodder tree	23(76.66)	52(85.24)	59(57.28)	47(77.04)	24(53.33)	205(68.33)
2	Non-availability of agro-industrial byproducts in nearby area	19(63.33)	49(80.32)	57(55.33)	48(78.68)	22(48.88)	195(65.00)

Table 5.Personal constraints faced by livestock owners

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1.	Low level of education	26 (86.66)	48 (78.68)	78 (75.72)	28 (45.90)	15 (33.33)	195 (65.00)
2.	Lack of interest	21 (70.00)	36 (59.01)	59 (57.28)	33 (54.09)	11 (24.44)	160 (53.33)

Table 6.Animal health constraints faced by the livestock owner

S.N.	Constraints	LL (30)	M (61)	S (103)	Med. (61)	L (45)	Total (n=300)
1	High Cost of Vet. Medicines	24(80.00)	55(90.16)	92(89.32)	54(88.52)	40(88.88)	265(88.33)
2	Unavailability of Medicine andV et. Doctor	12(40.00)	33(54.09)	57(55.33)	38(62.29)	19(42.22)	159(53.00)
3	Irregularity inVaccination	16(53.33)	38(62.29)	54(52.42)	29(47.54)	10(22.22)	147(49.00)

Table 7. Rank orders of various constraints

S. N.	Constraints	Mean	SD	CV (%)	Rank
1	Financial Constraints	263.25	7.93	3.01	I
2	Situational Constraints	218.33	19.69	9.02	II
3	Technical Constraints	206	8.48	4.11	III
4	Organizational Constraints	200	7.07	3.53	IV
5	Animal health Constraints	190.33	64.94	34.11	V
6	Personal Constraints	177.5	24.74	13.94	VI

operations and lack of grazing facilities. The technical constraints acquired third rank (206) with 4.11 per cent co-efficient of variation. This group mainly consists of lack of scientific knowledge and lack of technical guidance by extension agencies.The groups of organizational constraints were ranked fourth. This class of constraints consisted unavailability of fodder tree and non-availability of agro-industrial byproducts in nearby or in vicinity area.Animal health constraints were ranked at fifth position. This group of constraints consisting high cost of veterinary medicines, non-availability of veterinary medicine as well as veterinary doctor and the irregularity in vaccination. The groups of personal constraints ranked last at sixth. This class of constraints consists of low level of education andlack of interest. These trends were also reported by Sarap *et al.* (2012), Waykar *et al.* (2012), Patel *et al.* (2013) and Prasad *et al.* (2017), which supports the results observed in present study.

CONCLUSION

It was concluded from the present investigation that the majority of the dairy owners were facing number of constraints while adaptation of scientific management practices in dairy. It is therefore, necessary to give them the scientific oriented, skill base scientific management practices in dairy farming to the dairy owners. It will be helpful to reduce their numbers of constraints while adopting these practices in dairy farming.

LITERATURE CITED

Anonymous 2018; Brochure published on Unnat Bharat Abhiyan (UBA) by Ministry of Human Resource Development, Government of India.

Channappagouda.B., G.V. Deekshit, Krishna Bharadwaja and S.D. Mahesh, 2016. Constraints in adoption of scientific animal breeding and health care practices-farmers point of view, Int. J. Sci. Environ. Technol. 5(5) : 3435-3439.

Gupta, S. P., 1997. Statistical Methods, Sultan Chand and Sons, New Delhi

Patel, N.B., J.B. Patel, T.K.S. Rao, R.R. Singh and R.J. Modi, 2013 A Studies on housing management practices of dairy animal in Patan district of north Gujrat region, Indo-Am. J. Agric. & Vet. Sci.1(1) : 31-37.

Prasad, K., S. Savale, M.T. Mahantesh, M. Pavan, D. Barman and J. Abraham, 2017. Socio-Economic Profile and Constraints Faced By Dairy Farmers of Wayanad District, India, Int. J. Current Microbiol. Applied Sci., 6 (6) : 870-874.

Sarap, K. W., S.D. Chavan, R.R. Shelke, R.V. Pawar, H.P. Janorkar, 2012. Animal husbandry practices followed by cattle owners in Karanja Tehsil of Washim district, Res. J. Animal Husbandry and Dairy Science, 3(1) : 5-12.

Waykar, V. K., R.R. Shelke, S.D. Chavan, P.H. Janorkar, and S.B. Sakate, 2012. Study of feeding and management practices followed by buffalo owners in Patur Tehsil, Res. J. Animal Husbandry and Dairy Sci., 3(1) : 34-40.

