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Effect of Organic Nutrient Management Practices in Comparison with Conventional Method on Performance of Cotton in Tamil Nadu

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A field experiment was conducted in Tamil Nadu Agricultural University farm, Coimbatore to compare the organic nutrient management packages with integrated nutrient management (INM) in cotton. The experiment was consisted of eighteen treatments, laid out in Randomized Complete Block Design and replicated thrice. The results revealed that INM practices increased the plant height over other treatments. Significant increase in yield components like sympodial branches plant^{-1}, number of bolls plant^{-1} and boll weight were observed under INM treatment and was at par with recommended dose of fertilizers (RDF), Farm yard manure and poultry manure compared to all other treatment combinations. The INM practice resulted in significantly higher seed cotton yield and was comparable with RDF. The quality characters did not exhibit any significant variation among the nutrient management practices. Higher gross and net returns and B:C ratio were also recorded in INM practices.

Key words: Organic cotton, Nutrient management, Seed cotton yield, Fibre quality

Cotton is the backbone of Indian textile industry, accounting for 75 percentage of total fibre consumption in textile sector and 38 percentage of the country's export, fetching foreign exchange of Rs. 50,000 crores per annum. Area under cotton cultivation in India (10.15 million ha) is the highest in the world, i.e., 25 per cent of the world area.

Due to intervention of green revolution technologies during 1960s involving use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops, have enhanced the production output per hectare in most of crops including cotton (Ramesh *et al*., 2010). However, deterioration of the quality of soil as a natural resource is evident in the traditional cotton belt. High external input based cropping has degraded the soil water system, depleted soil organic carbon stocks and fertility. Imbalanced fertilizer application, accelerated soil loss and exclusion of organic sources, combined with overuse of nitrogen, compels the crop to exploit soil reserves for other nutrients, creating multiple nutrient deficiencies.

Development of appropriate nutrient management strategies becomes crucial in terms of enhancing soil health and quality. Sustaining the soil health in the long run, various organic amendments which are traditionally used by the farmers like farm yard manure, poultry manure, vermi-compost and also preparing and using Tricho compost are to be evaluated for their suitability along with green manures. Therefore, study on nutrient management in cotton was taken-up.

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Material and Methods

A field experiment was conducted in the Eastern block farm of Tamil Nadu Agricultural University, Coimbatore, which is located at 11°N latitude and 77°E longitude at an altitude of 426.7 m above mean sea level. The soil of the experimental field was sandy clay loam in texture with low in available nitrogen (195 kg ha^{-1}), medium in available phosphorus (17.5 kg ha^{-1}) and high in available potassium (712 kg ha^{-1}). The experiment was laid out in a randomized complete block design with 18 treatments and replicated thrice. The treatments are as follows.

T_1 – Control (No fertilizer / amendments / green manures)

T_2 – 100% Recommended dose of nitrogen (RDN – 80 kg ha^{-1}) through FYM (on equal N basis)

T_3 – 100% RDN through vermi compost (VC) (on equal N basis)

T_4 – 100% RDN through poultry manure (PM) (on equal N basis)

T_5 – 100% RDN through Tricho compost (TC) (on equal N basis)

T_6 – 50% RDN through FYM + 50% RDN through VC

T_7 – 50% RDN through FYM + 50% RDN through PM

T_8 – 50% RDN through FYM + 50% RDN through TC

T_9 – 50% RDN through VC + 50% RDN through PM

T_{10} – 50% RDN through VC + 50% RDN through TC

T_{11} – 50% RDN through PM + 50% RDN through TC

T_{12} – 25% FYM +25% VC +25% PM + 25% TC

T_{13} – Intercropping with green manure (Sunnhemp) and *in-situ* incorporation at 50% flowering stage (GM) + 50% RDN through FYM

T_{14} – Intercropping with GM + 50% RDN through VC

T_{15} – Intercropping with GM + 50% RDN through PM

T_{16} – Intercropping with GM+ 50% RDN through TC

T_{17} - 100% Recommended dose of fertilizers (RDF – 80:40:40 NPK kg ha^{-1}) exclusively through inorganic fertilizers

T_{18} - 100% RDF + 12.5 tonnes of FYM ha^{-1}

The treatments T_{17} and T_{18} were maintained separately with plot size of 6m x 5m adjacent to organic farming area. Nutrient content and the quantity of manures applied are given in Table 1.

