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Research Paper

Role of organic sources in enhancing the productivity *per se* of cotton genotypes under organic production systems in Karnataka

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ABSTRACT

The *per se* Performance of cotton genotypes Sahana (*G. hirsutum*) and Jayadhar (*G. herbaceum*) under different manurial treatments *viz.,* farmyard manure (FYM), vermicompost (VC), glyricidia, neemcake (NC), recommended dose of fertilizers (RDF) alone and in combination with FYM was analyzed under rainfed condition of Northern Karnataka. Jayadhar recorded significantly higher kapas yield (1326 kg/ha) under integrated application of RDF (45:25:25 kg NPK/ha) and FYM (7.5 t/ha). This increase was 12% higher than the kapas yield obtained after treatment with RDF alone. Additionally, genetic responses of agronomically important parameters such as yield, plant height, TDMP, LAI, number of monopodial branches, number of sympodial branches and number of bolls were significantly higher with RDF + FYM treatment. The net returns were significantly higher with Jayadhar (Rs.10992.00/ha). Among organic manurial treatments, application of FYM 100% (equivalent to 45 kg nitrogen) + glyricidia 100% (equivalent to 45 kg nitrogen) recorded significantly higher net returns (Rs. 8357.00/ha) when compared to treatments treated with VC and NC. Irrespective of manurial treatments, Jayadhar recorded significantly higher benefit cost (B:C) ratio (2.20) as compared to Sahana. Among manurial treatments, RDF alone and integrated application of RDF+FYM showed significantly higher B:C (2.16 and 2.15, respectively) ratio over rest of the treatments.

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Key words : Cotton, Genotypes, Organic manures, Kapas yield, Economics

INTRODUCTION

India has a unique place among the cotton growing countries of the world. Of the four species that are grown commercially in india, two are diploid (*Gossypium arboreum* and *G.herbaceum*) and the other two tetraploid (*G.hirsutum* and *G.barbadense*). Additionally, many hybrid varieties derived from crossing the tetraploid species are grown in the central and southern cotton growing zones of India (Chaudhary and Laroia, 2001). In 2008-09, it occupied an area of 93.73 lakh ha. Fertilizer use on irrigated cotton (153.5 kg/ha) was higher than on rainfed cotton (97.7 kg/ha). The share of irrigated and rainfed cotton in total fertilizer consumption were 2.7 and 3.3 per cent, respectively accounting for 6.0 per cent (1.01 million tonnes) of total fertilizer consumed in India on cotton alone (FAO 2003/04). The average per-hectare use of fertilizer on cotton was 116.8 kg (89.5 kg/ha N, 22.6 kg/ha P_2O_5 and 4.8 kg/ha K_2O). With introduction of high-yielding variety (HYV) seeds, there was acceleration in the growth of fertilizers consumption. Apart from fertilizers, cotton is a crop to which 45% of the pesticides and 58% of insecticides also used in India (Chaudhary and Laroia, 2001). This indiscriminate use of fertilizers and pesticides by farmers, the faulty marketing strategies by Indian and multinational companies is leading to build-up of pesticide resistance, resurgence of secondary pests and loss in soil fertility. This has further paid way for limitation in consumption of non-renewable form of energy (*i.e.*, chemical fertilizer and pesticides) mainly due to increase in cost of energy, chemical fertilizers and pesticides, which are not available at an affordable price to small and marginal farmers of India. The growing concerns over the environmental pollution, soil health, agro-ecology and poor profitability for cotton growers has further necessitated the demand for organically cultivated eco-friendly green cotton. The present investigations opened new approaches to answer some of these issues in cotton production.

