Dynamics of nitrogen by the combined use of organic compost and inorganic fertilizer nitrogen on nutrient uptake and post harvest soil fertility status in cotton (*Gossypium hirsutum L.)*

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ABSTRACT

A field experiment was conducted at experimental farm, Faculty of Agriculture, Annamalai University to study the dynamics of nitrogen by the combined use of organic compost and inorganic fertilizer nitrogen on nutrient uptake and post harvest soil fertility status in cotton (G*ossypium hirsutum L.).* The soil of the experiment farm is deep clay, low in available nitrogen, medium in available phosphorus and high in available potassium. The experiment was conducted in randomized block design and replicated thrice. The experiment comprised of eight treatments, which includes absolute control (No fertilizer and no organic manure), recommended dose of nitrogen alone and graded dose of fertilizer nitrogen along with different organic manures *viz.*, farmyard manure, pressmud compost, vermicompost, poultry manure, water hyacinth compost and sugar cane trash compost. Use of different sources and combination sources of nitrogen had significant influence on seed cotton and stalk yields of cotton, NPK uptake and post harvest soil nutrient status. The results of the experiment showed that 75% N through fertilizer along with 25 % N through vermicompost significantly recorded maximum seed cotton and stalk yields of cotton over other organic manures in combination with inorganic fertilizer, which was followed by 75% N through fertilizer along with 25 % N through pressmud compost. As per nitrogen use efficiency, plots received with 75% N through fertilizer along with 25 % N through vermicompost registered superior values of agronomic efficiency and apparent nitrogen recovery (%). Significantly lowest values for seed cotton, stalk yields, NPK uptake and post harvest soil available NPK was recorded in control (No fertilizer and no organic manure). Based on the above results, it could be concluded that 75% N through fertilizer along with 25%N through vermicompost will be more promising combination which resulted in higher yield of seed cotton and maintain good soil fertility.

Key words: Agronomic Efficiency (AE), Apparent Nitrogen Recovery (%) (ANR), Nitrogen, NPK uptake, Seed cotton yield, Vermicompost

INTRODUCTION

The English word Cotton *(Gossypium hirsutum L.)* comes from the Arabic word quttin or Kutun. The time when the cotton fibre was first utilized by man is not known but from the prehistoric time this crop enjoys the status of the most important cash and individual crop of India till today. Cotton is popularly called as "White Gold" and is considered as "King of fiber crops". It is the most important commercial crop of India cultivated in an area of 12.65 million ha with a production of 40 million bales of lint. Cotton contributes to 80 per cent of the raw material to the textile industry and provides employment to nearly 60 million people. India ranks first in area and second in global cotton production. The productivity of cotton in India is significantly lower (518 kg ha^{-1}) as compared to the other major cotton growing countries. Lower cotton productivity could be attributed to highly varying factors and management practices mainly low soil fertility status. Among the nutrients, nitrogen is the key element to which cotton shows a good response, as most of the soils are low in N. Use of chemical fertilizers alone does not sustain productivity under continuous intensive cropping, whereas inclusion of organic materials improves physical soil properties, builds up soil fertility and increases crops yield (Edwards and Hailu, 2011). So effort is needed to formulate an input package with a combination of organic and inorganic fertilizers for cotton crop. The research work on vermicompost and along with inorganic nitrogen on cotton is meagre. Therefore, the present study was conducted to evaluate yield, nutrient uptake and agronomic efficiency as influenced by INM practices in cotton *(Gossypium hirsutum L.)*