Tricho-compost

The cotton stalks were made into small pieces and spread over the marked area. A slurry consisting of 1.0 kg of *Trichoderma viride*, 2.5 kg of waste jaggery and 20 kg of fresh cow dung talc formulation were mixed with 100 litres of water and sprinkled over the cotton stalk and turned at 15 days interval. The tricho-compost material was ready after 50 days.

Crop cultivation

Seeds of the Suraj variety with field duration of 150 days were treated with cow dung slurry (1%) a day before sowing and shade dried. Then, the seeds were treated with bio-control agents like *Trichoderma* and *Pseudomonas* talc formulations @ 4 g kg^{-1} and 10 g kg^{-1}, respectively and bio-fertilizer, Azophos @ 1200 g ha^{-1} before sowing. Soil application of Azophos and Pseudomonas @ 5 kg ha^{-1} and 2.5 kg ha^{-1}, respectively were mixed with 25 kg of soil. Seeds were dibbled on one side of the ridge with a spacing of 30 cm between plants. A seed rate of 15 kg ha^{-1} was adopted. Organic pesticides, predators and parasites were used to control pests. Three rounds of neem oil sprays (3%) and fish oil resin soap sprays (1%) were given at 15 days interval against sucking pests at initial growth stages depending on extent of pest incidence. *Acorus calamus* dusting was done twice to control the sap feeders. The predator, *Chrysoperla* spp. @ 500 ha^{-1} was released two times to control sucking pests at 20 and again at 35 days after sowing. Egg parasite, *Trichogramma chilonis* @ 2.5 cc ha^{-1} was released on 45th day to control bollworms in cotton. Three rounds of TNAU Panchagavya (3%) spray were given on 45, 60 and 75 DAS as a means of foliar growth regulator.

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 heights of the plant and reproductive sympodial 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. The kapas weights collected from five fully opened bolls at random from the five marked plants in each plot was recorded and mean boll weight was expressed in g $boll^{-1}$. The ratio between the number of bolls and the number of fruiting points was worked out and expressed as percentage. Kapas was picked out in the net plots. Care was taken to avoid bracts and trash adherence while removing the seed cotton from the bolls. The kapas was dried in the shade, cleaned and weighed, arrived seed cotton yield (kg ha^{-1}). Kapas sample having 100 seed cotton from each plot were taken and weighed. The seed and lint weight were recorded after ginning. The ginning percentage was calculated by using the procedure suggested by Santhanam (1976).

$$\text{Ginning percentage} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

The weight of one hundred seeds obtained after ginning was expressed in g. The lint obtained by ginning of hundred seed cotton was weighed and expressed in g (Santhanam, 1976). The mean fibre length was determined by high volume instrument (HVI) where the weight ratio method was adopted and expressed in mm. Fibre strength is the ratio of the breaking strength of a bundle of fibres to its weight. It was expressed in tenacity at 1/8" gauge on HVI, using the standard methods (Sundaram, 1979). Uniformity ratio is the ratio of 50 per cent span length to the 2.5 per cent span length and expressed in percentage (Sundaram and Iyengar, 1968). Standard procedure was adopted to work out cost of cultivation (Rs. ha^{-1}), gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and B:C ratio based on the local prevailing price. The data subjected to statistical analysis (Gomez and Gomez, 2010).

Results and Discussion

Plant height

The data on plant height recorded at maturity stage showed significant variation among nutrient management practices (Table 2). Integrated nutrient management practices (INM) of recommended dose of NPK (80:40:40 kg ha^{-1}) coupled with farm yard manure application at 12.5 t ha^{-1} resulted in significantly taller plants over organic manure treatments in both the seasons of the experimentation. The INM treatment registered a plant height of 118.42 and 113.9 cm at maturity stages during rabi 2012-13 and 2013-14, respectively. However, it was on par with RDF. Khiani and More (1984) reported that increased soil organic carbon and higher concentration of available nutrients with integrated application of chemical fertilization with FYM enhanced growth parameters favourably. It is obvious that with the INM practice, any crop would perform at its best, because of adequate nutrient supply to the crop at the right time of crop requirement (Nagavani, 2010).

