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Effect of different sources of organic manures on soil properties under organic cotton production system

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ABSTRACT

We compared the nutrient uptake, nutrient status of the soil, moisture content, soil organic carbon and microbial biomass after the harvest of cotton genotypes. Cotton genotypes Sahana and Jayadhar were grown in black clay loam soil that had been exposed to different manurial treatments *viz.,* farmyard manure (FYM), vermicompost (VC), neemcake (NC) and glyricidia and compared with recommended dose of fertilizer (RDF) alone and integrated application of RDF + FYM. Cultivar Sahana recorded significantly higher (0.72 %) organic carbon (OC) as compared to Jayadhar (0.68 %).The increase in OC content with Sahana was to an extent of 5.88 % over Jayadhar. Among manurial treatments, RDF with FYM recorded significantly higher OC (0.78 %) over RDF alone (0.62%). The increase and buildup of available N, P and K was to an extent of 2.63, 17.37 and 3.87 per cent with Sahana. Soil available N, P and K were significantly higher with RDF + FYM (360.50, 60.50 and 495.33 kg NPK/ha, respectively) except RDF alone which was on par. The population of soil bacteria, fungi and actinomycetes ($85.40X10^4$,$52.66X10^3$ and $34.81X10^2$ CFU/g of soil, respectively) were significantly higher with FYM 100 per cent + VC 100 per cent as compared to RDF alone and other organic manurial treatments. Soil moisture content differed significantly as influenced by varieties and manurial treatments. However, no significant change in bulk density (BD) was observed with varieties and manurial treatments.

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Key words : Organic carbon, Sahana, Jayadhar, Bulk density, Microbial population.

INTRODUCTION

Organic manures play an important role as a substitute for mineral nutrients due to indiscriminate use of chemical fertilizers affecting soil health. The present structure and output of agricultural system could not be maintained without the advent and widespread use of synthetic or mineral fertilizers. Out of the major plant nutrient, nitrogen not only provides the greatest responses in crop yield from fertilizer addition but is also the most readily lost from the agroecosystem. Its use has increased dramatically in recent decades, but its losses have limited its use to full extent in any production system.

Nitrogen losses have a number of environmental consequences. In particular, N loss can negatively affect the quality of soils, groundwater, surface water and the atmosphere. The application of organic manures, generally added as a nutrient source not only improves soil properties including higher plant available water holding capacity and cation exchange capacity (CEC) and lower BD, but also foster beneficial microorganisms (Drinkwater *et al.,* 1995). Soil in organic production system losses less nitrogen into nearby water system compared to conventional production system. Conventional farming has played an important role in improving food and fibre productivity to meet human demands but has been largely dependent on intensive inputs of synthetic fertilizers, pesticides, and herbicides. These conventional farming practices and associated chemical inputs have raised many environmental and public health concerns (Horrigan *et al.,* 2002). Prominent among these are the reduction in biodiversity (Lupwayi *et al.,* 2001), environmental contamination (Horrigan *et al.,* 2002), and soil erosion (Reganold *et al.,* 1987). Public concerns over environmental health and food quality and safety have led to an increasing interest in alternative farming practices with lower inputs of synthetic chemicals and greater dependence on natural biological processes.

Looking into these myths and dogmas, the present investigations were initiated first time in organic cotton production system to asses the role of organic sources of nutrients on soil health including populations of soil flora.