Received on : 1.8.2020

* * *

PKV Res. J. Vol. 44 (1), January 2020

In vivo Digestibility of Nutrients in Calves Fed Urea Treated Soybean Straw

P. A. Kahate[1], S. D. Chavan[2], R. R. Shelke[3], K. U. Bidwe[4] and S. R. Munnarwar[5]

ABSTRACT

The present investigation was conducted at Livestock Instructional Farm, Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola. The digestibility coefficient value of DM was significantly higher (62.05 %) on 1.0 per cent urea treatment SBS diet. The DM from USBS (T_1), 1.5 per cent (T_3) and 2.0 per cent (T_4) urea treated SBS diet were equally digestible being 58.47, 60.09 and 60.23 per cent, respectively. With regards to digestibility of CP on different diet, significantly higher CP digestibility was noticed in T_2 over rest of the treatments. Probably, lower CP intake on T_1 diet might be one of the reasons for lower digestibility. In contrast, the CF digestibility was significantly higher on 2.0 per cent urea treated diet over the rest of the diets, while the digestibility coefficients between T_1, T_2 and T_3 did not show significant differences. It was also noted that EE and NFE digestibility decreased significantly with the increase level of urea ammoniation to straw. Thus, feeding of urea treated SBS had no adverse effect on availability of nutrients to calves.

Indian dairy farming has very unusual characteristics where out of total milk producer, two third are small and marginal farmers, producing small quantity of milk by rearing two to three milch animals under mixed farming system. Thus, emerging out a symbiotic relationship in Man-Land-Animal ecosystem. Under present crop farming scenario risk factor has been increased, thereby creating economic pressure on farmers. In this context dairying is discharging the role of risk coverage to relieve economic pressure of the farmers. The 50% of the cultivable land is either facing the problem of uncertain rains or flood situation. Beside this, milch animal rearing had a potential to generate additional income of Rs 9000/cow/year to farmers (Pore, 1998). On this background, milch animals could be regarded as bearer cheque and security for livelihood of farmers. The animal productivity under present situation is not at satisfactory levels (987 kg/cow/year). Calves are usually weaned at about eight to nine months of age, but depending on the season and condition of the dam, they might be weaned earlier. Calves need no other roughage while on good pasture. When pastures become short and dry some supplementary roughage, such as hay,green crops may be required.Considering the annual growth rate of more than 1.0 per cent in livestock population (Sirohi, 2010). To overcome this problem, we have to search alternative feed and fibrous material or agro industrial byproducts for animal feeding and development of technology for increasing the nutrients from conventional and non-conventional feeds in order to have optimized milk production from the animals. On this background, it is observed that presently animals are reared on crop residues and grazing on field boundaries, barren lands, inside and outside forest land with support of costly concentrate to milch animals on one hand and without concentrate growing and other animals on the other hand. Moreover, survey conducted in eleven districts of Vidarbha (Maharashtra) indicated that bovine population received 28 to 30 per cent less DCP than requirements, though enjoyed receipt of marginally more DM and TDN. The nutritional status was poor with small, marginal and landless farmers in comparison to medium and large farmers. Under present rural scenario diversification of land for forage crops seems to be beyond impossible. Hence, hardly 4.4 per cent of the cropped area is under fodder crops in the country. Hence, soybean crop residue seems to be emerging alternative roughage to sorghum and other cereal straws for animal feeding. Some reports did indicate that the urea enrichment of Soybean straw was advantageous for improving the palatability, digestibility of nutrients and nutritive value.

MATERIAL AND METHODS

The present investigation entitled "*In vivo* Digestibility of Nutrients in Calves fed Urea Treated Soybean Straw" was conducted at Livestock Instructional

1,3,4. Assistant Professor (AHDS), 2. Head (AHDS), 5. Sr. Research Assistant, Department of Animal Husbandry and Dairy Science, Dr. PDKV, Akola (M.S.)

Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, for a period of 90 days during 2016-17. The objective of the experiment was to observe the utilization of soybean straw when treated with urea in the ration of calves and its impact on growth and economy. Twenty descript growing calves ranging from 50 to 90 kg body weight and 6 to 11 months age were selected from the herd. These calves were randomly divided into four groups, each of five animals on the basis of nearness in their body weight and age. The randomly divided groups were subjected to four different feeding treatments. The differences .between the groups with regards to body weight and age were non significant indicating formation of homogenous groups.

Soybean straw (SBS) was given urea treatment at the rate of 1.0, 1.5 and 2.0 per cent. The feeding of untreated SBS was designated as control. Urea was used for improving the nutritive values, palatability and to weaken the outer wall and to increase the digestibility of the SBS. As per the requirement of urea was dissolved in 40 liters of water and the solution was sprinkled uniformly on 100 kg soybean straw. The treated soybean straw was stored at 40 per cent moisture level with filled in the thick plastic bags and covered with tarpoline cloth by 28 days for incubation in anaerobic condition. Water was sprinkled before feeding on untreated SBS in order to soften the straw. The DCP and TDN requirements were fulfilled by feeding SBS, Hybrid Napier and concentrate mixture. Thus, four different feeding regimes framed and offered as under.