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

Organic manure	Nutrient concentration (%)						Quantity applied (t ha^{-1})	
	2012-13			2013-14				
	N	P	K	N	P	K	2012-13	2013-14
FYM	0.60	0.48	0.41	0.50	0.38	0.62	13.33	16.00
Poultry manure	1.10	0.62	0.50	1.14	1.06	0.98	7.27	7.02
Vermi-compost	2.74	1.96	1.28	1.74	0.56	1.34	2.92	4.60
Tricho-compost	1.36	0.53	0.60	1.22	0.43	0.44	5.88	6.60

Yield Attributes

Yield attributing characters are totally responsible for the variation in the seed cotton yield (Table 2 and 3). The sympodial branches are the basic structure which bears various reproductive organs of the crop. This can be altered by the agronomic practices like nutrient management practices. There existed significant variation due to various nutrient management practices on sympodial branches of cotton.

Table 2. Effect of nutrient management practices on growth and yield attributes of cotton

Treatment	Plant height (cm)		Sympodial branches plant^{-1}		Number of bolls plant^{-1}	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 - Control	84.2	83.2	10.6	11.0	11.88	10.65
T_2 – FYM	96.6	94.4	14.6	15.4	15.11	15.44
T_3 – VC	93.7	92.3	11.9	15.2	14.90	15.23
T_4 – PM	95.7	93.7	13.4	15.3	15.04	15.66
T_5 –TC	93.8	93.4	12.9	12.9	13.30	13.24
T_6 – FYM + VC	92.0	92.6	12.6	13.2	14.10	13.47
T_7 – FYM + PM	89.1	88.8	12.6	12.7	13.40	12.88
T_8 – FYM + TC	91.8	91.1	11.3	12.9	12.60	11.34
T_9 – VC + PM	94.7	94.3	10.9	13.3	14.60	13.64
T_{10} – VC + TC	93.0	93.6	13.5	12.4	12.90	11.69
T_{11} – PM + TC	92.2	91.8	13.5	12.2	12.60	11.00
T_{12} – 25% each FYM + VC + PM + TC	89.3	88.1	12.1	11.3	12.50	10.94
T_{13} – IC + FYM	91.1	90.9	13.3	13.0	13.20	13.25
T_{14} – IC + VC	90.9	89.7	11.7	12.9	13.30	12.96
T_{15} – IC + PM	90.4	89.9	12.4	13.1	13.80	13.40
T_{16} – IC + TC	90.2	89.5	13.6	12.8	12.70	12.90
T_{17} – RDF	115.8	111.7	17.3	17.7	17.30	17.67
T_{18}- INM	118.4	113.9	18.5	18.1	20.30	18.11
SEd	5.2	4.6	0.1	1.3	1.53	1.41
CD (P=0.05)	10.7	9.4	0.2	2.6	3.10	2.87

The cotton crop that received the INM (18.5 and 18.1) and RDF (17.3 and 17.7) practice had produced more number of sympodial branches plant^{-1} followed by FYM (14.6 and 15.4) and poultry manure (13.4 and 15.3) during rabi 2012-13 and 2013-14, respectively. The reason for more number of sympodial branches was attributed to increased concentration of available nutrients through integrated application of chemical fertilizers with FYM. This had positive effect on sympodial branches, which resulted in increased top growth of the plant and more number of nodes which are the seating points for the sympodial branches (Solaippan, 2002). The organic sources of nutrient application treatments invariably had more number of sympodial branches plant^{-1} compared to control in both the years of the study. Obviously, due to the presence of more nutrients in organic treatments produced more number of sympodial branches over control which is not having any manures and fertilizers.

