Comparative Performance of Irrigated Hirsutum Cotton in Conventional and Organic Packages in Black Clayloam Soils of Tamilnadu

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Abstract

Field trials were conducted on Hirsutum Cotton cv. Surabhi on a typical mixed black clayloam soil in Coimbatore with organic inputs to study their comparative performance. The organic inputs used were in situ growing of sunnhemp and incorporating in situ, recycling of crop residues and addition of manures alone and in combination, along with conventional practice of crop nutrition as a control during 2003-04 and 2004-05. Combined application of FYM @ 5 t/ha 15 days before planting and sunnhemp seeded @ 15 kg/ha in inter-rows of cotton as green manure sown simultaneously with cotton and incorporated in situ at 45 days of planting produced the highest seed cotton yield of 1801 kg/ha as against the control yield of 1579 kg/ha. Over the years, higher fibre productivity efficiency in above followed by green manure based combinations and FYM @ 10 t/ha was also observed. The study indicated that organics grown in situ or locally available may act as an effective substitute to inorganic nutrition in cotton.

Among the serious problems confronting agriculture, access to water, credit and market besides technology are the most important as observed in the status paper on *Agrarian Crisis* by National Commission on Farmers (Swaminathan, 2005). When consistent plateau in yield of most of the crops is observed and/or increased cultivation costs associated with price spurt, farming by nature is becoming more relevant in recent years. This has prompted possibly for meeting the demand for growing crops applied with inputs grown locally and available easily. Moreover, the organic matter content of cultivated soils of the tropics and sub-tropics is low due to high temperature and intensive microbial activity, thereby necessitating replenishment of soil humus through microbial biomass/activity and/or periodic additions of organic manures for maintaining soil fertility and crop productivity (Subramanian, 2004).

It is in this context, an integrated supply system of essential nutrients through addition of manures of plant/animal origin, green manures (grown *in situ* along with crops and buried before flowering) and recycling of crop residues assumes importance. Besides improvement in soil and crop performance, addition of these is known to suppress the adverse effects of soil salinity (Yadav, 1975). Therefore, the present study was taken up to study the comparative performance of organic inputs and conventional practices of crop nutrition in irrigated cotton in the semiarid tract of the southern cotton zone in India.

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Materials and Methods

A field experiment was conducted on a mixed black calcareous clay loam soil with medium fertility on *hirsutum* cotton cv. Surabhi under irrigated conditions at Central Institute For Cotton Research, Regional Station, Coimbatore (at 11°N & 77° E with 427.6 m above msl) during 2003-05. The soils with pH of 8.72 and low EC (0.35 dsm^{-1}) belongs to PERIYANAICKANPALAYAM series (*vertic Ustropept*). It was low in both O.C. (0.37%) and available N (74 ppm), medium in available P (7.03 ppm) and high in K (248 ppm). The irrigation water had a pH of 7.4, EC 3.52 dsm^{-1} and total salt concentration of 0.23 %.with mostly neutral salt of sulphates and chlorides.

Nine treatment combinations involving *in situ* inter-row planting and incorporation of sunnhemp (*Crotalaria juncea*) as green manure (GM), recycling of cotton whole crop residues (CRI) along with farm yard manure (FYM) were tried in a CRBD (Table-1). Acid delinted seeds were sown during 1st week of September at 75 x 30 cm spacing and 2 plants/hill were maintained as an insurance against stem weevil prevalent in the region. FYM was applied to cotton as per treatment 2 weeks before planting while half of urea-N and whole of P & K were applied (to NPK treatment only) at planting followed by top dressing during earthing up of the crop. Dried and cut (2-3") cotton whole stalks were incorporated in the soil 2 months before planting of cotton (CRI). Sunnhemp as green manure (GM) was sown @ 15 kg/ha in the reverse side of cotton ridge initially and incorporated *in situ* at 45 DAS (with fresh biomass @ 5 t/ha with equivalent dry wt. of 1 t/ha) followed by earthing up and ridge formation along the cotton rows. The crop management practices were uniformly adopted in all the plots. The crop received 338.9 and 552.5 mm of rainfall during 1st & 2nd year respectively. First picking of cotton was taken in mid-January and the second/last in the mid-February.

Plant biometrics, yield & its attributes, fibre quality were recorded and soil samples (0-22.5 & 22.6-45 cm soil depth) were analyzed for nutrients as per treatment following normal procedures. Fibre quality was tested with High Volume Instrument and Fibre Quality Index calculated as L*T/SQRT(M) where L is 2.5 % Span length in mm, T is Bundle strength in g/tex and SQRT(M) is square root of Micronaire value (µg/in) defining fibre maturity. Fibre productivity efficiency (FPE) was calculated as mean fibre produced per unit area and growing day. FYM contained 0.52, 0.20 and 0.51 % N, P & K respectively whereas the values were 1.10, 0.10 & 0.60 % for cotton residues and 1.90, 0.30 & 1.70 % for GM respectively on dry weight basis.