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

MATERIALS AND METHODS

A field trial was conducted at Main Agricultural Research Station (MARS) of the University of Agricultural Sciences, Dharwad. The soil type was medium black clay, situated in transitional tract of Karnataka. Based on the nitrogen analysis of experimental site, different organic sources such as FYM, VC, NC and glyricidia were applied three weeks before the dibbling of cotton seeds as 100%, 50% and 25% making equivalent to 45, 22.5 and 11 kg of nitrogen. The different treatments with combination applications are presented in Table 1. The experiment was laid out in split plot design replicated three times. Two varieties Sahana and Jayadhar were evaluated under organic nutrient management and were compared with the integrated application of RDF + FYM and RDF alone. Dibbling of cotton seeds *viz.,* Jayadhar and Sahana was done with a spacing of 60 cm between rows and 45 cm between plants. All the recommended crop husbandry practices were followed. The observations on different growth stages, yield and yield attributes were recorded. The data was statistically analysed based on Panse and Sukhatme (1967) method.

RESULTS AND DISCUSSION

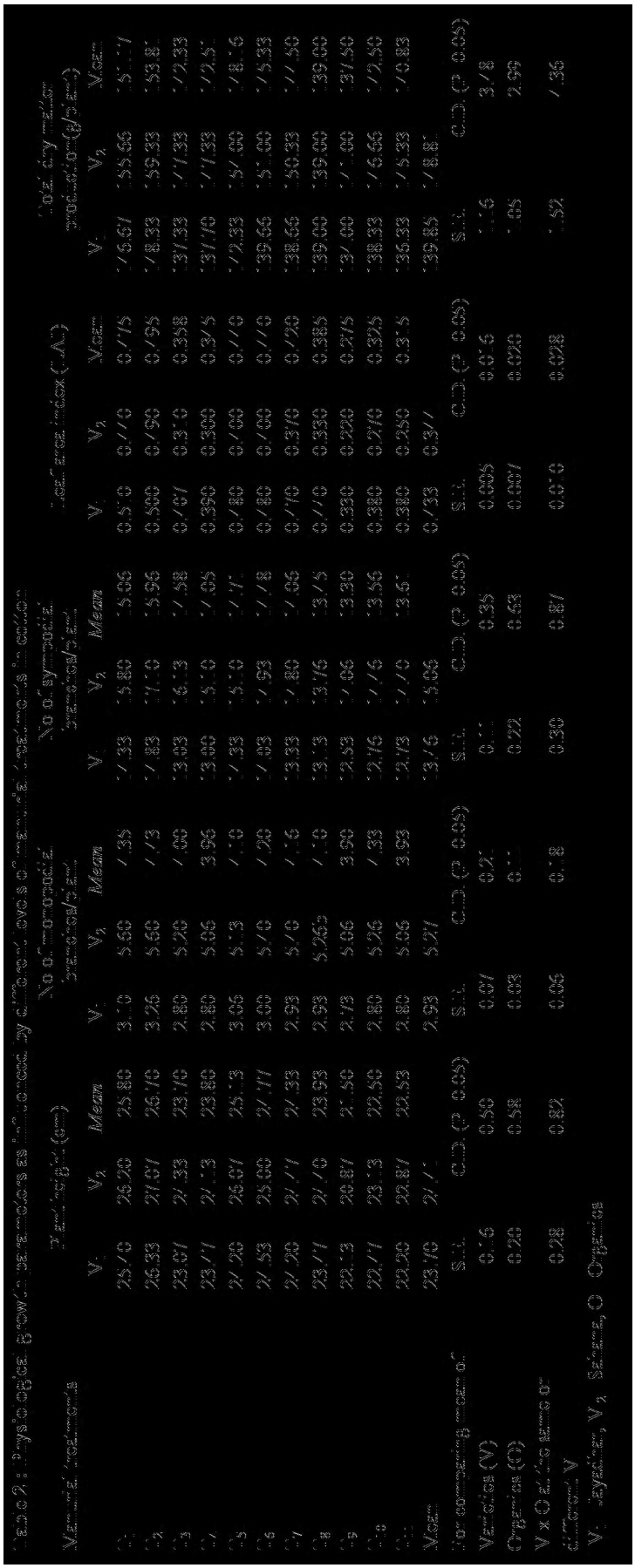
The data on agronomical parameters (plant height, TDMP, leaf area index (LAI), number of monopodial branches, number of sympodial branches, number of bolls per plant, yield and yield per plant) are presented in Table 2 and 3. Results revealed significant difference with respect to agronomical parameters influencing productivity *per se* of cotton genotypes Jayadhar and Sahana at different sources of manurial treatments.