Number of bolls plant^{-1} is the simple most important character in cotton influences the seed cotton yield. Nutrient management practices had significant influence on number of bolls plant^{-1} in cotton. Among the nutrient management practices, INM (20.30 and 18.11), RDF (17.30 and 17.67), FYM (15.10 and 15.44) and PM (15.04 and 15.66) treatments proved their superiority over others by recording higher number of bolls plant^{-1} during the first and second year, respectively. Number of bolls is a complex phenomenon influenced by set of interacting factors that involved nutrition, hormones, field environment and weather (Guinn, 1982). Malewar *et al.* (2000) and Sreenivasan (2004) reported that the

Table 3. Effects of nutrient management practices on yield attributes and yield of cotton

Treatment	Boll weight (g)		Boll setting percentage		Seed cotton Yield (kg ha^{-1})	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 – Control	3.00	3.12	34.53	32.70	1107	1013
T_2 – FYM	4.89	4.60	37.74	36.97	1603	1571
T_3 – VC	4.21	4.48	37.70	36.73	1453	1456
T_4 – PM	3.96	4.50	37.71	36.82	1583	1557
T_5 –TC	3.44	4.32	36.48	35.41	1296	1381
T_6 – FYM + VC	4.26	4.41	37.04	36.57	1336	1430
T_7 – FYM + PM	4.41	4.36	36.59	35.88	1379	1418
T_8 – FYM + TC	3.83	4.17	35.90	33.56	1343	1334
T_9 – VC + PM	4.50	4.44	37.20	36.69	1451	1443
T_{10} – VC + TC	3.59	4.24	36.13	34.11	1356	1345
T_{11} – PM + TC	4.45	4.21	35.92	33.66	1346	1338
T_{12} – 25% each FYM + VC + PM + TC	3.93	4.15	35.42	33.35	1337	1322
T_{13} – IC + FYM	3.68	4.25	36.15	34.75	1359	1418
T_{14} – IC + VC	4.79	4.26	36.30	35.05	1366	1359
T_{15} – IC + PM	4.88	4.38	36.59	36.33	1421	1426
T_{16} – IC + TC	3.24	4.23	36.11	33.95	1271	1351
T_{17} – RDF	4.89	4.68	41.75	40.83	2135	1729
T_{18}- INM	4.98	4.85	42.33	41.81	2252	1752
Sed	0.16	0.14	2.01	2.32	112	91
CD (P=0.05)	0.33	0.30	4.10	4.72	227	185

number of bolls in cotton was influenced by increasing level N and P. The cotton crop not receiving any nutrients recorded the least number of bolls plant^{-1} during both the years of study due to lack of nutrients.

Table 4. Effect of nutrient management practices on fibre quality parameters of organic cotton

Treatments	Ginning percentage		Seed index (g)		Lint index (g)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 – Control	34.1	33.7	11.0	10.9	6.25	6.39
T_2 – FYM	36.0	35.5	12.2	11.8	6.95	6.90
T_3 – VC	35.7	35.2	11.9	11.7	6.86	6.84
T_4 – PM	36.0	35.4	12.1	11.7	6.90	6.87
T_5 –TC	35.1	34.5	11.6	11.4	6.77	6.81
T_6 – FYM + VC	35.6	34.7	11.7	11.6	6.83	6.82
T_7 – FYM + PM	35.5	34.6	11.6	11.4	6.79	6.80
T_8 – FYM + TC	34.4	33.9	11.3	11.0	6.32	6.48
T_9 – VC + PM	35.6	34.8	11.8	11.6	6.85	6.83
T_{10} – VC + TC	34.7	34.0	11.4	11.3	6.64	6.72
T_{11} – PM + TC	34.5	33.9	11.3	11.1	6.38	6.53
T_{12} – 25% each FYM + VC + PM + TC	34.3	33.8	11.1	11.0	6.27	6.40
T_{13} – IC + FYM	34.7	34.3	11.4	11.3	6.72	6.76
T_{14} – IC + VC	35.3	34.5	11.5	11.4	6.75	6.79
T_{15} – IC + PM	35.6	34.6	11.7	11.5	6.82	6.82
T_{16} – IC + TC	34.6	34.0	11.3	11.2	6.56	6.70
T_{17} – RDF	36.2	35.7	12.2	11.9	6.97	6.93
T_{18}- INM	36.3	35.9	12.1	12.0	7.00	6.94
Sed	1.50	1.40	0.72	0.69	0.40	0.38
CD (P=0.05)	NS	NS	NS	NS	NS	NS

The boll weight was significantly influenced by nutrient management practices. Among the treatments, higher boll weight was recorded in the crop that received INM practice (4.98 and 4.85) followed by RDF (4.89 and 4.68) and FYM (4.89 and 4.60) during rabi 2012-13 and 2013-14, respectively over others. The boll weight recorded was the lowest (3.00 and 3.12) in the crop without any nutrient application in both the years of the study. Due to the presence of more and timely nutrients to the cotton crop through organic and inorganic sources influenced the size and weight of cotton bolls.