Results and Discussion

Seed cotton yield and yield traits

A perusal of the data in Table-1 indicated that combined application of FYM @ 5 t/ha, cotton whole residues @ 2.5 t/ha & sunnhemp seeded @ 15 kg/ha in inter-rows as GM incorporated *in situ* at 45 DAP produced significantly higher seed cotton yield over that in control and RDF during 2nd year although the difference was not significant during the 1st year because of initial soil homogeneity. Yet the trend was more or less similar in pooled data depicting the fact that the highest per hectare productivity in terms of SCY of 1801 kg was recorded along with highest FPE of 11.19 kg/ha/day under the combination of FYM @ 5 t/ha and *in situ* incorporation of sunnhemp as against the lowest yield of 1579 kg/ha (and FPE of 9.81 kg/ha/day) in control.

When FYM was applied alone or supplemented with green manure, it resulted in release of the nutrients for soil microbes following mineralization of organic sources, and enabled further release of available

Table 1. Effect of source of organic materials on *Kapas* yield, yield attributes, fibre quality and fibre productivity efficiency (pooled data)

Treatments	Seed yield (kg/ha)			Stalk wt. (q/ha)	Symp-odia/ plant	Bolls/ plant *	Boll wt. (g)	FPE (kg/ha /day)	2.5% S.L. (mm)	Fibre elonga-tion (%)	Bundle strength (g/tex)	Micornaire value	FGI
	2003-04	2004-05	Mean (%)										
T_1 : FYM @ 10 t/ha	1683	1729	1706	25.7	16.7	15.7	3.0	10.6	31.0	5.2	22.7	3.6	370.5
T_2: CRI@ 5t/ha	1691	1681	1686	26.7	16.5	15.5	2.9	10.5	31.3	5.4	21.6	3.6	356.0
T_3: GM @1t/ha)	1411	1867	1639	31.6	18.5	16.7	2.7	10.2	31.5	5.2	22.4	3.6	371.4
T_4: FYM @ 5t/ha + CRI @ 2.5 t/ha	1548	1536	1542	30.5	16.7	17.9	2.8	9.6	31.1	5.1	22.1	3.5	366.8
T_5: FYM @ 5 t/ha+ GM @ 1t/ha)	1864	1739	1801	28.7	17.2	18.0	2.8	11.2	30.9	5.3	21.9	3.6	360.1
T_6 :FYM @ 5t/ha+ CRI @ 2.5 t/ha+ GM @ 1 t/ha	1529	1904	1717	30.4	17.0	16.8	2.9	10.7	31.7	5.1	23.0	3.6	386.4
T_7: CRI @ 2.5 t/ha + GM @ 1 t/ha	1774	1701	1738	28.9	17.9	17.6	2.9	10.8	30.9	5.1	22.4	3.7	361.6
Mean (Organics)	**1643**	**1737**	**1690**	**28.9**	**17.2**	**16.9**	**2.8**	**10.5**	**31.2**	**5.2**	**22.3**	**3.6**	**367.5**
T_8: N:P:K::60:13:25 kg/ha (RDF)	1600	1701	1651	33.3	17.7	17.3	2.7	10.3	31.4	5.2	22.5	3.5	375.9
T_9: Absolute Control	1502	1655	1579	28.7	16.8	16.6	2.7	9.8	31.4	5.3	22.7	3.6	379.1
Mean (all treatments)	**1622**	**1724**	**1673**	**29.4**	**17.2**	**16.9**	**2.8**	**10.4**	**31.2**	**5.2**	**22.4**	**3.58**	**369.8**
SEM+	182.7	65.71	137.3	4.47	0.44	1.36	0.19	-	0.28	0.06	0.38	0.06	8.8
C.D. (0.05)	NS	196.9	NS	NS	1.27	NS	NS	-	NS	0.16	NS	NS	NS

* Burst bolls count /plant; FPE is based on 161 days of actual mean crop duration

nutrients from GM for the cotton crop even in presence of its residues (Table-2). Venugopal *et al.* (1999) reported that sunnhemp grown as green manure and incorporated in *situ* was found to improve productivity of widely spaced hybrid cotton under western Maharastra (Rahuri) condition and even application of green manure or FYM @ 12-18 t/ha increased the yield of cotton by 16-20 % at Coimbatore. Sunnhemp starts decomposing following incorporation *in situ* and in the process releases nutrients especially N for better growth and performance of the crop.