Peformance of genotypes :

Yield:

The yield *per se* of Jayadhar (*G. hebaceum*) revealed higher kapas yield of 1172 kg/ha when compared to Sahana (*G. hirsutum*) 826 kg/ha. The per cent increase in Jayadhar yield over Sahana was 41.83 (Table 3). Response of Jayadhar to organic nutrient management was found better than Sahana, which was reflected in growth and yield. Jayadhar has a potential to use organic sources much better under several biotic and abiotic stresses, which has resulted in higher kapas yield compared to Sahana. Similar type of varietal differences in their yielding ability when grown under varied nutritional levels in cotton were reported by Wankhade and Bathakal (1994) and Kattimani (1995) under general cultivation. Venugopalan and Blaise (1999) reported better yield response of *G.arboreum* (AK 8401) when compared with *G.hirsutum* (Anjali) by 17% under organic production. Seed cotton yield variations in two cotton genotypes was mainly attributed to the result of growth and development as indicated by TDMP, and its distribution in various parts of plant is an evident in the present investigation.

Highly positive correlation between yield and its components such as number of squares, boll number, yield per plant and number of seeds per plant was observed by Kattimani (1995). In this research the yield components, mean boll numbers and their weight are closely associated



with seed cotton yield under rainfed conditions. Jayadhar recorded significantly higher total number of bolls harvested per plant (40.18) than Sahana (25.04). The former recorded 60.14 per cent higher number of bolls per plant than Sahana (Table 3). These results are in conformity with the findings of Venugopalan and Blaise (1999). The effect of all these yield components manifests in the seed cotton yield per plant. Jayadhar possessed significantly higher yield per plant (31.75 g) than Sahana (22.30) with 42.4 per cent increase over Sahana (Table.3).

Growth and dry matter accumulation pattern:

Growth and dry matter production in different plant parts have indirect influence on the final yield. In this study, Jayadhar possessed significantly taller plants (135.52 cm) as compared to Sahana (100.22 cm) (Table 2) this was 35.22% higher over Sahana. Many research worker obtained varietal differences in cotton plant height (Kattimani, 1995; and Venugopalan and Blaise, 1999).

The vegetative branches mainly, monopodial branches have greater significance in architect of plant under rainfed conditions. Jayadhar possessed (5.27) more number of monopodial branches than Sahana (2.93) (Table 2). Similar observations were recorded by Kattimany (1995). Sympodial branches form principle segment of super structure in cotton where the fruiting bodies develop. Jayadhar recorded significantly higher number of sympodial branches (15.06) at harvest than Sahana (13.46) (Table. 2). It may be attributed to adoption of Jayadhar to late *Kharif* conditions and suitability to *Rabi* cultivation. Sahana put up better growth during early season *via-a-visa* Jayadhar put up better growth on later stage. Hence, the Jayadhar has advantage over Sahana in the present investigation. These findings are in conformity with that of Giri and Upadhyay (1980).

Higher yield was a consequence of greater dry matter production and its distribution in the earlier stage and in to reproductive parts at advanced stage of growth (Krishnegowda. 1974). In the present study, Sahana had higher leaf area and LAI compared to Jayadhar in the initial stage of growth. However, Jayadhar possessed more of them at 135, 180 and at harvest indicating an effort to put on vegetative growth later in the season as it was adapted to late *Kharif* and *Rabi* conditions. Whereas, Sahana was well adapted to early *Kharif* to express its full potentiality.

In the early stage of growth, Sahana possessed higher LAI than Jayadhar. When fruiting bodies started

Table 3 : Seed cotton yield, number of bolls/plant, boll weight (g)/plant and economics as influenced by different levels of manurial treatments in cotton