Table 5. Effect of nutrient management practices on fibre quality parameters of organic cotton

Treatments	Staple length		Uniformity ratio (%)		Micronaire value (10^{-6} g inch^{-1})	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 – Control	28.6	28.3	46.0	46.0	4.0	4.0
T_2 – FYM	30.1	30.1	47.0	46.7	4.6	4.6
T_3 – VC	30.0	30.0	46.8	46.6	4.6	4.5
T_4 – PM	30.0	30.1	46.9	46.7	4.6	4.5
T_5 –TC	29.6	29.7	46.5	46.3	4.3	4.3
T_6 – FYM + VC	29.7	29.9	46.7	46.4	4.5	4.4
T_7 – FYM + PM	29.6	29.8	46.5	46.4	4.4	4.4
T_8 – FYM + TC	29.0	28.7	46.1	46.1	4.1	4.1
T_9 – VC + PM	29.8	30.0	46.7	46.6	4.5	4.4
T_{10} – VC + TC	29.3	29.3	46.2	46.2	4.2	4.2
T_{11} – PM + TC	29.1	28.7	46.1	46.1	4.1	4.2
T_{12} – 25% each FYM + VC + PM + TC	28.7	28.6	46.0	46.0	4.0	4.1
T_{13} – IC + FYM	29.4	29.4	46.3	46.3	4.2	4.3
T_{14} – IC + VC	29.6	29.4	46.3	46.3	4.3	4.3
T_{15} – IC + PM	29.7	29.9	46.6	46.4	4.4	4.4
T_{16} – IC + TC	29.2	28.9	46.1	46.2	4.1	4.2
T_{17} – RDF	30.1	30.1	47.0	46.7	4.6	4.5
T_{18}- INM	30.1	30.1	47.1	46.7	4.6	4.6
Sed	1.3	1.2	1.5	1.4	0.35	0.33
CD (P=0.05)	NS	NS	NS	NS	NS	NS

The boll setting percentage exhibited significant variation among nutrient management practices. The INM practice produced higher number of boll setting percentage (42.33 and 41.81) compared to all other treatments except with RDF (41.75 and 40.83), FYM (37.74 and 36.97), VC (37.70 and 36.73) and PM (37.71 and 36.82) during both the years of the study. Cotton is an indeterminate crop in which vegetative and reproductive structures compete for available photosynthates throughout the growing season. Adequate nutrient availability under INM practice at critical stages influenced the boll setting percentage and number of bolls. Wadleigh (1944) reported that among plant nutrients, N had the largest effect on the number of bolls retained by cotton plants. The hormonal effect might have increased with enhanced fertilizer application. This could have improved the boll retention by increased fertility co-efficient (Bhatt *et al*., 1982).

Seed Cotton Yield

The seed cotton yield was found to be influenced significantly by nutrient management practices (Table 3). Among the nutrient management practices evaluated, integrated nutrient management consisting of RDF (80:40:40 kg ha^{-1}) along with FYM at 12.5 t ha^{-1} registered the highest seed cotton yield of 2252 and 1752 kg ha^{-1} during rabi 2012-13 and 2013-14, respectively. This was followed by application fertilizers at recommended doses (2135 and 1729 kg ha^{-1}). These two treatments were comparable and positively influencing the seed cotton yield and significantly superior over organic sources of nutrient management. Higher seed cotton yield was realized with complementary alliance of inorganic and organic manures in the presence study. Higher yield is attributed to the nutrients that are readily released by inorganic fertilizer and the cotton crop is able to utilize for its growth and yield, besides, complementation of nutrients from organic manures. The complementarities between inorganic fertilizer and organic manures attempts to achieve tight nutrient cycling with synchrony between nutrient demand by the crop and nutrient release in the soil, while minimizing losses through leaching, runoff, volatilization and immobilization (Maurya *et al*., 2008). Comparing with INM and RDF, application of RDN through organic manure recorded lesser yield was mainly due to the fact that manures are known to have the characteristics nature of slow release of nutrients. Even though organic manures contains both macro and micro nutrients, they are not available