T_1 – Untreated SBS + 2 kg green Hybrid Napier + 400 g sugras (control)

T_2 – 1.0 per cent urea treated SBS + 2 kg green Hybrid Napier + 300 g sugras

T_3 – 1.5 per cent urea treated SBS + 2 kg green Hybrid Napier + 200 g sugras

T_4 – 2.0 per cent urea treated SBS + 2 kg green Hybrid Napier + 100 g sugras

Management and feeding of calves

The experimental calves were tethered individually in close house. Calves were examined for their health before the start of the experiment and deworming of calves before start of experiment. Daily cleaning of shade and washing with water thrice in a week were carried out. Thus maximum care was taken to maintain the cleanliness of the shade. A sufficient quantity of clean drinking water was provided twice a day in morning and evening to all animals. All the experimental calves were fed with SBS in the ration for 10 days so as to make them accustom for consumption SBS before the start of actual experimental period. The nutrient requirement in terms of DM, DCP and TDN were computed for the individual calf as per the standards Jagdish Prasad and Neeraj (2008) on the basis of body weight. The average daily quantities of feed under different treatments were worked out at the start of the trial on the basis of 3.2 kg dry matter per 100 kg body weight. The computation of ration was revised every week on the basis of BW achieved in calves. The required quantity of concentrate and green hybrid Napier were offered to animals at 9.0 a.m. At about 11.0 a.m. known quantity of soybean straw was offered, of which the leftover was measured at 3.0 PM and again measured quantity of SBS was fed of which leftover was taken in the next day morning in order to calculate intake of hybrid Napier, concentrate and soybean straw.

Statistical analysis

The data were analyzed statistically by applying FRBD and RBD design as per the procedure given by Amble (1975).

Digestibility of Nutrients

The digestibility trial was conducted at the end of thirteen weeks trial. The digestibility trial was conducted for a period of 14 days, out of which first seven days were preliminary period and rest of seven days as collection period.

The growing calves were offered measured quantity of feed and leftover was measured. During collection period the dung voided in 24 hrs by individual calf was collected manually and measured to know the weight of dung voided. Individual sample of dung was collected and kept for DM estimation every day. All the seven days dried samples of individual calf were mixed together to form composite sample for analysis of proximate principles.

RESULTS AND DISCUSSION

1. Chemical composition of feed stuffs

The quality of feeds in terms of its physical and chemical composition has a direct impact on supply of nutrients through the ration. It seems therefore necessary to discuss the composition of different feed stuffs used in the study. In the present study, soybean straw (SBS) was basic roughage in the ration of calves. The nutritive value of SBS was improved with urea treatment. Moreover, the ration was supported with green hybrid Napier and concentrate mixture (SUGRAS) In view of this the proximate principles of untreated and treated SBS, hybrid Napier and concentrate mixture are presented in the Table 1.

The data (Table 1) indicated that the untreated soybean straw (USBS) was containing 90.53 per cent DM while the content of other nutrients were 8.82, 39.31. 1.50, 38.39 and 11.98 per cent CP, CF. EE, NFE and total ash on DM basis, respectively. Similarly, Bacchu Singh *et al.* (2008) and Chopade *et al.* (2010) also reported the CP content of SBS between 8.22 to 10.40 per cent which is comparable with present values. The corresponding composition of nutrients in green Hy Napier were 23.10 per cent and 9.72, 30.90, 2.52, 45.56 and 11.30 per cent DM and CP, CF, EE, NFE and total ash, respectively. Balraman (1995) was agreement with the present values of chemical composition. The concentrate mixture was containing 22.18 and 10.80 per cent CP and CF on DM basis, respectively. Slightly lower CP content of calf mixture (19.17 %) than that of present value was reported by Adangale *et al.* (2009). The CP and CF contents in SBS were influenced significantly by the treatment of urea at different levels. Significantly highest CP (12.96 %) was noticed as a result of 2.0 per cent urea treatment while, lowest CP content of 8.82 per cent was observed in USBS and the CP content of 10.32 and 11.42 per cent was obtained with 1.0 and 1.5 per cent urea treatments, indicating there was increase in the CP content of straw with increase the level of urea treatment. On the other hand CF content showed significant decrease with the increase level of urea treatment, being 39.31, 37.80, 36.71 and 30.90 per cent on DM basis in USBS, 1.0, 1.5 and 2.0 per cent urea treated SBS, respectively. Dahiya *et al.* (1998) reported increased in CP content of Berseem straw by 1.72 folds and decreased in CF content by 4 to 5 units as a result of 4.0 per cent urea treatment as compared to untreated straw. While, Mudgal *et al.* (2006) and Pachauri *et al.* (2010) was observed increase in CP content and decrease in CF content of the straw as a result of urea treatment.

2. Nutrients utilization on SBS diet

The results indicated the acceptability of SBS diet by the growing calves and its palatability in terms of DMI / unit body size. It seems therefore, necessary to ascertain whether the availability of different nutrients to body were adequate or otherwise. In order to assess this, the digestibility trial was conducted for different feeding treatments at the end of the trial. From the data daily intake of different nutrients, digestibility of nutrients, nutritive value of the rations and nutritional fulfillment of calves were calculated and discussed.

Daily nutrient intake

The daily intake of different nutrients in calves under different treatments were calculated from the intake of dry matter made available from SBS, green hybrid Napier and concentrates and the composition of different feeds (Table 2).

