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EFFECT OF ORGANIC SOURCES OF NUTRIENTS ON PERFORMANCE, NUTRIENT UPTAKE AND YIELD OF RAINFED COTTON IN VERTISOLS UNDER SEMI ARID CONDITION

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ABSTRACT

A field experiment was initiated during 2019-20 and the present study was conducted during kharif season of 2023-2024 at research farm of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra), to assess the impact of organic sources of nutrients on crop performance, nutrient uptake and yield of rainfed cotton (*Gossypium* spp.) in Vertisols under semi-arid conditions. The various organic sources of nutrients used were FYM, vermicompost and gliricidia green leaves. The nine treatments consisting of various combinations of organic sources of nutrients along with three replications were evaluated in randomized block design. The results revealed that the significantly higher increase in seed cotton yield and yield components like height of plant, branches plant^{-1}, number of bolls plant^{-1}, length of roots, fresh weight of roots and boll weight were observed with application of 50% N through FYM + 50% N through gliricidia and was at par with application of 50% N through vermicompost + 50% N through gliricidia and recommended dose of fertilizers (RDF), compared to all other treatment combinations. Similarly, the nutrient uptake after five years of experiment indicated that the significantly higher N,P,K uptake was observed with application of 50% N through FYM + 50% N through gliricidia and was at par with application of 50% N through vermicompost + 50% N through gliricidia, recommended dose of fertilizers (RDF), 25% N through FYM + 25% N through Vermicompost + 50% N through Gliricidia, Vermicompost 3.0 t ha^{-1}.Hence, it can be concluded that integrated application of 50% N through FYM or vermicompost + 50% N through gliricidia resulted in improvement in nutrient uptake and yield components with higher seed cotton yield in Vertisols under semi arid rainfed conditions.

***Key words*:** Nutrient uptake, Organic sources, Seed cotton yield, Vertisols.

Introduction

Cotton (*Gossypium* spp.) known as 'king of fibres' and 'white gold' dominated India's cash crops and makes up 65 per cent raw material requirements of the Indian textile industries. It has huge potential in the textile industry and provides a source of income for millions of farmers and others involved in its trading and processing. Throughout history, cotton had a greater impact on the global economy than any other agricultural product. Organic manures play an important role as a substitute for mineral nutrients; on the other hand indiscriminate use of chemical fertilizers affects soil health. Use of organic manures such as FYM, vermicompost and gliricidia for supplying nutrients for a cropping system as a whole is a sound management practice for increasing yields and maintaining soil fertility (Nanjappa *et al.*, 2001).

Organic fertilizer improves soil fertility, physical, chemical and biological factors of soil, yield of crop, it stimulates the activity of microorganisms that makes the plant to get the macro and micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, sodicity and pH (Alabadan *et al*., 2009), which also indirectly helps to reduce all the malefic effects

Table 1: Nutrient content of organic manures during the study period.

Sr. No.	Name of organic material	Nutrient content (%)		
		N	P	K
1.	FYM	0.50	0.19	0.43
2.	Gliricidia (green basis)	0.75	0.09	0.48
3.	Vermicompost	2.0	0.42	0.76
4.	Phosphocompost	-	10.4	-

of conventional practices and conserve the natural resources.

Green manuring is inexpensive but effective technology that helps in lowering investment cost on fertilizers and in safeguarding the production capacity of the soil while avoiding soil degradation without any impoverishment. Leguminous green manures have the ability to utilize insoluble phosphates through the well-developed root system, and upon mineralization, release the P in the forms that are available to them. Green manuring is a practice of turning green biomass in the soil to improve the physical, chemical, and biological qualities of soil that are favourable for plant development. It is a convenient means to furnish higher amount of nitrogen to the beneficiary crops. Therefore, the soil must be 'fed' in a way that the beneficial soil organisms that are essential for recycling nutrients and humus production is not inhibited. Long-term manurial experiments carried out in many regions have demonstrated the advantages of integrated nutrient supply systems in sustaining crop productivity in comparison to chemical fertilizer alone (Gaur, 1991). Hence, the present study was planned to witness how the conjugation of FYM/vermicompost with Gliricidia green leaves at various doses stimulate the crop performance and cotton productivity in Vertisols under semi- arid rainfed conditions.