Although various organic residues/ manure had differential reserves of N, P & K inputs (as per NPK concentrations) yet application of FYM @ 5 t/ha and sunn hemp *in situ* incorporated produced highest yield because of adequate nutrient supply (45 kg N, 13 kg P & 43.5 kg K), and was followed by other GM combinations.

Improvement in seed cotton yield is largely reflected from similar enhancement in biometrical traits especially sympodia and more so because of better soil nutrient availability (following composting of inputs in organic (GM/FYM/residues) plots over control plots (Table-1). Although significantly higher number of sympodia was counted under *in situ* incorporation of GM over that in FYM and GM combination, yet the fruiting branches was compensated by higher number of burst bolls in the latter. Other plant growth parameters and yield traits at harvest were not influenced by the treatments tried.

Table 2. Soil parameters (0-22.5 cm soil depth) under different organic treatments*

Treatments	Available 'N' (ppm)	Available 'P' (ppm)	Available 'K' (ppm)	Organic Carbon (%)	pH	EC (dsm^{-1})	Available Na (%)
T1 : FYM @ 10 t/ha	83	7.4	303	0.42	8.5	0.67	0.09
T2 : CRI@ 5t/ha	77	6.0	273	0.41	8.5	0.79	0.09
T3: GM dry wt. @1t/ha)	77	6.5	290	0.43	8.6	0.73	0.09
T4: FYM + CRI	79	8.2	343	0.47	8.6	0.67	0.09
T5: FYM + GM	79	7.1	290	0.45	8.6	0.63	0.09
T6 :FYM+ CRI+ GM	79	8.2	330	0.47	8.6	0.68	0.09
T7: CRI + GM	75	7.5	320	0.48	8.6	0.69	0.09
Mean (Organics)	**78**	**7.3**	**307**	**0.44**	**8.6**	**0.69**	**0.09**
T8:N:P:K::60:13:25kg/ha	75	7.9	320	0.46	8.5	0.76	0.09
T9:Absolute Control	73	7.6	273	0.48	8.7	0.72	0.09
Mean (treatments)	75	7.4	309	0.45	8.6	0.70	0.09
Initial status	**74**	**7.0**	**248**	**0.37**	**8.7**	**0.35**	**0.06**

* C.D.(0.05) is significant in respect of Soil Available N with the value of 5.2 ppm

Fibre quality

Fibre qualitty attributes viz., 2.5 % span length, Micronaire value and bundle strength were not influenced by the residues/FYM/ GM application individually or in combination. However, higher fibre elongation of 5.32% was recorded under combined application of FYM and GM added plots and was statistically similar with the highest value (5.37%) obtained under cotton residue incorporated plots. Interestingly, a maximum FQI of 386.4 was recorded under the combined application of all the organic sources (FYM+GM+CRI), thereby indicating the role of organics in production of matured fibre with higher fibre length & strength (Table-1).

Soil fertility

Net availability of a limiting nutrient determines the crop performance in terms of growth, development and yield as availability of an essential nutrient in the soil is both supply and demand driven inclusive of loss constituent. Thus, in the semi-arid region with high elevation where temperature ranges between 18 to 38°C, nutrient losses by way of leaching and denitrification may have been minimized by way of organic matter incorporation techniques within and around the rhizosphere. Although appreciable changes in soil fertility parameters were not evident, yet higher N, P & K tended to be available under FYM supplemented treatments following mineralization and lowest P in crop residue incorporated treatment due to P-immobilization and its uptake, and lowest K in control/crop residue plots because of K uptake irrespective of profile depth (Table-2) (data not given for subsurface soil).

Similarly, other soil chemical properties viz., OC, pH, EC and Na content are quite similar to NPK availability (Table-2). Relatively lower EC was measured under organic treatments especially FYM applied plots because of adsorption by organic complex. However, EC and sodium content in the soil was more pronounced at the surface because of salinization resulted in enhanced salinity especially after harvest of the crop (salt rises to the soil surface following capillary action of water and gets deposited there following uptake of water by plants (Praharaj, 2005). Quantification of the nutrient removed by the plants indicates that these are similar in all the treatments.

Economics

Mean values over the years on the economics of cotton cultivation with organic inputs revealed that net return was higher with least cost of cultivation following application of crop residues/GM over that in control or recommended NPK plots. Crop residue being a low cost material in comparison to FYM or GM, both net margin and B:C ratio were higher under the treatment. However, adequate and proper blend of green & herbaceous materials with dark, dry and hard lignocelluloses are required to serve differential purposes including restoration of soil fertility and crop performance (Singh and Singh, 2002). Thus, the above study indicated that organics grown *in situ* or locally available may act as an effective substitute to inorganic nutrition in cotton.

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References

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