Table 1: Average proximate composition of different feed stuffs (% DM basis)

Particulars	DM	CP	CF	EE	NFE	Ash
Untreated SBS (T_1)	90.53	8.82	39.31	1.50	38.39	11.98
1.0% urea treated SBS (T_2)	91.05	10.32	38.15	1.55	37.94	12.04
1.5% urea treated SBS (T_3)	91.55	11.42	37.80	1.67	36.87	12.24
2.0% urea treated SBS (T_4)	91.69	12.96	36.71	1.70	36.14	12.49
Hybrid Napier (Yeshwant)	23.10	9.72	30.90	2.52	45.56	11.30
Concentrate mixture(Calf ration, Grade I)	90.84	22.18	10.80	2.60	61.65	3.77

Table 2 : Daily intake of different nutrients under different treatments (kg/calf)

Treatment	DM	CP	CF	EE	NFE
T_1	2.857	0.304	0.984	0.051	1.209
T_2	3.178	0.355	1.099	0.056	1.292
T_3	2.863	0.340	1.005	0.053	1.137
T_4	2.661	0.339	0.930	0.050	1.026
GM.	2.867	0.335	1.004	0.052	1.166
S.E. (m)$\pm$	0.078	0.006	0.023	0.003	0.062
C.D. at 5%	0.233	0.017	0.070	—	—
C.V.	6.06	3.69	12.02	12.07	11.86

The calves from all the treatments consumed more DM than that of their recommended levels (3.2 % BW). However, it was observed that the calves from T_2 treatment consumed significantly higher DM (3.178 kg) over that of other groups, while, lowest consumption of (2.661 kg) DM in calves was noticed under T_4 group (Table 2). The calves reared on 1.0 per cent urea ammoniated SBS diet received more CP (0.355 kg) against the intake of CP in calves on feeding untreated diet. Moreover, the calves fed with 1.5 and 2.0 per cent urea ammoniated SBS diet also consumed more CP in spite of the lower DMI than that of untreated SBS group. However, the intake of CP between T_2, T_3 and T_4 did not differ significantly. On an average CP intake in calves was 0.304, 0.355, 0.340 and 0.339 kg/calf in T_1, T_2, T_3 and T_4, respectively.

With regards to intake of CF on different rations, it was noted that 1.0 per cent urea ammoniated SBS diet provided more quantity of crude fibre to calves (1.099 kg day^{-1}) over rest of the feeding treatments. Moreover, the calves from T_1, T_3 and T_4 received more or less equal amount of CF from the diet as the differences did not reach the level of significance, the intake being 0.984, 1.005 and 0.930 kg day^{-1} $calf^{-1}$, respectively. In respect to availability of ether extract (EE) on different feeding treatments to calves, it is observed that the calves from all the treatments received similar EE from the diet as the differences between the treatments were non significant. The overall intake of EE was 0.051, 0.056, 0.053 and 0.050 kg^{-1} day^{-1} calf under T_1, T_2, T_3 and T_4, respectively. All the feeding treatments were found at par in reference to providing Nitrogen Free Extract (NFE) to calves. On an average the intake of NFE was 1.209, 1.292, 1.137 and 1.026 kg /day /calf under T_1, T_2, T_3 and T_4, respectively. However, the calves from T_2 group received 6.86, 13.63 and 25.92 per cent more NFE nutrient from the diet over the intake NFE on T_1, T_3 and T_4 diet, respectively.

Thus, the results on daily intake of different nutrients did indicate that treatment of urea ammoniation to leguminous SBS did not hamper nutrient intake in calves. On the contrary urea treatment proved a potential method to improve the acceptability of the lignified fibrous straw and thereby supply of different nutrients in sufficient quantity.

3. Digestibility of different nutrients

The digestibility of different nutrients was calculated from the intake of nutrients and nutrient excreted in the faeces. The observations on the digestibility coefficient of different nutrients are tabulated in Table 3.

Table 3: Effect of feeding different treatments on digestibility coefficient of different nutrients (%)

Treatment	DM	CP	CF	EE	NFE
T_1	58.47 a	61.01 a	58.80 a	68.69 ab	65.42 a
T_2	62.05 b	63.24 b	60.95 a	70.52 b	68.48 b
T_3	60.09 ab	59.81 a	61.08 a	67.22 a	65.69 a
T_4	60.23 ab	58.98 a	62.62 b	67.47 a	65.87 a
GM.	60.21	60.98	60.86	68.47	66.36
S.E. (m)$\pm$	0.778	0.737	0.515	0.758	0.772
C.D. at 5%	2.332	2.211	1.545	2.272	2.314
C.V.	2.889	2.847	1.977	2.475	2.601

The digestibility of different nutrients differed significantly between the treatments. The digestibility coefficient value of the DM was significantly higher in T_2 treatment over that of T_1 treatment. However, the differences in digestibility coefficients between T_1, T_3 and T_4 as well as T2, T3 and T4 were found non significant. The overall digestibility values of DM were 58.47, 62.05, 60.09 and 60.23 per cent in T_1, T_2, T_3 and T4, respectively. This means 1.0 per cent urea ammoniation to SBS resulted in increasing the DM digestibility over that of untreated diet.