Materials and Methods

A field study was conducted during 2023-2024 on the research field of AICRP for Dryland Agriculture, Dr. PDKV, Akola on experiment which was initiated during 2019-20. The experimental site is characterized by sub-tropical climate with average maximum high temperature of 42.9°C and minimum low temperature of 12.5°C. The soil was Vertisols belonging to smectite, hyperthermic family of Typic Haplusterts. The experiment was conducted with nine treatments comprising T_1:100% RDF (60:30:30 NPK kg ha^{-1}), T_2:FYM 12 t ha^{-1}, T_3:Gliricidia 8 t ha^{-1}, T_4:Vermicompost 3.0 t ha^{-1}, T_5:50% N through FYM + 50% N through Gliricidia, T_6:50% N through FYM + 50% N through Vermicompost, T_7:50% N through Vermicompost + 50% N through Gliricidia, T_8:25% N through FYM + 25% N through Vermicompost + 50% N through Gliricidia, T_9:25% N through Gliricidia + 25% N through Vermicompost + 50% N through Gliricidia. The phosphorus dose was compensated through phosphocompost from treatments T_5 to T_9: 50 % N as basal and remaining 50 % N as topdressing at 30DAS.The nnutrient content of various organic sources used during the study period was determined and presented in Table 1.

Data collection and analysis

Five plants were selected at random from the net area of each plot, tagged and biometric observations were recorded only on these plants. The height of plant and

Table 2: Effect of organic sources of nutrients on growth and yield attributes of cotton.

Treatment		Plant height (cm)	No. of branches $plant^{-1}$	No. of bolls $plant^{-1}$	Boll weight (gm)	Length of roots	Fresh weight of roots
T_1	100% RDF (60:30:30 NPK kg ha^{-1})	92.74	19.33	17.56	3.32	37.93	22.86
T_2	FYM 12 t ha^{-1}	89.19	14.67	15.06	3.13	36.98	19.50
T_3	Gliricidia 8 t ha^{-1}	82.33	15.67	13.67	3.12	36.37	20.65
T_4	Vermicompost 3 t ha^{-1}	83.64	16.33	14.61	3.18	36.69	21.18
T_5	50% N through FYM + 50% N through Gliricidia	96.23	19.67	18.06	3.39	39.11	25.00
T_6	50% N through FYM + 50% N through Vermicompost	77.33	15.00	13.74	3.19	35.68	20.15
T_7	50% N through Vermicompost + 50% N through Gliricidia	93.74	19.00	17.33	3.31	38.88	24.92
T_8	25% N through FYM + 25% N through Vermicompost +50% N through Gliricidia	83.80	17.17	16.18	3.21	37.70	21.77
T_9	25% N through Gliricidia +25% N through Vermicompost + 50% N through Gliricidia	81.50	15.33	13.59	3.06	35.71	17.25
SE (m) ±		2.03	0.48	0.62	0.05	0.62	0.75
CD at 5%		6.08	1.44	1.87	0.15	1.85	2.25

Table 3: Effect of organic sources of nutrients on cotton yield.

Treatment		Cotton yield (kg ha^{-1})		% increased /Decreased seed cotton yield over T_1	Productivity rating Index	HI (%)
		Seed cotton	Cotton stalk			
T_1	100% RDF (60:30:30 NPK kg ha^{-1})	900.0	1559.0	-	62.07	36.60
T_2	FYM 12 t ha^{-1}	813.0	1408.9	-9.67	56.07	36.59
T_3	Gliricidia 8 t ha^{-1}	784.0	1358.3	-12.89	54.07	36.60
T_4	Vermicompost 3.0 t ha^{-1}	891.0	1546.5	-1.00	61.45	36.55
T_5	50% N through FYM + 50%Nthrough Gliricidia	1008.8	1664.9	12.09	69.57	37.73
T_6	50% N through FYM + 50% N through Vermicompost	765.8	1335.0	-14.91	52.81	36.45
T_7	50% N through Vermicompost+ 50% N through Gliricidia	969.2	1649.5	7.69	66.84	37.01
T_8	25% N through FYM + 25% N through Vermicompost + 50% N through Gliricidia	927.9	1548.1	3.10	63.99	37.48
T_9	25% N through Gliricidia + 25% N through Vermicompost + 50% N through Gliricidia	639.5	1110.6	-28.94	44.10	36.54
SE (m) ±		52.5	82.7	-	-	-
CD at 5%		157.4	248.0	-	-	-
CV		10.6	9.8	-	-	-

reproductive branches at maturity stage were measured. From five plants in each plot, total numbers of bolls retained by each plant were counted on 120 DAS and mean number of bolls were worked out. Cotton was picked out from the net plots. Care was taken to avoid bracts and trash adherence while removing the seed cotton from the bolls. The cotton was dried in the shade, cleaned and weighed for estimation of seed cotton yield.