MATERIALS AND METHODS

Field experiment was conducted at the experimental farm, Department of Agronomy, Annamalai University, Annamalai nagar, Tamil Nadu to study the dynamics of nitrogen by the combined use of organic compost and inorganic fertilizer nitrogen on nutrient uptake and post harvest soil fertility status in cotton (*gossypium hirsutum l.)*. The experimental soil was clay loam in texture with pH 7.7, EC 0.45 dsm^{-1}, organic carbon 0.62, and low N (218.0 Kg ha^{-1}), medium in P (24 Kg ha^{-1}) and high in K (264 Kg ha^{-1}). The experiment was laid out in a randomized block design with eight treatments and replicated thrice. The treatments were T_1 - control (no fertilizer and no organic manure), T_2 - 100% recommended dose of nitrogen through fertilizer (RDN), T_3 - 75% N through fertilizer + 25% N through FYM , T_4 -75% N through fertilizer + 25% N through pressmud compost, T_5 - 75% N through fertilizer + 25% N through vermicompost, T_6 – 75% N through fertilizer + 25% N through poultry manure, T_7 - 75% N through fertilizer + 25% N through water hyacinth compost and T_8 - 75% N through fertilizer + 25% N through sugarcane trash compost. The organic manures were applied as basal one week before sowing as per treatment schedule. The cotton variety LRA 5166 used as test variety for this experiment. The seeds were sown at a spacing of 75 X 30 cm. A recommended fertilizer schedule of *viz.*, 80:40:40 kg of N, P_2O_5 and K_2O was applied. As per treatment schedule 50 per cent of N, entire dose of P_2O_5 and K_2O were applied as basal and remaining 50 per cent N was applied on 40 DAS. Recommended cultural practices were also adopted as per need of the crop. Observations on seed cotton and stalk yield were recorded. Plants were also analysed for N, P and K uptake. Agronomic Efficiency and Apparent Nitrogen Recovery (%) were derived.

Agronomic Efficiency (AE)

In this approach, agronomic efficiency was calculated in terms of seed yield obtain from fertilized plot and unfertilized plot to kg^{-1} of nitrogen applied. It was computed using the formula as given below:

$$AE = \frac{\text{Grain yield in fertilized plot (kg ha}^{-1}) - \text{Grain yield in unfertilized plot (kg ha}^{-1})}{\text{Amount of nitrogen applied (kg ha}^{-1})}$$

Apparent N recovery (ANR) (%)

Apparent N recovery efficiency is defined as the quantity of nitrogen absorbed per unit of nitrogen applied. It was computed as per the formula suggested by Pillai and Vamadevan (1978).

$$ANR = \frac{Y_t - Y_o}{N_t} \times 100$$

Y_t = Uptake of N in particular treatment (kg ha^{-1})

Y_o = Uptake of N in unfertilized plot (kg ha^{-1})

N_t = Quantity of N applied for the treatment (kg ha^{-1})

The post harvest composite soil samples were collected after the harvest of cotton and analysed for post harvest available nutrients. Analytical methods employed for soil/manure were as under

Particulars	Author(s)	Method
Organic carbon	Walkley and Black (1934)	Chromic acid wet digestion method
Available N	Subbiah and Asija (1956)	Alkaline permanganate method
Available P	Olsen *et al.* (1954)	Colorimeter method
Available K	Stanford and English (1949)	Flame photometric method

The data on various studies recorded during the investigation were subjected to statistical scrutiny suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Seed cotton and stalk yields

All the INM treatments significantly influence on seed cotton and stalk yields of cotton**.** Among the treatments, plots received with 75% N through fertilizer along with 25% N through vermicompost (T_5) significantly recorded a higher seed cotton yield of 20.98 q ha^{-1} and stalk yield of 53.98 q ha^{-1}. This might be due to the fact that vermicompost offer a balanced nutritional release pattern to plants, providing nutrients such as available N, soluble K, exchangeable Ca, Mg, and P that can be taken readily by plants (Edwards, 2004). The least seed cotton yield of 7.15 q ha^{-1} and stalk yield of 17.52 q ha^{-1} was registered under T_1 (No fertilizer and no organic manure).

Crop nutrient uptake

Cotton crop with different organic manures along with inorganic fertilizer registered higher nutrient uptake and was significantly superior to recommended dose of nitrogen alone and absolute control. The date on the effect of INM practices shows that, 75% N through fertilizer along with 25% N through vermicompost (T_5) excelled other treatments by recording the highest nutrient uptake of 89.96 kg of N, 17.35 kg of P_2O_5 and 80.96 kg of K_2O.

This might be due to the fact that it modified the soil environment besides improving the physical properties of the soil and also the slow microbial decomposition of humus which gradually increased the nutrients availability for uptake by the cotton crop. This result are in consonance with the findings of kavitha *et al.* (2008). The least uptake of N, P and K were registered under T_1 (absolute control).

