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EFFECT OF INM ON SOIL FERTILITY STATUS OF COTTON (*Gossypium hirsutum* L.)

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ABSTRACT

Reliance on inorganic fertilizers with less or no use of organic fertilizers has impaired the productivity of soil worldwide. An imbalance use of inorganic fertilizers without organic fertilizers has led to deterioration of soil health, crop yield loss which has become a concern. The basic concept of integrated nutrient management (INM) is maintenance or adjustment of soil fertility and supply of plant nutrients to desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated way. This study was executed to quantify the best possible combination of integrated nutrients and their availability to cotton crop. The present study pertains to the effect of Integrated Nutrient Management (INM) on nutrient uptake, post harvest soil available nutrients and NUE of cotton under irrigated condition. The nine treatment combinations comprising of organic manures (FYM, vermicompost), foliar spray (Panchagavya and Dasagavya), inorganic fertilizers (NPK) and bio-fertilizers. T_1- Control, T_2- FYM @ 10 t ha^{-1}+Bio fertilizer (soil application) +50 % RDF, T_3- Vermicompost @ 2.5 t ha^{-1} + Bio fertilizer + 50% RDF ,T_4 - T_2+ Panchagavya @ 3% (2 sprayings), T_5 - T_2+Dasagavya @ 3% (2 sprayings), T_6 - T_3+ Panchagavya @ 3% (2 sprayings), T_7- T_3+

Panchagavya @ 3% (2 sprayings), T_8- Panchagavay @ 3% (2 sprayings), T_9 - Dasagavya @ 3% (2 sprayings). The experimental result showed that the significantly highest nutrient uptake of N, P and K were recorded under T_6- Vermicompost @ 2.5 t ha^{-1}+ BF+50% RDF+ Panchagavya spray @ 3% (2 sprayings). The study revealed that, combined application of Vermicompost @ 2.5 t ha^{-1}+Bio fertilizer+50% RDF+ Panchagavya spray @ 3% foliar spray could have impacted on fertility status of soil grown with cotton.

Key words: INM- FYM, VC, Bio-fertilizers, Panchagavya and Dasagavya

INTRODUCTION

Cotton (Gossypium *spp*.) is an important commercial crop of India often referred as "white gold" the most versatile cash crop which plays a distinguishable role in national economy in terms of foreign exchange and employment generation. The productivity of cotton in India is significantly lower (568 kg ha^{-1}) as compared to the four major cotton growing countries *viz*; China (1300 kg ha^{-1}), USA (900 kg ha^{-1}), Pakistan (700 kg ha^{-1}) and Brazil (2027 kg ha^{-1}) though India ranks first in area with 11.88 m ha^{-1}, accounting 30 per cent of world coverage and 22 per cent (351 lakh bales of lint) of the world cotton production (second rank) with a productivity of 568 kg ha^{-1}. (Vani et al, 2020).

Balanced fertilizer application has emphasized to improve crop productivity and minimize negative nutrient balance. The recommended dose of fertilizer (RDF) strategy was developed based on the nutrient response of crops to fertilizer nutrients. Presently in India, these are recommendations are provided as an advisory to farmers. (Manigandan *et al.*, 2021).

According to Huang *et al*., 2021 stated that more emphasis has been given to the balanced fertilization strategy by reducing the usage of mineral fertilizers to improve crop quality, production, and uptake of essential plant nutrition and crop productivity. However an inappropriate or extensive application of fertilizers leads to severe problems of soil acidification, soil and water pollution,

greenhouse gas emission. Moreover it leads to excessive and sudden plant growth with an insufficient root system to provide adequate mineral nutrients and water supply to the plants.

Murillo- Amador *et al.*, 2015 reported that INM aims for optimal soil fertility and plant nutrition, increasing fertilizer input efficiency, decreasing environmental risks, and improving crop productivity through root/ rhizosphere management. Application of organic and inorganic sources of nutrient elements has been used to obtain optimum productivity. Therefore INM is a matter of great interest that could provide a healthy soil environment for plant roots to uptake the soil nutrients efficiently. Also, Heerendra Prasad *et al.*, 2017 concluded that FYM occupies an important position among bulky organic manures. FYM seems to act directly by increasing crop yield either by acceleration of respiratory process by cell permeability or by hormone growth action. It supplies N, P and K in available form to plants through biological decomposition.

Wang *et al.* (2022) stated that application of Vermicompost may increase the mineralization and degradation of organic waste during the biological oxidation stage. The basic plant nutrients in raw materials, such as nitrogen, potassium, phosphorous, calcium become more readily available from than base plants. Most organic raw materials are decomposed into stable materials and converted into components similar to those in soil. Basavaraj Patil and Chetan (2018) stated that foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements trough their leaves. The absorption takes place through stomato and also by epidermis.

