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Effect of organic sources of nutrients on soil fertility and yield of rainfed cotton (*Gossypiumspp.*) in Vertisols

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ABSTRACT

A field experiment was conducted during kharif season of 2020 at research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, (Maharashtra) to study the effect of organic sources of nutrients on soil fertility and yield of rainfed cotton(Gossypiumspp.) in Vertisols. The experiment was laid out in randomized block design with three replications and nine treatments. The results revealed that, there was a reduction in bulk density, pH and electrical conductivity and an increase in hydraulic conductivity and organic carbon content with application of 50% N through FYM + 50% N through gliricidia green leaves. This treatment also resulted in significantly higher available N (193.2 kg ha^{-1}) and K (331.1 kg ha^{-1}) content whereas available P (15.98 kg ha^{-1}) content was higher with application of 50% N through FYM + 50% N through vermicompost. Improvement in the seed and stalk yield of cotton was observed with application of 50% N through FYM + 50% N through gliricidia green leaves. Seed and stalk yield was increased by 8.9% and 7.7% with application of 50% N through FYM + 50% N through gliricidia green leaves as compared to inorganic treatment, respectively. The minimum seed (540.9 kg ha^{-1}) and stalk (997.2 kg ha^{-1}) yield were recorded with application of 12 t FYM ha^{-1}.

Keywords: Vertisols, FYM, vermicompost, gliricidia green leaves, soil fertility, yield

INTRODUCTION

Cotton (*Gossypium* spp.) crop belongs to Malvaceae family and it is the most important fiber crop originated in India. It is known as “king of fiber” as well as “white gold”. Agriculture sector in present condition is facing serious challenges due to shrinking of non-renewable energy sources and depletion of land fertility. The use of chemical fertilizers alone in the intensive cropping system leads in decreasing soil fertility, reduction in biodiversity and unfavorable physical condition. It can be overcome by judicious use of organic manures for soil health and sustainable crop production. On the contrary, organic residues help to maintain and improve the soil. Soil organic matter provides nutrients for crops as it decomposes and contributes to the cation exchange complex necessary for holding applied nutrients in the soil. Soil aggregation is improved by increased organic matter content and hence has a primary role in maintaining soil structure, drainage and aeration; all of which are necessary for good crop yields. Soil organic matter also plays a role in increasing moisture retention and consequently the drought tolerance of the crop. A soil with an adequate level of organic matter will be less erodible, have increased nutrient retention and also be easier to work and plow. Other advantages include resistance to soil crusting and compaction, greater fertility, better root growth of crops, and improved crop yields. FYM is the most important source of organic matter and a key factor in conserving soil moisture, as well as improving and sustaining soil fertility and productivity. Green manure helps to add organic matter to soil while vermicompost contains most nutrients in plant available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium. So far, less consideration has been given on fulfilment of nutritional necessity of the crops through organic resources under rainfed condition and this aspect needs to be addressed through research on the effects of organic manures to improve soil nutritional quality and yield. Therefore, present investigation was undertaken to study the performance of organic manuring on soil fertility and yield of cotton.

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MATERIALS AND METHODS

A field experiment was conducted on Vertisols during *kharif* season of 2020 on the research field of AICRP for Dryland Agriculture, Dr. PDKV, Akola, Maharashtra. Experimental field is situated at the latitude of $22^0$41' North and 77^0 02' East longitude at the altitude of 307.4 m above mean sea level (MSL). Average annual precipitation, maximum and minimum temperatures were 733.6 mm, 42.9^0C, 12.5^0C, respectively. Most of the rainfall is received from south west monsoon. The soil was Vertisols belonging to smectitic, hyperthermic family of Typic Haplusterts. The texture of soil was clay with pH 8.1, EC 0.30 dS m^{-1}, organic carbon 5.1 g kg^{-1}, available N 184.5 kg ha^{-1}, available P 14.6 kg ha^{-1}, available K 322.0 kg ha^{-1} and available micronutrient status was Fe 6.59 mg kg^{-1}, Mn 9.97 mg kg^{-1}, Cu 2.14 mg kg^{-1} and Zn 0.63 mg kg^{-1}. The nine treatments comprising T_1 : 100% RDF (60:30:30 kg NPK ha^{-1}), T_2 : 12 t FYM ha^{-1}, T_3 : 8 t gliricidia ha^{-1}, T_4 : 3 t vermicompost 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, with three replications were evaluated in randomized block design. The organic material added were FYM (0.50:0.20:0.41), gliricidia (0.74:0.08:0.49), vermicompost (1.8:0.40:0.75) and phosphocompost (0:10.4:0) percent of NPK. The recommended dose of fertilizer was applied using urea, single superphosphate and muriate of potash prior to sowing. Remaining phosphorus was compensated through phosphocompost. Gliricidia green leaves were incorporated 30 days after sowing. Cotton variety "AKH 9916" was sown on 19^{th} of June 2020 at a spacing of 60 X 30 cm. picking of cotton was done on 3^{rd} November and 21^{st} December, 2020. Surface (0-15 cm) soil samples were collected from experimental plots after harvest of cotton. The collected soil samples were analyzed for soil bulk density, saturated hydraulic conductivity, pH and EC, organic carbon (Jackson, 1973) available nitrogen (Subbiah and Asija, 1956), available phosphorus (Watanabe and Olsen, 1965), available potassium (Jackson, 1973) and available Zn (Lindsay and Norvell, 1978). The mean data on various parameters were subjected to statistical analysis as per procedure given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield

The most of the treatments did not have any significant influence on seed cotton and cotton stalk yield (Table 1) over RDF alone. The mean seed cotton yield ranged between 540.9 to 660.4 kg ha^{-1} and numerically higher seed cotton yield (660.4 kg ha^{-1}) was observed with application of 50% N through FYM + 50% N through gliricidia (T_5) followed by application of 3 t vermicompost ha^{-1} (T_4). Treatment T_5 had 8.9% higher seed cotton yield over 100% RDF. The lowest seed cotton yield (540.9 kg ha^{-1}) was recorded with treatment 12 t FYM ha^{-1} (T_2). Similar to seed cotton yield, numerically higher cotton stalk yield

Table 1: Effect of organic sources of nutrients on cotton yield (kg ha^{-1})

Treatments		Seed cotton	Cotton stalk
T_1	100% RDF (60:30:30 NPK kg ha^{-1})	606.4	1125.2
T_2	FYM 12 t ha^{-1}	540.9	997.2
T_3	Gliricidia 8 t ha^{-1}	579.5	1065.6
T_4	Vermicompost 3.0 t ha^{-1}	656.6	1205.3
T_5	50% N through FYM + 50% N through Gliricidia	660.4	1211.6
T_6	50% N through FYM + 50% N as vc	581.7	1077.5
T_7	50% N through vc+ 50% N through G	598.5	1100.3
T_8	25% N through FYM + 25% N as vc + 50% N through G	573.5	1057.0
T_9	25% N through G + 25% N as vc + 50% N as G	554.2	1018.8
SE (m) ±		37.6	69.1
CD (p=0.05)		NS	NS

VC Vermicompost, G = Gliricidia

(1211.6 kg ha^{-1}) was also recorded with combined application of 50% N through FYM + 50% N through gliricidia (T_5) followed by application of vermicompost 3 t ha^{-1}. Treatment T_5 had 7.67% higher cotton stalk yield over T_1 *i.e.* 100% RDF. The lowest cotton stalk yield (997.2 kg ha^{-1}) was recorded with treatment 12 t FYM ha^{-1}. Higher cotton yield with conjunctive application of FYM and gliricidia green leaf manure may be due to balanced supply of nutrients to the crop throughout the crop growth period. These results are in conformity with the findings of Joga Rao *et al.* (2017).

Physical Properties

The data (Table 2) indicated that the bulk density ranged from 1.44 to 1.47 Mg m^{-3}, where lowest (1.44 Mg m^{-3}) was recorded with application of 50% N through FYM + 50% N through gliricidia (T_5) and higher bulk density (1.47 Mg m^{-3}) with application of 100% RDF. The lower values of bulk density with application of gliricidia and FYM treated plots may be due to aggregation of soil particles due to increasing organic matter as well as stability of aggregates which leads to increase the total pore space in soil. Similar result was observed by Patel *et al.* (2020). Hydraulic conductivity ranged from 0.69 to 0.73 cm hr^{-1} and the higher (0.73 cm hr^{-1}) was recorded with the application of 50% N through FYM + 50% N through gliricidia (T_5) followed by application of vermicompost 3 t ha^{-1} (T_4). Treatment T_1 showed lower value of hydraulic conductivity (0.69 cm hr^{-1}). The increase might be due to the better soil particle aggregation, microbial respiration, increased pore space and decreased soil bulk density. These results are in conformity with the findings of Gudadhe *et al.* (2015) and Khuspure *et al.* (2018). Soil pH and electrical conductivity was not significantly influenced by different treatments (Table 2). Lower pH (8.02) was recorded with the application of 50% N through FYM + 50% N through gliricidia (T_5) followed by application of 3 t vermicompost ha^{-1} (T_4). Higher value of pH (8.08) was recorded with application of 100% RDF (T_1). Decrease in pH with addition of gliricidia green leaf manuring and FYM, may be due to releasing H^+ which is responsible for reducing alkalinity of the soil. Khuspure *et al.* (2019) reported lowest pH with application of FYM. Electrical conductivity was decreased with application of organic nutrient sources and lowest value (0.20 dS m^{-1}) was observed with application of 3 t vermicompost ha^{-1}. These results are in conformity with the findings of Khuspure *et al.* (2019) and Sapkal *et al.* (2019). The effect of organic sources on build- up of soil organic carbon content was non-significant. The higher values of organic carbon content with application of organic materials may be attributed to addition of organic matter and greater root biomass. These results are in conformity with the findings of Khuspure *et al.* (2019), Sapkal *et al.* (2019) and Bose *et al.* (2021).