MATERIALS AND METHODS

The experiment was carried out at University of Agricultural Sciences, Dharwad, Main Agricultural Research Station (MARS), Karnataka, India. The soil

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Table 1 : Treatment particulars

Treatment particulars	
Main Plots: Varieties (V)	
V1	Sahana
V2	Jayadhar
Sub Plots : Organic manures and fertilizers (T)	
Sr. No.	Treatments
1.	T_1- RDF (40:25:25 kg/ha)
2.	T_2 – RDF + FYM (7.5 t/ha)
3.	T_3 –FYM equivalent to100 % RDN
4.	T_4 –VC equivalent to 100% RDN
5.	T_5 –FYM equivalent to 100% RDN + VC equivalent to100% RDN
6.	T_6 –FYM equivalent to 100 % RDN + glyricidia equivalent to100 % RDN
7.	T_7 –FYM equivalent to100% RDN + VC equivalent to 50% RDN + NC equivalent to 50% RDN
8.	T_8 –FYM equivalent to100 % RDN+ glyricidia equivalent to 50 % RDN + NC equivalent to 50 % RDN
9.	T_9 –FYM equivalent to 50 % RDN+ glyricidia equivalent to 50 % RDN
10.	T_{10} –FYM equivalent to 50 % RDN+ VC equivalent to 25 % RDN+ NC equivalent to 25 % RDN
11.	T_{11} –FYM equivalent to 50 % RDN+ glyricidia equivalent to 25 % RDN+ NC equivalent to 25 % RDN

RDN-Recommended Dose of Nitrogen, RDF-Recommended Dose of Fertilizer, FYM- Farmyard Manure, VC- Vermicompost, NC-Neemcake, T-Treatment

was medium black clay with physical properties, BD value of 1.27 g/cc and chemical properties, available nitrogen 218.2, phosphorus 29.3, potassium 428.3 (kg/ha) and OC 0.5%. The previous cropping history included the following: 2002-crop Jowar, and 2003-crop Sunhemp. Following harvest of Jowar (winter) in 2003 the site was left fallow over summer 2004 (August). Based on the nitrogen analysis of FYM, VC, NC and glyricidia (Table 2) were applied to field as 100 per cent, 50 per cent and 25 per cent organic manures equivalent to 45, 22.5 and 11 kg of nitrogen per ha basis. Different combination of organic manures was applied three weeks before dibbling of cotton seeds (Sahana and Jayadhar). The experiment was laid out in Split Plot Design with three replications. Sowing of cotton genotypes *viz.,* Jayadhar and Sahana was done with a spacing of 60 cm between rows and 45 cm between plants. Soil samples to a 15 cm depth were collected from each treatment and subjected to physical and chemical analyses and assayed for selected microbial populations at harvest. The data were statistically analyzed based on Panes and Sukhatme (1967) method.

Table 2 : Chemical characteristics of organic manures

Organic manures	Nutrient content (%) air dry basis			
	N (%)	P_2O_5 (%)	K_2O (%)	Organic carbon (%)
FYM	0.98	0.30	0.81	40.70
Vermicompost	1.75	0.34	0.48	39.20
Neemcake	2.52	0.39	0.79	38.59
Glyricidia	1.54	0.33	0.58	37.51

RESULTS AND DISCUSSION

The data on nutrient availability, nutrient uptake by cotton and population dynamics of different flora at harvest are presented in Table 3, 4 and 5.

Increase in seed cotton yield and dry matter production could be related with increase in uptake of N, P and K by the cotton. All these major nutrients are important for many physiological processes controlling growth and development in plants. Application of RDF + FYM, RDF alone and integrated application of organics (FYM, VC, NC and glyricidia) increased the concentration of nutrient ions in the soil solution and their uptake by cotton. Significantly higher uptake of nutrient by cotton (79.78 kg N, 15.97 kg P_2O_5 and 80.68 kg K_2O) was recorded with RDF + FYM over other treatments and which was on par with RDF alone. The lowest nutrient uptake was recorded with 100 % RDN applied through FYM 50 % + glyricidia 50% (59.33 kg N, 10.65 kg P_2O_5 and 61.35 kg K_2O) (Table. 3). Slower mineralization process of glyricidia combined with lower microbial biomass might have affected the release of nutrient ions in the soil. The result suggests that organics with inorganic fertilizer not only increased the availability of nutrients in the soil but also favoured the release of nutrients from organic sources through mineralization by microorganisms at a faster rate. Significant increase in the uptake of NPK was observed with application of 5 t sewage waste + 0.