Table 6. Effect of nutrient management practices on fibre quality parameters of organic cotton

Treatments	Fibre strength (g tex^{-1})		Elongation (%)		Bartlett`s index	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 – Control	22.43	22.53	5.91	5.90	0.41	0.40
T_2 – FYM	23.81	23.70	6.50	6.33	0.45	0.45
T_3 – VC	23.63	23.67	6.33	6.31	0.45	0.45
T_4 – PM	23.81	23.69	6.48	6.32	0.45	0.45
T_5 –TC	23.01	23.52	6.29	6.26	0.43	0.43
T_6 – FYM + VC	23.22	23.62	6.32	6.30	0.44	0.43
T_7 – FYM + PM	23.13	23.55	6.30	6.28	0.44	0.43
T_8 – FYM + TC	22.69	22.62	6.15	6.15	0.41	0.41
T_9 – VC + PM	23.46	23.65	6.32	6.31	0.44	0.44
T_{10} – VC + TC	22.84	23.00	6.20	6.19	0.42	0.42
T_{11} – PM + TC	22.73	22.78	6.18	6.16	0.41	0.41
T_{12} – 25% Each FYM + VC + PM + TC	22.57	22.60	5.96	5.96	0.41	0.41
T_{13} – IC + FYM	22.91	23.25	6.26	6.20	0.43	0.41
T_{14} – IC + VC	23.07	23.33	6.29	6.20	0.43	0.42
T_{15} – IC + PM	23.14	23.60	6.30	6.30	0.44	0.43
T_{16} – IC + TC	22.77	22.86	6.18	6.19	0.43	0.41
T_{17} – RDF	23.89	23.70	6.34	6.33	0.45	0.45
T_{18}- INM	23.82	23.73	6.35	6.34	0.46	0.45
Sed	1.13	1.06	0.42	0.40	0.03	0.03
CD (P=0.05)	NS	NS	NS	NS	NS	NS

to crop and could not meet the NPK requirement of the crop in the initial years due slow decomposing nature of manures (Nagavani, 2010).

During the first year of the study, a yield reduction under various organic nutrient management practices (T_2 to T_{16}) was recorded to an extent of 14.8 to 29.0 per cent.

In the second year, the yield reduction began to decrease to 10.2 to 24.5 per cent under various organic treatments as compared with INM practices. The yield gap among the plots treated with chemical fertilizers and organic manures began to decrease during second year onwards due to slow and continuous release of nutrients by organic manures (Acharya *et al.*, 2003).

Quality Characters

The fibre quality is a prime factor in combination with lint yield, decides the acceptance of a technology. All the fibre quality parameters have to be simultaneously considered together with the seed cotton yield. The increase in productivity alone could not benefit the cotton growers, as quality of cotton fibre is the primary concern for fetching higher price.

The quality did not show significant variation due to nutrient management practices (Table 4 – 6). However, higher values of ginning percentage was observed under INM (36.3 and 35.9), RDF (36.2 and 35.7) and FYM (36.0 and 35.5) during rabi 2012-13 and 2013-14, respectively compared to other treatments. The ginning percentage values registered by nutrient management practices were slightly higher than that under no manure treatment in both the years of the study. The similar trend was noticed with respect to all other quality parameters of cotton. Blaise et al. (2004) opined that a better soil moisture regime and improved nutrient availability in the organic system enabled cotton to produce lint with longer and stronger fibres. Since the quality parameters of cotton are genetically controlled and management practices had little effect, there was not much difference and was also endorsed by Venugopalan et al. (2004). The different fertilizer levels did not cause any impact on quality of fibres was reported earlier (Hallikeri *et al.*, 2004; and Narayana *et al.*, 2007).