Table 2: Effect of organic sources of nutrients on physico-chemical properties of soil

Treatments	BD (Mg m^{-3})	HC (cm hr^{-1})	pH (1:2.5)	EC (dS m^{-1})	OC (g kg^{-1})
T_1	1.47	0.69	8.08	0.25	5.1
T_2	1.45	0.71	8.02	0.22	5.4
T_3	1.46	0.70	8.04	0.21	5.3
T_4	1.45	0.72	8.03	0.20	5.3
T_5	1.44	0.73	8.02	0.20	5.5
T_6	1.45	0.71	8.04	0.22	5.5
T_7	1.45	0.70	8.04	0.21	5.4
T_8	1.46	0.70	8.05	0.22	5.2
T_9	1.46	0.71	8.04	0.22	5.2
SE (m) ±	0.16	0.01	0.01	0.01	0.01
CD (P=0.05)	NS	NS	NS	NS	NS

Soil fertility

The available N in soil varied from 184.4 to 193.2 kg ha^{-1} and higher available nitrogen (193.2 kg ha^{-1}) was observed with 50% N through FYM + 50% N through gliricidia which was on par (192.3 kg ha^{-1}) with 3 t vermicompost ha^{-1}. The increase in available N content was 4.7% higher in T_5 as compared to RDF which showed lowest available nitrogen (184.4 kg ha^{-1}).

Table 3: Effect of organic sources of nutrients on status of available nutrients in post harvest soil

Treatments	Nitrogen	Phosphorus	Potassium	Zn
T_1	184.4	15.0	322.9	0.59
T_2	189.8	15.5	326.7	0.68
T_3	191.1	14.7	330.4	0.68
T_4	192.3	15.3	328.2	0.70
T_5	193.2	15.3	331.1	0.81
T_6	190.7	15.9	324.8	0.78
T_7	191.1	14.8	324.8	0.64
T_8	189.0	14.7	322.9	0.70
T_9	189.0	14.4	323.7	0.64
SE (m) ±	1.37	0.24	1.6	0.06
CD (P=0.05)	4.1	0.72	4.8	NS

FYM may increase the activity of soil microbes which convert the organically bound nutrients into inorganic form also gliricidia leaves have higher amount of nitrogen content in it which might have helped the mineralization of soil N leading to build-up of higher available N. These results are in conformity with the findings of Karikatti *et al.* (2020) and Kumar *et al.* (2020). The highest (15.9 kg ha^{-1}) available P was found with the application of 50% N through FYM + 50% N through vermicompost (T_6) which was on par with the application of 12 t FYM ha^{-1} An increase of 6.5% in available P content was recorded in treatment T_6 as compared to RDF.The appreciable build up in available phosphorus may also be due to influence of organic matter in increasing the labile phosphorus in soil through complexing of cations like Ca^{2+} which is mainly responsible for fixation in swell shrink soils. Lowest available phosphorus was observed with 25% N through gliricidia + 25% N through vermicompost + 50% N through gliricidia which might be due to gliricidia contains significantly lower available phosphorus. These results are in conformity with the findings of Ingle *et al.* (2020) and Kumar *et al.* (2020). Similar to N, highest available K (331.1 kg ha^{-1}) was observed with the application of 50% N through FYM + 50% N through gliricidia which was on par with the application of gliricidia 8 t ha^{-1} (T_3). The lower value of available K was observed in RDF. Organic matter holds nutrients at the exchangeable surface and thereby reduce K fixation and thus help in greater availability of K in soil. These results are in conformity with the findings of Ingle *et al.* (2020), Karikatti *et al.* (2020) and Kumar *et al.* (2020). The organic sources of nutrients did not effect the Fe, Zn and Mn over RDF.