Table 3: Nutrient uptakes by cotton (Kg / ha) as influenced by varieties and manurial treatments

Manurial treatments	Nitrogen (Kg / ha)			Phosphorus (Kg / ha)			Potash (Kg / ha)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	68.53df	83.46ab	76.00ab	14.46cd	16.50ab	15.48a	72.00cd	84.13ab	78.06a
T_2	73.86fh	85.70a	79.78a	15.00d	16.93a	15.97a	76.33de	85.03ab	80.68a
T_3	57.16kl	76.30cd	66.73de	12.20f	14.43d	13.31d	59.80ij	77.00cd	68.40bc
T_4	59.06jl	79.83ad	69.45cd	11.93fg	15.03ab	13.48d	62.90hi	77.70cd	70.30b
T_5	65.56gI	85.50a	75.53ab	14.20d	16.46ab	15.33ab	72.66de	84.73ab	78.70a
T_6	63.46hj	85.06a	74.26ac	12.73ef	16.26ab	14.50bc	69.06eg	86.26a	77.66a
T_7	59.53il	80.70ac	70.11bd	12.66ef	16.23ab	14.45bc	63.53gI	80.03bc	71.78b
T_8	60.60ik	78.13bd	69.36cd	12.53ef	15.83bc	14.18cd	61.73eh	79.50bc	70.61b
T_9	53.93l	64.13gj	59.33f	9.06h	12.23f	10.65f	57.26j	65.45fh	61.35d
T_{10}	53.73l	75.83ce	64.78df	11.20g	13.33e	12.26e	56.93j	75.80cd	66.40bd
T_{11}	55.16kl	70.10eg	62.63ef	9.60h	13.23e	11.41ef	58.16ij	70.00ef	64.08cd
Mean	60.96b	78.67a		12.32b	15.13a		64.58b	78.70a	
For comparing mean of	S.E. ±	C.D. (P=0.05)		S.E. ±	C.D. (P=0.05)		S.E. ±	C.D. (P=0.05)	
Varieties (V)	1.10	3.03		0.26	0.78		1.21	3.64	
Organics (O)	1.37	3.93		0.21	0.61		1.27	3.63	
V x O at the same or different V	1.92	5.49		0.31	0.90		1.81	5.19	

V_1= Jayadhar, V_2 =Sahana, O= organics

Table 4: Effect of FYM, VC, NC and glyricidia on nutrient availability after the harvest of cotton

Manurial treatments	Nitrogen(kg/ha)			Phosphorus(kg/ha)			Potassium(kg/ha)			Organic carbon (%)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	193.33	182.00	187.66	34.00	32.50	33.25	381.00	379.00	380.00	0.519	0.512	0.516
T_2	344.00	338.00	341.00	46.00	42.00	44.00	504.00	486.00	495.00	0.590	0.561	0.576
T_3	254.00	254.00	254.00	32.00	31.00	31.50	447.00	450.00	448.50	0.550	0.543	0.546
T_4	251.00	247.00	249.00	34.00	32.00	33.00	448.00	453.00	450.50	0.544	0.540	0.542
T_5	305.00	301.00	303.00	40.00	38.00	39.00	485.00	472.00	478.50	0.574	0.560	0.567
T_6	293.00	289.00	291.00	38.00	37.00	37.50	483.00	470.00	476.50	0.569	0.567	0.568
T_7	289.00	284.00	286.50	39.00	37.00	38.00	481.00	468.00	474.50	0.567	0.561	0.564
T_8	288.00	284.00	286.00	37.00	36.00	36.50	478.00	466.00	472.00	0.540	0.538	0.539
T_9	244.00	289.00	241.50	31.00	30.00	30.50	441.00	439.00	440.00	0.542	0.553	0.534b
T_{10}	248.00	245.00	246.50	32.00	31.00	31.50	446.00	440.00	443.00	0.520	0.552	0.519
T_{11}	249.00	244.00	246.50	31.00	30.00	30.50	445.00	437.00	441.33	0.520	0.517	0.518
Mean	268.84	264.27		35.81	34.22		458.09	450.97		0.549	0.540	
For comparing mean of	S.E. ±	C.D. (P=0.05)		S.E. ±	C.D. (P=0.05)		S.E. ±	C.D. (P=0.05)		S.E. ±	C.D. (P=0.05)	
Varieties (V)	1.20	NS		0.32	NS		1.83	NS		0.001	NS	
Organics (O)	4.43	12.67		1.52	4.33		5.52	15.79		0.004	0.012	
V x O at the same or different V	6.10	NS		2.07	NS		7.67	NS		0.006	NS	