Results and Discussion

Plant height

Different organic manure treatments had significant influence on the growth attributes of cotton. During the years of experimentation organic nutrient management practices had marked influence on the plant height. The data on plant height recorded at maturity stage showed significant variation among nutrient management practices (Table 2). Among the different organic sources of nutrient management practices, application of 50% N through FYM + 50% N through Gliricidia resulted in significantly taller plants over other organic manure treatments of the experimentation. The application of 50% N through FYM + 50% N through gliricidia (T_5) registered a plant height of 96.23 cm at maturity stage during *kharif* 2023. However, it was on par with application of 50% N through vermicompost + 50% N through gliricidia and 100% RDF. These results are in conformity with results obtained by (Gabhane *et al.*, 2023) and (Patil *et al.*, 2021). There was significant variation in plant height at harvest due to the application of various organic manures. This might be due to availability of nutrients from organic sources and favourable conditions created in uptake of plant nutrients by the crop (Katkar *et al.*, 2000), besides supplying more essential nutrients, could be attributed to faster mobilization with increased photosynthesis, enzymatic and biochemical activities and multiplication, like cell division in meristematic region. It is also known that nitrogen has a role in cell elongation. These results are in conformity with results obtained by Chandramohan and Chandaragiri, 2007.

Number of branches

Yield attributing characters are totally responsible for the variation in the seed cotton yield. The branches are the basic structure which bears various reproductive organs. Higher number of branches (19.67) were observed with application of 50% N through FYM + 50% N through gliricidia which was at par with application of 100% RDF and 50% N through vermicompost + 50% N through gliricidia (Table 2). The increase in number of branches per plant of cotton might be due to enhanced availability and uptake of nutrients which results in higher accumulation of photosynthates in various sinks and expansion of leaves and translocation of nutrients to reproductive parts. Similar finding was also observed by (Patil *et al.*, 2021). (Blaise *et al.*, 2005) revealed that the application of FYM had significantly greater sympodial branches than the control plot where in FYM was not applied. FYM supplies not only NPK but also secondary and micronutrients and helps in storing soil moisture, which is of great value in rainfed agriculture.

Boll number

Because of increased number of branches per plant,

Table 4. Effect of organic sources of nutrients on nutrient uptake by cotton.

Treatments		Total uptake of nutrients (kg ha^{-1})		
		N	P	K
T_1	100% RDF (60:30:30 NPK kg ha^{-1})	41.98	10.41	31.42
T_2	FYM 12 t ha^{-1}	36.60	9.63	28.38
T_3	Gliricidia 8 t ha^{-1}	36.35	8.80	28.25
T_4	Vermicompost 3.0 t ha^{-1}	41.43	10.30	31.35
T_5	50% N through FYM + 50% N through Gliricidia	46.89	11.65	34.93
T_6	50% N through FYM + 50% N through Vermicompost	33.58	7.92	25.27
T_7	50% N through Vermicompost + 50% N through Gliricidia	44.05	10.61	33.04
T_8	25% N through FYM + 25% N through Vermicompost + 50% N through Gliricidia	41.81	9.91	31.33
T_9	25% N through Gliricidia + 25% N through Vermicompost + 50% N through Gliricidia	27.95	6.63	21.76
SE (m) ±		2.26	0.60	1.59
CDat 5%		6.78	1.80	4.77
CV		10.1	10.9	9.3

the number of harvestable bolls per plant also increased. Significantly higher number of bolls per plant (18.06) were recorded with application of 50% N through FYM + 50% N through gliricidia which was at par with 100% RDF, 50% N through vermicompost + 50% N through gliricidia. (Nawlakhe *et al.*, 2010) also recorded similar observations. Besides the supply of nutrients, FYM helps in storing soil moisture and. apart from this, vermicompost contained growth promoting substances such as NAA, cytokinins, gibberellins, etc (Lokesh *et al.*, 2012).

Boll weight

The boll weight was higher in the plot receiving nutrients with application of 50% N through FYM + 50% N through gliricidia which was at par with 100% RDF and 50% N through vermicompost + 50% N through gliricidia. The organics like FYM supplies some micronutrients besides major nutrients and vermicompost contain some beneficial growth promoting substances and vitamins, which might have helped in higher boll retention and improved boll weight (Channagouda *et al.*, 2015; Gabhane *et al.*, 2023).

Root length and weight of root

The root length and fresh root weight was significantly higher in the plot receiving nutrients with application of 50% N through FYM + 50% N through gliricidia, which was at par with 50% N through vermicompost + 50% N through gliricidia and 100% RDF respectively. However, treatment T_8 also showed at par in root length. Organics are known to have a favourable effect on soil structure, texture, tilth and thus facilitate quick and greater availability of plant nutrients and thus provides a better environment for root growth and proliferation, thereby creating more absorptive surface for uptake of nutrients