Manurial treatments	No. of bolls/plant			Boll weight (g)/plant			Seed cotton yield (kg/ha)			Net return (Rs./ha)			B:C ratio		
	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
O_1	26.73	45.66	36.20	40.08	54.79	47.43	850	1201	1025	6472	12552	9512	1.80	2.53	2.16
O_2	27.33	47.66	37.50	40.99	57.19	49.09	958	1326	1142	7223	13601	10412	1.80	2.50	2.15
O_3	24.33	37.00	30.66	36.49	44.40	40.44	821	1120	975	5323	10501	7912	1.60	2.20	1.90
O_4	24.80	36.33	30.56	37.20	43.59	40.39	798	1156	977	4553	10635	7694	1.50	2.20	1.85
O_5	25.80	43.33	34.56	38.70	51.99	45.34	850	1192	1021	4545	10525	7535	1.46	2.03	1.75
O_6	25.46	43.00	34.23	38.15	51.60	44.87	814	1186	1000	5142	11572	8357	1.60	2.30	1.95
O_7	25.26	41.00	33.13	37.89	49.20	43.54	740	1257	994	2108	10862	6485	1.16	2.00	1.58
O_8	24.73	40.33	32.53	37.08	48.38	42.73	824	1138	981	4129	9584	6857	1.40	1.93	1.66
O_9	22.66	33.33	28.00	33.99	39.99	36.99	797	1109	953	5455	10956	8205	1.66	2.30	1.98
O_{10}	24.06	38.33	31.03	36.08	45.99	41.03	800	1130	965	4576	10297	7437	1.50	2.13	1.81
O_{11}	24.26	36.33	30.30	36.39	43.59	39.99	835	1086	961	5447	9825	7636	1.60	2.06	1.83
Mean	25.04	40.18		37.45	48.24		826	1172		5016	10992		1.55	2.20	
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)	1.03	3.11		0.64	1.94		14.63	43.90		186	560		0.02	0.06	
Organics (O)	0.72	2.08		1.09	3.12		18.65	53.29		290	829		0.02	0.08	
V x O at the same or different V	1.10	3.16		1.50	4.43		26.17	74.75		402	1537		0.04	0.11	

V_1 - Jayadhar, V_2 - Sahana, O - Organics, NS - Non Significant

to develop at 90 DAS after dibbling of cotton seeds, the trend was reversed, bolls were growing at faster rate in Sahana than in Jayadhar. When majority of bolls were essentially started growing Sahana had significantly higher TDMP per plant than Jayadhar until 90 DAS. Hence, better photosynthesis and growth of Sahana observed in the early stages and in Jayadhar at later stages. Cultivar Jayadhar accumulated significantly higher TDMP at 180 and at harvest. Thus, Jayadhar proved to be more efficient in diversion of assimilates from leaves through stem to reproductive parts (sink), when the demand from sink is high. Higher yield in cotton is in association with the higher TDMP (Venugopalan and Blaise, 1999).

Effect of manurial treatments:

In the present study, seed cotton yield differed significantly due to different levels of manurial treatments (Table 3). Integrated application of RDF with FYM recorded significantly higher seed cotton yield over RDF alone and other organic manurial treatments (FYM, VC, NC and glyricidia treated soils). The increase in seed cotton yield was 11.34 %. Increased soil organic carbon and higher concentration of available nutrients in integrated application of chemical fertilizer with FYM enhanced the yield of cotton (Prakash *et al.,* 2001; Solaiappan, 2002). Mean yield (1078 kg/ha) with 30:13:25 kg NPK + 5t FYM was significantly higher by 14 % over 90:20:38 (945 kg/ha) and by 36 % over 60:13:25 kg NPK/ha (Venugopalan and Blaise, 1999). In this study, the next best treatment recorded with respect to yield was RDF alone and which was at par with all the organic manurial treatments. Among the organics, the input level equivalent to 100 % RDN did not show any significant difference with respect to yield. However, they differed significantly with respect to yield attributes. The higher input level of 200 % RDN substituted through FYM, VC, NC and glyricidia showed their superiority over 100% RDN substituted through their individual organic application. The factors mainly responsible for variation in the seed cotton yield was variation in manurial treatments which have effect on yield components like number of squares, flowers, green bolls, and open bolls per plant at harvest. Other factors that indirectly influenced seed cotton yield were growth attributes *viz.*, plant height, LAI, monopodial branches, sympodial branches, TDMP and its distribution in various plant parts.