NS= Non Significant, V_1= Jayadhar, V_2 =Sahana, O= organics

25 t NC (72.42 kg N, 16.83 kg P_2O_5 and 83.99 kg of K_2O) treatment over inorganic fertilizers (50:25:30 kg of NPK/ha) treatment (58.04 kg N, 13.22 kg P_2O_5 and 72.63 kg of K_2O) (Padole *et al.,* 1998). Badole and More (2000) reported that, the maximum total N uptake was recorded with NC + *Azospirillum* + PSB while maximum P uptake was recorded with pressmud cake + *Azospirillum* + PSB and maximum K uptake was recorded with FYM +

Table 5 : Effect of FYM, VC, NC and glyricidia on moisture content and micro-bial biomass (CFU) after the harvest of the cotton

Manurial treatments	Bulk density (g/cc)			Moisture content (%) At harvest (30-60 cm)			Microbial biomass (CFU g/soil) Bacteria			Fungi			Actinomycetes		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	1.263	1.410	1.337	24.13	24.04	24.07	30.33	35.24	32.78	19.43	21.20	20.31	8.00	9.90	8.95
T_2	1.280	1.300	1.29	27.02	26.72	26.87	81.00	83.00	82.00	42.33	44.00	43.16	24.40	26.70	25.55
T_3	1.227	1.287	1.257	27.41	26.74	27.07	69.33	71.00	70.15	38.00	40.20	39.10	23.00	24.67	23.85
T_4	1.223	1.273	1.258	27.00	26.51	26.75	60.66	69.20	64.93	23.33	25.20	24.26	14.20	16.21	15.20
T_5	1.227	1.280	1.253	29.12	28.59	28.85	86.99	85.40	86.19	51.66	53.66	52.66	34.00	35.62	34.81
T_6	1.277	1.323	1.300	29.03	28.90	28.96	78.00	80.00	79.00	48.22	49.22	48.72	29.00	31.61	30.30
T_7	1.273	1.343	1.308	28.00	27.62	27.81	56.00	62.00	59.00	31.33	31.20	31.26	13.00	14.61	13.80
T_8	1.240	1.303	1.272	28.04	27.40	27.72	52.66	56.80	54.73	27.33	29.34	28.35	11.40	13.40	12.40
T_9	1.324	1.327	1.323	27.31	26.79	27.05	61.31	63.62	62.46	29.33	31.00	30.16	12.00	14.50	13.25
T_{10}	1.333	1.330	1.332	27.00	26.53	26.76	40.90	45.20	43.05	26.00	26.30	26.15	9.70	11.35	10.52
T_{11}	1.343	1.273	1.308	27.10	26.25	26.67	39.66	43.00	41.33	25.00	24.00	24.50	9.00	11.11	10.05
Mean	1.273	1.315		27.37	26.91		59.71	63.13		32.90	34.12		17.06	19.06	
For comparing mean of	S.E. ±		C.D. (P=0.05)	S.E. ±		C.D. (P=0.05)	S.E. ±		C.D. (P=0.05)	S.E. ±		C.D. (P=0.05)	S.E. ±		C.D. (P=0.05)
Varieties (V)	0.006		NS	0.42		1.28	0.93		2.81	0.23		0.69	0.06		0.19
Organics (O)	0.028		NS	0.71		2.04	0.50		1.45	0.31		0.89	0.09		0.28
V x O at the same or different V	0.038		NS	0.98		NS	0.82		2.36	0.43		1.25	0.13		0.39

NS=Non Significant, V_1= Jayadhar, V_2 =Sahana, O= organics

pressmud cake + glyricidia + *Azospirillum* + PSB + cowdung urine slurry.