Yield

The significantly higher seed cotton yield (1008.8 kg ha^{-1}) was observed with application of 50% N through FYM + 50% N through gliricidia (T_5) which was at par with application of 50% N through vermicompost + 50% N through gliricidia (T_7), 25% N through FYM + 25% N through vermicompost + 50% N through gliricidia (T_8), 100% RDF (60:30:30 NPK kg ha^{-1}) (T_1) and application of vermicompost 3.0 t ha^{-1} (T_4). The increase in seed cotton yield with application of 50% N through FYM + 50% N through gliricidia was 12.1% and 7.7% with application of 50% N through vermicompost + 50% N through gliricidia (T_7) over 100% RDF (T_1). Similarly, the significantly higher cotton stalk yield (1664.9 kg ha^{-1}) was observed with the application of 50% N through FYM + 50% N through gliricidia (T_5) and similar trend was found like seed cotton yield. Higher cotton yield with conjunctive application of 50% N through FYM/ vermicompost + 50% N through gliricidia resulted in improvement in cotton yield might be due to balanced supply of nutrients to the crop throughout the growing period. Similar results were reported by (Bhalerao *et al.*, 2011), (Solunke *et al.*, 2011), (Channagouda *et al.*, 2015) and Rao *et al.*, (2017). The higher yield in organic treatments were mainly due to vermicompost, FYM and gliricidia which supplied both macro (N, P_2O_5, K_2O, Ca and Mg) and micro-nutrients (Fe, Mn, Zn and Cu) in optimum quantities resulting in better performance of crop. Green leaf manure addition into soil stimulates microbial activity, nutrient transformation, release and their plant availability as well as higher nutrients uptake by the crops, resulting in higher yield. These results are in conformity with the findings of (Gabhane *et al.*, 2014), (Doli *et al.*, 2015), (Yadav *et al.*, 2019) and Satpute *et al.*, (2019).

Productivity rating index

The highest productivity rating index of cotton (69.57) was observed in the treatment with application of 50% N through FYM + 50% N through gliricidia followed by

treatment (T_7 & T_8). The increase in productivity rating index may be due to conjoint application of FYM/ vermicompost + gliricidia.

Harvest Index (HI)

After 5 years of experiment the highest harvest index of cotton (37.73%) was observed in the treatment with application of 50% N through FYM + 50% N through gliricidia followed by treatments T_7& T_8. Increase in Harvest index is due to the application of FYM or vermicompost + gliricidia.

Total uptake of nutrients

After harvest of cotton N uptake ranged from 27.95 to 46.89 kg ha^{-1}, furthermore, it was observed that, significantly highest N uptake (46.89 kg ha^{-1}) was recorded with the application of 50% N through FYM + 50% N through gliricidia, which was on par (44.05 kg ha^{-1}) with application of 50% N through vermicompost + 50% N through gliricidia and treatments T_1, T_8 and T_4. Similar results were observed by Das *et al*., (2008), (Zaki and Habshy 2011), (Naik *et al*.. 2013), (Manchala *et al*., 2017) and Rao *et al*., (2017), This might be due to the fact that favourable soil conditions enhances soil biological activity which helped the mineralization of soil N leading to build-up of higher N. FYM and vermicompost are organic manure that release nutrients slowly and gliricidia green leaf manuring which contains larger amount of N in their leaves and that facilitates higher rate of mineralization process, also effective root system and increased concentration of nutrients in soil solution as well as better soil physical environment coupled with sufficiency of moisture and nutrients and slow release of nutrients to cotton crop resulting in higher uptake of nutrients with the increased seed cotton yield. Similar results were also reported by (Katkar *et al*., 2002), (Dhawan *et al.*, 2005) and Satpute *et al*., (2019).

Total phosphorus and potassium uptake showed the similar trend as that of nitrogen. The improvement in soil physical condition caused due to addition of organics is beneficial for enhanced uptake of nutrients. The organics inputs help in enhancing nutrients available in soil by reducing fixation of phosphorus. During decomposition of organic inputs, various organic acids are produced which solubilize phosphatise which might have resulted into increased phosphorus uptake which improves the efficient use of added phosphorus. Similar results were observed by Dhawan *et al.*, (2005), (Devraj *et al.*, 2007), (Manchala *et al.*, 2017) and Satpute *et al*., (2019).

The increase in total potassium uptake was due to incorporation of organic material which contains larger amount of potassium and on decomposition, release of organic acids that solubilize native K and which may get available to the plant. It is attributed to greater capacity of organic colloids to hold K ions on the exchange sites which enhanced the availability of potassium resulting in more uptake. Similar results were recorded by Devraj *et al.*, (2007), (Thimmareddy *et al*., 2013), (Manchala *et al*., 2017) and (Satpute *et al.*, 2019).

Conclusion

Hence, it can be concluded that integrated application of 50% N through FYM or vermicompost + 50% N through gliricidia resulted in improvement in nutrient uptake and yield components with higher seed cotton yield in Vertisols under semi-arid rainfed conditions.

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