With regards to digestibility of CP on different

Table 3.1:Mean sum of squares for digestibility coefficient of different nutrients

Source	df	MSS				
		DM	CP	CF	EE	NFE
Treatments	3	10.643*	22.374*	4.406*	11.314*	10.004*
Error	16	3.025*	2.718*	1.327*	2.872*	2.979*
Total	19					

* Significant at 5 % level

treatment diets, it was observed that significantly higher CP digestibility was noticed on T_2 treatment diet over rest of the treatments, the values being 61.01, 63.24, 59.81 and 58.98 per cent for T_1, T_2, T_3 and T_4 respectively. Moreover, there were non significant differences in CP digestibilities between T_1, T_3 and T_4 treatments. The present results are comparable with the findings of Mudgal *et al* (2006). This explanation supports higher digestibility of CP on T_2 diet over CP digestibility of untreated SBS.

In respect of CF digestibility on different treatments, it was observed that the digestibility coefficients differed significantly between treatments. Significantly higher digestibility of fibre was noticed on T_4 diet over the rest of diet, while the digestibility coefficients between T_1, T_2 and T_3 did not show significant differences. The overall average digestibility coefficients for CF were 58.80, 60.95, 61.08 and 62.62 per cent on T_1, T_2, T_3 and T_4 treatments, respectively. The past workers like Mudgal *et al.,* (2006) and Saini *et al.,* (2007) observed improvement in the digestibility of CF as a result of urea ammonization to leguminous straw.In reference to ether extract (EE) digestibility of untreated and treated SBS diet, it was noticed that the EE digestibility decreased significantly with the increase level of urea ammonization to straw. As a result the EE digestibility on T_3 and T_4 diet were at par with that of EE digestibility on untreated SBS. However, The EE digestibility observed on 1.0 per cent urea treatment of SBS (T_2) was significantly higher over T_3 and T_4 treatment. The average digestibility coefficients were 68.69, 70.52, 67.22 and 67.47 per cent on T_1, T_2, T_3 and T_4 treatment, respectively. On the other hand, NFE digestibility did not exhibit significant differences between T_1, T_3 and T_4 treatment, while NFE digestibility on T_2 treatment was found significantly more over rest of the treatments. Adangale *et al.,* (2008), Mule *et al.,* (2008) and Hossain *et al* (2010) reported the digestibilities values of different nutrients were slightly more or less with the present values. Also Pachauri *et al* (2010) are in agreement with present results as they reported higher digestibility of nutrients on feeding of urea treated wheat straw ration to calves.

CONCLUSION

The growing calves fed with 1.0 per cent urea enriched SBS received significantly more quantity of CP and CF, being 0.355 and 1.099 kg^{-1} day^{-1} calf against intake of 0.304 and 0.984 kg under USBS diet. However, all the treatments were at par in terms of providing EE and NFE nutrients to calves. Thus, enrichment of leguminous SBS with 1.0 per cent urea did not hamper nutrient intake in calves. The digestibility coefficient value of DM was significantly higher (62.05 %) on 1.0 per cent urea treatment SBS diet. It was also noted that EE and NFE digestibilities decreased significantly with the increase level of urea ammoniation to straw. The results on nutrient intake in relation to requirement as per feeding standards indicated that all the calves except T_4 group received higher quantity of DM, DCP and TDN over their requirements.

LITERATURE CITED

Adangale, S. B.; K. R. Mitkari and S. V. Baswade, 2008. Associative effect of feeding Jowar straw in combination with soybean straw to crossbred (HF x Deoni) interse calves on digestibility and economics, Indian J. Anim. Res. 42(2) : 145-147.

Adangale, S. B.; K. R. Mitkari, T. R. Walkunde and S. V. Baswade, 2009.Effect of feeding Jowar straw in combination with soybean straw on the growth performance of crossbred calves, Indian J. Anim. Res. 43(1) : 142-144.

Amble, V. N., 1975. Statistical method in animal science.

First Editor Published by Indian Society of Agriculture Statistics, New Delhi : 199-219.

Bacchu Singh, J. L. Chaudhary and N. K. Rajora, 2005. Nutritive evaluation of soybean straw in sheep and goats, Indian J. Anim. Nutr., 22(1) : 07-09.

Balaraman, N., 1995.Nutritive value of hybrid Napier grass, Indian J. Anim. Nutr. 12(4) : 245-246.

Dahiya, S. S.; B. S. Punia and T. R. Chauhan, 1998. Voluntary feed intake and nutrient utilization in buffalo bullocks fed untreated and urea (ammonia) treated Berseem and Oat straws, Indian J. Anim. Nutr. 15(2) : 93-96.

Hossain M.M., M.J. Khan and M. A. Akbar, 2010. Nutrient digestibility and growth of local bull calves as affected by feedingurea and urease enzysources treated rice straw, Bang. J. Anim. Sci. 39(1&2): 97-105.

Jagdish Prasad and Neeraj, 2008.Principles and practices of Animal Nutrition Second Edition, Kalyani Publishers, New Dehli.

Mudgal, V.; M. K. Mehta and A. S. Rane, 2006.Feeding value of urea-ammoniated Lentil straw (Lens Culinaris) in the diet of growing Barbari bucks, Anim. Nutr. And feed technology 6 : 01-07.

Mule, R. S.; R. P. Barbind, S. V. Baswade, D. T. Samale and S. B. Adangale, 2008.Nutritive value of soybean straw in Osmanabadi kids,Veterinary World. 1(10) : 314-316.