Effect on soil properties:

In this study the highest OC (0.576 %) content of the soil was recorded with integrated application of RDF + FYM over all the treatments (Table. 4). Parlawar *et al.,* (2000) reported that, OC of soil (8.90 g/kg) was significantly higher with half of the RDF + cowpea buried at 10 per cent flowering of whole plant over control (no fertilizer). Malewar *et al.* (2000) reported similar result *i.e.,* OC increased slightly in the soil receiving FYM 10 t/ha and FYM 10 t/ha + 100 per cent RDF (6.75 and 6.70 g/kg of soil) as compared to inorganic fertilizer alone. Annual application of FYM 10 t/ha along with RDF significantly increased the OC content of the soil from an initial value of 0.33 and 0.42 per cent at the end of Ist year cycle and further to 0.49 per cent at the end of II year cycle (Solaiappan, 2002). Among the organic manurial treatments, FYM 100 % + VC 100% recorded significantly higher (0.567%) OC over other treatments, except 200% organic treated treatments (T_6 and T_7) which were at par. Significantly, lower OC (0.516%) was recorded with RDF alone. There was no significant difference with respect to BD on soils treated with organic manures and synthetic fertilizers. Highest BD was recorded in treatment T_{10} fallowed by T_9 and lowest was recorded in soil treated with RDF alone (Table. 5).

Soil moisture content:

Organic manures help in nutrients supply, soil aeration and moisture retension. Soil organic manures also help in faster water infiltration rate due to enhanced soil aggregation (Stamatiadis *et al.,* 1999). In this experiment at all the growth stages (90, 135, 180 DAS and at harvest) at the depth of 30- 60 cm the maximum soil moisture content was recorded with all the 200% organic manurial treated soils (T_5, T_6, T_7 and T_8) fallowed by 100 % organic treated soils (T_3, T_4, T_9, T_{10} and T_{11}). Whereas, RDF alone noticed significantly lower soil moisture content due to its lower soil moisture holding capacity as compared to organic manures (Table.5).

Soil nutrient availability at harvest:

Significantly higher (341.00 kg/ha) nitrogen content of soil was recorded with integrated application of RDF + FYM over other treatments. Among organic manurial treatments FYM 100 % + VC 100 % recorded significantly higher (303.00 kg/ha) nitrogen content, except 200 % organic treated soils (T_6, T_7 and T_8), which were at par. Whereas, RDF alone treated soil noticed significantly lower (187.66 kg/ha) nitrogen content (Table 4). Similarly, P status in soil, recorded at harvest was significantly higher (44.00 kg/ha) with integrated application of FYM + RDF, except treatments T_3, T_4, T_5, T_6, T_7 and T_8 which were at par. At the same time potassium also recorded significantly higher with integrated application of FYM + RDF (495.00kg) except, 200 % organic treated soils T_5, T_6, T_7 and T_8 which were at par. Whereas, RDF alone recorded significantly lower (380.00 kg/ha) soil potassium content. Padole *et al.,* (1998) and Malewar *et al.* (2000) reported similar results that the available NPK and sulfphur were significantly higher in soil receiving RDF + FYM 10 t/ha. The present study clearly revealed increase in available NPK, if the inorganic source is mixed with organic sources compared to inorganic source alone. This gives scope for long term experimentation and sustainable nutrient management in organic cotton production system.