Different plant growth attributes *viz.,* plant height, number of monopodial branches, sympodial branches, LAI and dry matter production in various plant parts was influenced by different levels of manurial treatments. Integrated application of RDF + FYM recorded higher

plant height over RDF alone and all the organic manurial treatments. Significantly, lower plant height recorded with FYM 50 % + glyricidia 50 %. Significantly higher number of monopodial branches per plant (4.43) was recorded with integrated application of RDF + FYM followed by RDF alone (4.35) which was at par. Further RDF alone was at par with 200 per cent organic manurial treated treatments. Whereas, FYM 50 % + glyricidia 50 % noticed significantly lower number of monopodial branches per plant (Table 2).

Significantly higher number of sympodial branches per plant (15.96) was recorded with integrated application of RDF + FYM. Among organic manurial treatments, combined application of FYM 100 % + VC 100 % noticed significantly higher sympodial branches per plant. Significantly, higher LAI was recorded at all the growth stages with RDF+FYM as compared to RDF alone and all the organic manurial treatments. This increased LAI might have attributed to better growth and development of leaves and higher leaf area per plant. These results are in line with the findings of Prakash *et al.* (2001). Increased LAI intern resulted in higher dry matter accumulation in leaves. Among organic treatments, FYM100 % + VC100 % recorded significantly higher TDMP/plant (148.16g) over other organic manurial treatments. Whereas, FYM 50 % + glyricidia 50 % noticed significantly lower TDMP/ plant (137.50 g) (Table 2).

Another most important factor contributing to the final seed cotton yield is the partition of dry matter in to reproductive parts. Integrated application of RDF + FYM influenced the dry matter accumulation in reproductive parts. Dry matter accumulation in bolls was significantly higher with RDF + FYM over RDF alone and organic treatments. Similar, trend was noticed in squares and flowers. These results proved better partitioning of dry matter in to reproductive parts with RDF + FYM. These results are in conformity with the findings of Venugopalan and Blaise (1999). Maximum dry matter was recorded with integrated nutrient supply system (50 % NPK through chemical fertilizer + 50 % NPK through FYM + azospirillum + cow dung urine spray + phosphate solubilizing bacteria). It may be due to the substituted release of NPK and other nutrients through mineralization of organic materials and CO_2, which in turn increased the available inorganic nutrients through fertilizers (Badole and More, 2000). The increase in seed cotton yield was noticed due to combined application of RDF (40:20:20 kg NPK / ha) + FYM @ 7.5 t /ha over RDF alone and other organic manurial treatments which range from 11.34 to 19.79 % and were at par with each other.

Economics:

Economic analysis indicated that combined application of RDF + FYM significantly increased the net return as compared to organic treatments (Table 3). The highest net returns was recorded with integrated application of RDF + FYM (Rs.10412) and it was at par with RDF alone (Rs.9512). Solaiappan, (2002) reported, application of inorganic fertilizer 40:20:20 kg NPK/ha every year and FYM 25 t/ha once in two years recorded significantly higher net income (Rs. 8439/ha) which was closely followed by application of 40:20:0 kg NPK + FYM 12.5 t/ha. Among organic manurial treatments, FYM 100% + glyricidia 100% recorded significantly higher net return (Rs. 8357) over other organic treatments. Relatively higher, cost of cultivation in the treatment FYM 100 % + VC 50% + NC 50% resulted in lower net returns. Maximum benefit cost ratio (B:C) of 2.16 and 2.15 were obtained in RDF alone and integrated application of RDF + FYM, respectively. Among the organic manurial treatments FYM 50 % + glyricidia 50 % noticed significantly higher B:C ratio of 1.98 and was at par with FYM 100 % + glyricidia 100 % and FYM 100 %. Minimum B:C ratio of 1.58 was was noticed in organic treatment FYM 100 % + VC 50 % + NC 50 %, which was due to higher cost of cultivation (Table 3).

Thus, the present findings clearly brought out the role organic sources in enhancing the productivity of different cotton genotypes. The results of study are the first line of research in organic cultivation of cotton in Karnataka and be utilized further in developing a module for organic cultivation of cotton in subcontinent.

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