Pachauri, S. K.; S. K. Singh and Vishal Mudgal, 2010. Effect of feeding wheat straw and urea ammoniated straw based total mixed rations on the performance of female crossbred calves, Indian J. Anim. Nutr. 27(1) 73-76.

Pore, S. N., 1998. Status of crossbred cattle maintained in Akola TahsilUnpub. M.Sc. thesis (Unpub) submitted to Dr. PDKV, Akola.

Saini, N.; G. P. Singh and A. K. Nagpal, 2007.Nutrient utilization from Clusterbean straw, supplemented with urea and Prosopis cineraria leaves in growing camel, Indian J. Dairy Sci. 60 (2) : 342-345.

Sirohi, S. K., 2010. Role of protected nutrients (protein and fat) in high producing dairy animals. Compendium of winter school organized on 10-30 Nov. 2010, NDRI, Karnal.

Received on : 5.8.2020

* * *

SHORT NOTES

Recovery Rate of Pigeonpea Dal by PKV Mini Dal Mill as Influenced by Varieties

Pigeonpea occupies a prominent place among pulses in India. It is consumed in various forms and subjected to primary processing i.e. dehulling, splitting etc. Consumers of pigeonpea are sensitive to quality characteristics depending on the use. In India, split pigeon peas (toor *dal*) are one of the most popular pulses, being an important source of protein in a mostly vegetarian diet. Pigeonpea grains are milled to prepare *dal*. Milling also helps to improve storability and palatability besides cooking qualities and digestibility. Millers prefer pigeonpea genotypes having high *dal* recovery. Pigeonpea is generally consumed in the form of decorticated split cotyledons i.e. *dal*. Pigeonpea kernels while passing through the *dal* mill, is firstly converted to decorticated unsplit grains i.e. gota. This split dal is considered as top grade good quality *dal* called "*Fatka Dal*". The *dal* is subsequently graded into different sizes as large sized *dal* fetches premium price in the market. The *dal* miller strikes a balance between recovery rate and *dal* size. Pigeonpea suffers substantial milling losses which can be reduced to some extent by genetic and post harvest management practices. In the past, no efforts has been made to evaluate pigeonpea genotypes with good *dal* recovery and high nutritional quality.

The seed material for the present study consisted of seven newly developed varieties. Bulk sample of seed were assessed for their milling recovery using PDKV mini *dal* mill. Seed samples were sundried to about 8 per cent moisture level and graded to keep the uniformity of grain. The varieties were milled in an especially designed pulse milling machine having speed of 880 rpm, 3 HP motor and 220 V supply. This machine is especially designed for milling different pulses with minimum sample requirement of 30 kg, therefore, 30 kg grains of different varieties of

Table 1. Graded *dal* recovery (kg) in different pigeonpea varieties.

Variety	A-Grade 1	B-Grade 2	C-Grade 3	D-Grade 4	E-Grade 5	Total *Dal* recovery 6 (1+2+3)	Total (4+5+6)	Unavoidable loss
Asha	5.958 (19.86)	5.812 (19.37)	11.33 (37.77)	0.530	4.412	23.100 (77.00)*	28.042	1.958
C-11	8.334 (27.78)	4.69 (15.65)	10.54 (35.13)	0.480	4.398	23.566 (78.55)*	28.444	1.556
PKV TARA	12.560 (41.87)	3.780 (12.60)	6.940 (23.13)	0.598	4.644	23.280 (77.60)*	28.522	1.478
ICPH-2671	9.546 (31.82)	5.852 (19.51)	7.508 (25.03)	0.574	4.442	22.906 (76.35)*	27.922	2.078
AKT-8811	9.800 (32.67)	3.290 (10.97)	8.452 (28.17)	1.032	4.296	21.542 (71.81)*	26.870	3.130
Maruti	12.624 (42.08)	3.712 (12.37)	6.172 (20.57)	0.800	4.518	22.508 (75.03)*	27.826	2.174
AKPHE 8-1	10.548 (35.16)	4.434 (14.78)	7.19 (23.97)	1.036	4.782	22.172 (73.91)*	27.990	2.010

Figure in parenthesis indicate per cent grade *dal* recovery to total *dal* recovery

*Figure in parenthesis indicate per cent *dal* recovery to sample taken (30 kg) pigeonpea were taken. On the basis of breakage of *dal*, the varieties were grouped into five grades i.e. A (*unbroken dal*), B (less than 25% breakage), C (25-75% breakage) and D (broken) and E (powder and husk).

The result showed that there was substantial variation for *dal* recovery among the varieties (Table 1). Recovery of unbroken *dal* (A-grade) ranged from 5.958 kg (19.86 %) in Asha to 12.624 kg (42.08%) in Maruti followed by PKV TARA 12.560 kg (41.87) while recovery of B-grade *dal* was in the range of to 3.290 kg (10.97%) in AKT-8811 to 5.852 kg (19.51%) in ICPH-2671 followed by Asha 5.812 kg (19.37 %). In case of C-grade *dal* minimum recovery was obtained with Maruti 6.172 kg (20.57%) next to PKV TARA 6.940 (23.13%). Among the varieties with higher total *dal* recovery comprising A-, B- and C- grade was reported by C-11 23.566 kg (78.55 %), PKV TARA 23.280 kg (77.60 %) and Asha 23.100 (77.0 %), However, minimum broken i.e. D- grade was obtained with C-11 followed by Asha and maximum with AKPHM 8-1 and AKT-8811. Besides these five grades there was certain unavoidable loss which was more in case of AKT-8811, Maruti and ICPH-2671. The results showed that varieties C-11, PKV TARA and Asha which had better milling characteristics can be used as donor in breeding programmes for improving milling quality (Malima Perrera, 2000).