Microbial population:

Specific components of soil microbial community were changed by the addition of organic manures to soil in this experiment. The addition of organic manures increased propagule densities of bacteria, fungi and actinomycetes in soil. Limited field studies have been conducted to determine the impact of soil amendments on microbial communities in actual organic and conventional production system (Drinkwater *et al.,* 1995; Gunapala and Scow, 1998). However, it has been shown that microbial activity and biomass is higher in field with organic amendments than fields with conventional fertilizers (Drinkwater *et al.,* 1995). Significantly higher bacterial, fungal and actinomycete population (86.19, 52.66 and 34.81 CFU/g soil, respectively) were recorded in soil treated with FYM 100 % + VC 100 %. Solaiappan (2002) who opined that, the addition of organic manures might have improved microbial activity and enhanced the availability of native and applied nutrients which in turn increased the yield of cotton. RDF alone noticed significantly lower microbial population (32.78, 20.31 and 8.95 CFU/g soil, respectively) among all the manures. The amount of soil nitrogen in field under conventional production system has been negatively correlated with soil microbial components (Gunapala and Scow, 1998). There was a gap of 162.93, 164.20 and 289.38 per cent microbial population density between highest and lowest recorded treatments. Among organic treatments, soil treated with neemcake had lower microbial biomass than soils with VC, FYM and glyricidia. It may be due to microbial inhibitory action of azadirachtin, a chemical content in neem seeds might have reduced microbial biomass in neemcake treated soils.

Conclusions:

The studies clearly brought out influence of increased availability of nutrients with combined application of RDF and FYM or vermicompost. The organic nutrients also helped in increased population of beneficial soil flora suggesting enhanced bioconversion. These results can be used as indicators for estimating nutrient status of different soils under different production systems.

REFERENCES

Badole, S.B. and More, S.D. (2000). Yield and nutrient uptake as influenced by integrated nutrient supply system in cotton. *J. Indian Soc. Improve.*, **25** (3): 161-165.

Drinkwater, L.E., Letourneau, D.K., Workneh, F., Van Bruggen, A.H.C. and Shennan, C. (1995). Fundamental differences between conventional and organic tomato agroecosystem in California. *Ecol. Appl.,* **5** : 1098-1112.

Gunapala, N. and Scow, K. (1998). Dynamics of soil microbial biomass and activity in conventional and organic farming system. *Soil Biol. Biochem.,* **30** : 805-816.

Horrigan, L., Lawrence, R.S. and Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture, *Environ. Health Perspect.,* **110** : 445–456.

Lupwayi, N.Z., Monreal, M.A., Cylayton, G.W., Grant, C.A., Johnston, A.M. and Rice, W.A. (2001). Soil microbial biomass and diversity respond to tillage and sulphur fertilizers, *Can. J. Soil Sci.,* **81** : 577–589.

Malewar, G.U., Bodale, S.B., Mali, D.V., Siddiqui, M.B. and Syed Ismail (2000). Influence of flyash with and without FYM and fertilizers on physico-chemical properties of sunflower and cotton growing soils. *Ann. Agric. Res.,* **21**(2): 187-191

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

Panse, V.G. and Sukhatme, V. (1967). *Statistical methods for agricultural workers*. Indian Council of Agricultural Research, New Delhi, pp. 152-155.

Reganold, J.P., Elliott, L.F. and Unger, Y.L. (1987). Long-term effects of organic and conventional farming on soil erosion, *Nature (London)* **330** : 370–372.

Solaiappan, U. (2002). Effect of inorganic fertilizer and organic manure on cotton-sorghum rotation in rainfed vertisols. *Madras Agric. J.*, **89** (7-9): 448-450.

Stamatiadis, S., Werner, M. and Buchanan, M. (1999). Field assessment of soil quality as affected by compost and fertilizer application in a broccoli field (San Benito County, California). *Appl. Soil Ecol.,* **12** : 217–225

Parlawar, N.D., Adpawan, R.M., Yadgirwar, P.V. and Bhoyte, S.B. (2000). Organic recycling through different intercrops in the base crop of cotton. *P.K.V. Res. J.*, **24** (2): 66-68.

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