In view of the above, it may be concluded that the integrated use of 50% N through FYM + 50% N through gliricidia resulted in improvement in soil fertility and yield of cotton grown in Vertisols under rainfed conditions. However, the magnitude of improvement was low which is expected to be increase in long run of this experiment.

REFERENCES

Bose, P., Roy, M. and Patra, P.K. (2021) Evaluation of long term different nutrient management practices on crop productivity and soil quality in rice (*Orzya sativa*) – potato (*Solanum tuberosum*) – groundnut (*Arachis hypogaea*) cropping system in new alluvial soil zone of West Bengal, India. *Plant Archives* **21**(1): 2383-2392.

Gomez, K.A. and Gomez, A.A (1984) *Statistical Procedure for Agriculture Research*, 2nd Edition John Wiley and Sons, Newyork, 680p.

Gudadhe, Nitin, Dhonde, M.B. and Hirwe, N.A. (2015) Effect of integrated nutrient management on soil properties under cotton-chickpea cropping sequence in Vertisols of Deccan plateau of India. *Indian Journal of Agricultural Research* **49**(3): 207-214.

Ingle, S.R., Singh, H., Sarware Alam, M.D., Kharche, V.K. and Wankhade, S.G. (2020) Effect of different resource conservation practices on soil chemical properties under cotton cultivation. *Journal of Pharmacognosy and Phytochemistry* **9**(1): 1140-1143.

Jackson M.L.,(1973) *Soil Chemical Analysis*, Printice Hall of India Pvt. Ltd., New Delhi, pp.458.

Joga Rao, P., Prasad, P.R.K., Lalitha Kumari, A., Prasuna Rani, P. and Pulla Rao, C.H. (2017) Long term effect of manures and fertilizers on nutrient status under cotton mono-cropping in Vertisol. *International Journal of Current Microbiology and Applied Sciences* **6**(7): 2084-2094.

Karangami, L.D., Bhoyar, S.M., Manchala, Santosh Kumar, Deshmukh, P.W. and Dhurve, N. (2017) Effect of rainfed organic cotton on chemical properties in Vertisol. *Agriculture Update* **12**(4): 912-916.

Karikatti, P., Bhat, S.N., Balanagoudar, S.R., Mastanareddy, B.G., Veeresh, H. and Rao, Satyanarayana (2020) Long term effect of organics, integrated and inorganic nutrient management practices on soil properties in a Vertisols. *International Journal of Current Microbiology and Applied Sciences* **9**(1): 2317-2326.

Khuspure, J.A., Bhoyar, S.M. and Deshmukh, P.W. (2018) Influence of organic manure on physical properties of vertisol under cotton cultivation. *Journal of Soil and Water Conservation* **17**(3): 294-298.

Khuspure, J.A., Bhoyar, S.M. and Deshmukh, P.W. (2019) Influence of manure application on soil chemical properties and crop yield under cotton cultivation. *International Journal of Chemical Studies* **7**(6): 159-163.

Kumar, V., Goyal, V. and Dey, P. (2020) Impact of STCR based long term integrated management practices on soil chemical properties and yield attributing parameters of wheat and pearl millet in semi-arid North-West India. *International Journal of Chemical Studies* **8**(4): 1320-1328.

Lindsay. W.L. and Norvell, W.H. (1973) Development of a DTPH soil test for zinc, iron, manganese and copper. *Soil Science Society of American Journal* **42** 421-425

Patel, B., Ghodpage, R.M., Patel, J., Karwade, S.G. and Ekka, A.A. (2020) Impact of long term organic sources on physical properties and yield of vegetable crops in Nagpur district. *International Journal of Chemical Studies* **8**(2): 2723-2727.

Sapkal, K.A., Bhoyar, S.M. and Rathod, P.H. (2019) Effect of organic sources on physico-chemical properties of soil and uptake of nutrient in cotton under rainfed conditions. *Journal of Pharmacognosy and Phytochemistry* **8**(5): 1492-1496.

Subbiah, B.V. and Asija, G.L.(1956) A procedure for estimation of available nitrogen in soils. *Current Science,* 25: 260.

Watanabe, F.S. and Olsen, S.R. (1965) Test of ascorbic acid method for determining phosphorus in water and sodium bicarbonate extracts of soils*. Soil Science Society of America Proceedings***29**: 677-678.