The results suggest that losses in terms of broken and powder and husk fraction would be more in ICPH-2671 . The grain colour of ICPH-2671 is dark brown which, however, no difference was observed in colour of other varieties. Appearance of *dal* plays an important role in determining the quality of *dal*. Amongst variety C-11, PKV TARA and Asha exhibited high quality *dal* with yellow colour, more uniformity and shining effect and less breakage in edges of cotyledons, however, higher breakage was recorded in AKPHE-8-1 and AKT-8811. The results suggested that losses in terms of brokens, and powder and husk fraction would be more, if grains of varieties are small as in Maruti and AKT 8811.

Substantial variability was observed amongst different varieties of pigeonpea showing C-11, PKV TARA and Asha are the best. It is also reported that recommended varieties gives high quality *dal* with favourable characteristics. Therefore, it would be very important to consider the quality attributes and consumer acceptance before releasing pigeonpea varieties. C-11, PKV TARA and Asha recorded higher *dal* recovery and better milling characteristics can be used as donor in breeding programmes for improving milling quality.

LITERATURE CITED

Malima Perrera, 2000. Variability in recovery rate and quality of pigeonpea dhal produced by FMRC dhal processing machine, Annals of the Srilankan Department of Agriculture 200/3: 195-200.

Pulses Research Unit,
Dr.Panjabrao Deshmukh Krishi Vidyapeeth,
Akola 444 104,

V. V. Goud
M. P. Meshram
A. N. Patil

Received on : 15.6.2020

* * *

Production Potential in Pigeonpea+Urdbean Intercropping System Under Rainfed Condition

Besides expansion of cultivated area and increasing the yield per unit area of crop, the modern agriculture adds two more dimensions viz., time and space. The main concept of intercropping is to get increased total productivity per unit area and time, besides equitable and judicious utilization of land resources and farming inputs. Pigeonpea grown as a sole crop shows inefficient utilization of resources especially the space because of its slow initial growth rate and low harvest index. Intercropping of short duration cereals and pulses provides an opportunity to utilize of available resources more efficiently with enhancement of productivity and profitability of system. Being one of the most drought tolerant legumes, pigeonpea has a great potential to increase the sustainability of cropping systems in the arid and semi-arid regions. In India, pigeonpea is generally intercropped with maize, sesamum, soybean, mungbean, urdbeanand groundnut. Different maturing habit, growth pattern, nutrient and water requirement and rooting pattern of these crops make them suitable to grow as intercropping system with pigeonpea. Blade *et al*. (1997) argued that the sole crop produced higher yield when insecticide spray is used, most farmers traditionally practices mixed cropping. But in general, intercropping has been reported to be more productive than monocropping (Ghosh *et al*. 2006) this might be through efficient use of light energy and other growth resources. Kamara *et al*. (2017) stated that the optimization of land resource use could be achieved when crops are grown under intercropping and plant population density increased. However, intercropping offers potential advantage for resource utilization decreased inputs and increased sustainability in crop production as reported by Egbe *et al*. (2010).

The experiment was conducted at the Pulses Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* 2012. The experiment was laid out in randomized block design with pigeonpea as sole and in intercrop with urdbean (1:2). Sowing of pigeonpea cv. PKV TARA and urdbean different genotypes was done on 4th July in 45 cm apart rows. The soil of the experimental unit was clayey and the soil pH was 8.04, while the EC was 0.44 dSm^{-1}. The organic carbon of the soil was 4.65 g kg^{-1} during the years of study. The soils of the experiential field was low in available nitrogen (236 kg ha^{-1}), medium in available phosphorus (18.80 kg ha^{-1}) and high in available potassium (363 kg ha^{-1}). It was laid out in a Randomized Block Design with four replications, with a gross plot size of 5.4 m x 4.0 m and netplot size of 3.6 m x 3.8 m. Recommended doses of 25 kg N and 50 kg P_2O_5ha^{-1} of pigeonpea and 20 kg N and 40 kg P_2O_5 for urdbean were side drilled in the form of urea and di-ammonium phosphate just after sowing. In intercropping system fertilizer dose according to area occupied by intercrop along with recommended dose for sole pigeonpea was applied. Recommended cultural practices were adopted for the respective crops. The total rainfall received during the crop growth period was 269 mm.