Economics

The data on the economics of nutrient management practices are presented in Table 7. Higher gross returns (Rs. 94100 and Rs. 78850) were recorded during rabi 2012-13 and 2013-14 with the application of recommended dose of fertilizer along with FYM at 12.5 t ha^{-1} (T_{18}). This was followed by nitrogen application through poultry manure (T_4) (Rs. 79150 and Rs. 70560) and FYM (T_2) (Rs. 80150 and Rs. 70830), respectively. Lower gross returns of 44280 and Rs. 40520 were obtained without manure application (T_1) during both the years of study.

During both the years of the study, the net returns were also higher (Rs. 48973 and Rs. 33713) with the application of RDF + FYM 12.5 t ha^{-1} (T_{18}). This was followed by application of recommended N through poultry manure (T_4) (Rs. 36325 and Rs. 27485), FYM (T_2) (Rs. 32825 and Rs. 25005) and intercropping with green manure and its *in-situ* incorporation along with poultry manure (T_{15}) (Rs. 29513 and Rs. 22508) during rabi 2012-13 and 2013-14, respectively. Lower net returns (Rs. 5115 and Rs. 1395) were obtained with unmanured plot during both the years of the study. Relatively higher cost of cultivation in the treatment 100 per cent RDN through Vermi compost resulted in lower net returns was due to higher price of inputs than inorganic cotton. The cost of cultivation per hectare of organic cotton was relatively higher due to purchase of organic manures from outside sources.

Table 7. Effect of nutrient management practices on Economics of cotton

Treatments	Total cost of cultivation (Rs ha^{-1})		Gross return (Rs ha^{-1})		Net return (Rs ha^{-1})		B:C Ratio	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
T_1 – Control	39125	40125	44280	40520	5155	1395	1.13	1.04
T_2 – FYM	47325	45825	80150	70830	32825	25005	1.69	1.55
T_3 – VC	59325	59325	74250	65520	14925	6195	1.25	1.10
T_4 – PM	42825	43075	79150	70560	36325	27485	1.85	1.64
T_5 –TC	43700	42950	68100	62145	24400	19195	1.56	1.45
T_6 – FYM+VC	53325	52575	72150	64350	18825	11775	1.35	1.22
T_7 – FYM+PM	45075	44450	68950	63810	23875	19360	1.53	1.44
T_8 – FYM+TC	45513	44388	67150	60030	21638	15643	1.48	1.35
T_9 – VC+PM	51075	51200	72550	64935	21475	13735	1.42	1.27
T_{10} – VC+TC	51513	51138	67800	60525	16288	9388	1.32	1.18
T_{11} – PM+TC	43263	43013	67300	60210	24038	17198	1.56	1.40
T_{12} – 25% each FYM+VC+PM+TC	48294	47794	66850	59490	18556	11696	1.38	1.24
T_{13} – IC+FYM	43788	43038	67950	60795	24163	17758	1.55	1.41
T_{14} – IC+VC	49788	49788	68300	61155	18513	11368	1.37	1.23
T_{15} – IC+PM	41538	41663	71050	64170	29513	22508	1.71	1.54
T_{16} – IC+TC	41975	41600	67350	60480	25375	18880	1.60	1.45
T_{17} – RDF	38617	38617	70680	65160	32063	26543	1.83	1.69
T_{18} – INM	45127	45127	94100	78840	48973	33713	2.09	1.75

Data not statistically analysed

The benefit cost ratio (BCR) was higher with RDF + FYM 12.5 t ha^{-1}(T_{18}) (2.09 and 1.75). This was closely followed by N application through poultry manure (T_4) (1.85 and 1.64), RDF (T_{17}) (1.83 and 1.69), FYM (1.69 and 1.55) and intercropping with green manure and its *in-situ* incorporation along with poultry manure (T_{15}) (1.71 and 1.54) during rabi 2012-13 and 2013-14, respectively. Lower BCR values (1.13 and 1.04) were recorded with control plot (T_1) during both the years of study which was due to the higher cost of cultivation.

Conclusion

From two years of field experiments, it can be concluded that integration of 100 per cent inorganic fertilizers along with FYM @12.5 tonnes ha^{-1} not only increases the seed cotton yield and economic parameters, but also, maintain the quality characters of cotton. Hence, this INM practices can be followed for sustainable cotton production in Tamil Nadu.

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