Assessing nitrogen use efficiency

Agronomic Efficiency (AE) and Apparent nitrogen recovery (ANR) (%) registered higher values under 75% N through fertilizer along with 25% N through vermicompost (T_5) as agronomic efficiency of 22.49 and apparent nitrogen recovery (%) of 73.05. This might be due to increased availability of nitrogen in vermicompost in the form of mucous, nitrogenous excretory substances which were not present in other organic sources. Nitrogen fixing bacteria were also found to be more in this vermicompost which might have reduced the loss of nitrogen from the soil and increased the use efficiency of inorganic fertilizers (Verendra Kumar and Ahlawat, 2004). The aforesaid parameters lowest value was observed in 100% RDN alone (T_2) plots.

Organic carbon content

Appreciably higher availability of organic carbon (0.71) was recorded from plots received 75% N through fertilizer along with 25% N through vermicompost (T_5). This increasing the soil organic carbon content status in soil due to addition of organic matter through organic manures for supply of major and micro nutrient content in soil can be assigned as possible cause for variation of initially soil fertility status to post harvest the crops (Chaudhary *et al.*, 2004). The increase in organic carbon with the application of vermicompost was attributed to greater input of root biomass due to better crop productivity. Similar results also observed by Ramesh (2011).

Post harvest soil nutrient status

Application of organic compost enhanced the available soil N, P and K contents at the end of the experiments when compared to their initial status and over recommended dose of nitrogen alone and control. Among the different treatments, plots received with 75% N through fertilizer along with 25% N through vermicompost (T_5) significantly recorded higher post harvest soil available nitrogen of 210.72 kg ha^{-1}, phosphorus of 22.59 kg ha^{-1} and potassium of 281.36 kg ha^{-1}. This might be due to addition of organics, which might have regulated soil temperature and available soil moisture and the humus content of soil. This might have created favourable soil environment for sustenance, rapid multiplication and their activity on nutrient availability (Banerjee *et al*. 2011). The least post harvest available soil N, P and K were registered under T_1 (absolute control).

CONCLUSION: Thus, on the basis of the experimental result, it could be concluded that for realising higher yield of seed cotton and maximum conserving of nitrogen, farmers are recommended to take up 75% N through fertilizer along with 25% N through vermicompost for achieving higher yield in seed cotton.

Table. 1 - Effect of INM practices on seed cotton and stalk yields, nutrients uptake (NPK), agronomic efficiency and apparent nitrogen recover efficiency (%)

Treatments	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium Uptake (kg ha^{-1})	Agronomic* Efficiency	Apparent* Nitrogen Recovery (%)
T_1	7.15	17.52	31.56	6.31	28.40	-	-
T_2	16.86	37.15	62.44	12.49	56.20	15.51	38.60
T_3	18.97	44.47	74.12	14.82	66.71	18.43	53.20
T_4	20.04	46.70	77.84	15.57	70.06	19.36	57.85
T_5	20.98	53.98	89.96	17.35	80.96	22.49	73.05
T_6	19.26	45.74	76.24	15.25	68.62	18.96	55.85
T_7	18.15	43.42	72.36	14.47	65.12	17.99	51.00
T_8	17.80	41.04	68.40	13.68	61.56	17.00	46.05
SED	0.33	0.47	0.69	0.12	0.72	-	-
CD (P=0.05)	0.62	0.98	1.38	0.26	1.39	-	-

*Agronomic efficiency and Apparent nitrogen recover - Data was not statistically analysed

Table. 2 - Effect of INM practices on post harvest soil nutrient status in cotton

Treatments	Organic carbon	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})
T_1	0.51	196.67	18.84	263.94
T_2	0.53	200.88	20.53	269.28
T_3	0.61	206.63	21.87	274.19
T_4	0.68	208.19	22.91	279. 24
T_5	0.71	210.72	22.03	281.36
T_6	0.63	207.24	22.18	275.31
T_7	0.60	205.35	23.57	278.18
T_8	0.58	204.27	23.25	277.08
SED	0.004	0.30	0.16	0.54
CD (P=0.05)	0.01	0.59	0.31	1.08

Treatment details: T_1- control (no fertilizer and no organic manure), T_2- 100% ecommended dose of nitrogen (RDN), T_3- 75% N through fertilizer + 25% N through FYM , T_4 – 75% N through fertilizer + 25% N through pressmud compost, T_5 - 75% N through fertilizer + 25%

N through vermicompost, T_6 – 75% N through fertilizer + 25% N through poultry manure, T_7 – 75% N through fertilizer + 25% N water hyacinth compost and T_8 – 75% N through fertilizer + 25% N sugarcane trash compost**.**

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