Pigeonpea grain yield was not affected significantly in the intercropping system (Table 1). It was because of non-significant difference in dry matter accumulation in leaves, stem, reproductive parts and total dry matter production. Similarly on par seed yield of pigeonpea under 1:1 and 1:2 row proportion were reported by Tomar *et al*. (1984) when intercropped with soybean. But, the cropping systems significantly affected the yield of pigeonpea. The highest grain yield was recorded with sole pigeonpea (2169 kg ha^{-1}). Intercropping different urdbean genotypes significantly decreased the pigeonpea grain yield. The highest reduction in yield was recorded with AKU 10-4 and AKU 11-15. But the pigeonpea yield was on par between the intercropping systems of pigeonpea with different urdbean genotypes. Goyal *et al*. (1991), Singh and Singh (1994) and Verma and Warsi (1997) reported higher yield when pigeonpea was intercropped with sesame and blackgram. Among the different urdbean genotypes tested as intercrop, AKU 10-1 intercropped with pigeonpea (Table 1) recorded significantly the highest yield (1551 kg ha^{-1}) followed by AKU 10-2 (1467 kg ha^{-1}). Similarly, total number of branches plant^{-1}, pods plant^{-1} and grain weight plant^{-1} were also higher with AKU 10-1 genotypes. The urdbean equivalent yield in 1:2 row

Table 1: Effect of urdbean genotypes + pigeonpea intercropping system on urdbean equivalent yield

Symbol	Treatments	Yield (kg ha^{-1})		Urdbean equivalent
		Pigeonpea	Urdbean	yield (kg ha^{-1})
T1	Pigeonpea +AKU 10-1	1531	1551	3301
T2	Pigeonpea +AKU 10-2	1480	1467	3191
T3	Pigeonpea +AKU 10-4	1401	1324	3020
T4	Pigeonpea +AKU 10-6	1613	1328	3477
T5	Pigeonpea +AKU 11-15	1468	1400	3165
T6	Sole pigeonpea	2169	—	2508
	S.Em$\pm$	58	34	122
	CD 5%	175	105	371

Table 2: Ancillary parameters of urdbean as influenced by intercropping with pigeonpea

Symbol	Treatments	Plant height (cm)	Branches plant^{-1}	No. of Pods plant^{-1}	Grain weight plant^{-1}	100-seed weight (g)
T1	Pigeonpea + AKU 10-1	52.3	6.6	44.3	9.5	4.5
T2	Pigeonpea + AKU 10-2	49.0	6.4	38.5	9.3	4.8
T3	Pigeonpea + AKU 10-4	54.9	6.0	26.8	9.4	5.3
T4	Pigeonpea + AKU 10-6	54.2	5.7	29.1	8.1	5.1
T5	Pigeonpea + AKU 11-15	55.1	6.2	34.4	9.0	5.3
T6	Sole pigeonpea	—	—	—	—	—
	S.Em$\pm$	2.37	0.17	1.64	0.16	0.12
	CD 5%	NS	0.51	5.06	0.48	0.37

proportions did not differ significantly with each other (Table 2). Higher urdbean equivalent yield was obtained when pigeonpea intercropped with AKU 10-6 and AKU 10-1 over remaining treatments. The higher urdbean equivalent yield was due to higher yield of both pigeonpea and intercrops (urdbean genotypes) and higher market price. Thus, it can be concluded that intercropping pigeonpea with urdbean genotype AKU 10-6 and AKU 10-1 is more productive and profitable than other sole and intercropping system under rainfed conditions.

LITERATURE CITED

Blade, S.F., S.V.R. Shetty, T. Terao and B.B. Singh, Recent developments in cowpea cropping systems research. In: Advances in cowpea research. Eds. Singh BB *et al*., 114-128.

Egbe, O.M. and M.O. Adeyemo, 2006. Estimation of the Effect of Intercropped Pigeonpea on the Yield and Yield Components of Maize in Southern Guinea Savannah of Nigeria, J. Sustainable Devel. Agric. Environ., 2(1):107-119.

Ghosh, P.K., M.C. Manna, K.K. Bandyopadhyay, A. Tripathi, A.K. Wanjari and K.M. Hati, 2006. Inter specific interaction and nutrient use in soybean/ sorghum intercropping system, Agron. J., 98:1097-1108.

Goyal, S.N., N.M. Patel and I.P.S. Ahlawat, 1991. Intercropping studies in pigeonpea under rainfed conditions, Indian J. Agron., 36:49-51.

Kamara, A., A. Tofa, T. Ademulegun, R. Solomon, Shehu, N.K., and L. Omoigui, 2017. Maize-soybean intercropping for sustainable intensification of cereal-legume cropping system in Nothern Nigeria, Exptl. Agric., 1-15.

Singh, R.A. and A.K. Singh, 1994. Comparative performance of different intercropping systems with pigeonpea under rainfed conditions of Vindhyan region. Indian J. Agron., 39:613-615.

Tomar, S. S., R. B. Sharma and S.C. Sengar, 1984. Relative efficiency of multi intercrop studies in pigeon pea under rainfed condition. Indian J. Agron, 29 : 475-479.

Verma, K.P. and A.S. Warsi, 1997. Production potential of piegeonpea based intercropping systems under rainfed conditions, Indian J. Agron., 42:419-421.

Pulses Research Unit,
Dr.Panjabrao Deshmukh Krishi Vidyapeeth,
Akola 444 104

V. V. Goud
A. N. Patil

Received on : 20.1.2020

* * *

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 : December, 2020

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). 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 2020 and Printed by him at Tanvi Graphics, Ranpise Nagar, Akola