Bajaj *et al.*, 2022 stated that application of Panchagavay ensures zero usage of harmful synthetic fertilizers, pesticides, insecticides and antibiotics. No other manure can be as cost-effective and beneficial as panchagavya. It can enhance soil fertility, improve the quality of earthworms and promote crop health by acting as an organic fertilizer.

(Ram Awadh Ram, 2019) Dasagavya has potential to promote plant growth and boost immunity in the plant system against pest and diseases. The fermentative bacteria, Lactobacillus that develop in the solution produce various beneficial metabolites such as organic acids, hydrogen per oxide and antibiotics which are effective against other pathogenic microorganisms.

Shanu *et al*., 2019 reported that chemical fertilizers are the main sources of nutrients used for cropping. However, continuous dependence on chemical fertility causes nutritional imbalance and adverse effect on physico-chemical and biological properties soil. INM is a better approach for supplying nutrition to crop by including organic and inorganic source of nutrients. Thus a combined use of organic use of organic manures. BF with reduced dose of chemical fertilizers not pave way for higher yield and quality produce but also help to maintain soil health and reduce pollution problem.

Keeping all the views in mind an experiment was planned to find out the influence of INM on nutrient uptake and post harvest soil available nutrients of cotton influenced by organic manures and foliar spray.

MATERIALS AND METHODS

The field experiments were conducted at farmer's field, Bommanaickenpalayam village, Gobichettipalayam Taluk, Erode District during (Feb 2019- Aug 2019). The variety Surabhi was chosen for this study. The experimental site is geographically situated at 10°74' N latitude and 77° 15' E longitude with an altitude of about + 213 m above mean sea level (MSL). The mean maximum and minimum temperature are 36^0 and 27^0C respectively. The relative humidity range from 5 to 63 per cent. The experimental plots had assured irrigation facility coupled with uniform topography, good drainage and soil suitable for cotton cultivation. The soil of the experimental farm is classified as udic chrom (clay) according to FAO/UNESCO (1974). The soil is low in available Nitrogen, medium in available Phosphorous and high in available Potassium. The experiment was laid out in randomized block design with three replications. The treatment comprised of nine treatments *viz*., T_1- Control , T_2-

FYM @ 10 t ha^{-1}+Bio fertilizer (soil application) +50%RDF, T_3- Vermicompost @ 2.5 t ha^{-1}+Bio fertilizer+50% RDF ,T_4 - T_2+ Panchagavya @ 3% (2 sprayings), T_5 - T_2+Dasagavya @ 3% (2 sprayings), T_6 - T_3+ Panchagavya @ 3% (2 sprayings), T_7- T_3+ Panchagavya @ 3% (2 sprayings), T_8- Panchagavay @ 3% (2 sprayings), T_9 - Dasagavya @ 3% (2 sprayings). to study the cumulative effect of INM involving use of organic manures (FYM and vermicompost) and organic sprays (Panchagavya and Dasagavya) on nutrient uptake and post harvest soil available nutrients. FYM @ 10 t ha^{-1} and vermicompost @ 2.5 t/ha were incorporated uniformly at the time of last ploughing. Fertilizer was applied according to treatment schedule for cotton. For cotton, recommended dose of 80:40:40 kg ha^{-1} of N, P_2O_5 and K_2O was applied. Nitrogen was applied in two equal splits *viz.*, half the dose of N and full dose of P_2O_5 and K_2O were applied at 20 DAS and remaining half dose N was applied at 40 DAS. The *Azotobacter* and Phosphobacteria were applied in soil @ 2 kg ha^{-1}. The required quantity of each of the bacterial culture was mixed with 25 kg of sand and applied 3 days before sowing evenly over the respective plots as per the treatment schedule. The **f**oliar spraying of Panchagavya, Dasagavya @ 3 per cent foliar spray was done as per treatment schedule at 45 and 75 DAS using hand operated knapsack sprayer. Pre-sowing and post harvest soil samples were taken from each treatment plot at 0-15 cm depth and the samples were dried and passed through a 2mm sieve. The soil sample was analyzed for their nutrient status (N, P and K) and expressed in Kg ha^{-1}. The plant samples collected at the time of harvesting from the net plot was used for analysis of N, P, and K uptake by crops. The plant samples collected for DMP estimations were ground (after taking DMP readings) into fine powder using a Wiley Mill and stored in air tight glass containers, analyzed for nutrient content (N, P and K). The nutrient content of the samples was multiplied with DMP and the nutrient uptake by crop was recorded and expressed in kg ha^{-1}.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Percentage of nutrient} \times \text{Total dry matter production (kg ha}^{-1})}{100}$$

NITROGEN USE EFFICIENCY (NUE)

Agronomic efficiency (AE)

Agronomic efficiency was calculated in terms of seed yield kg^{-1} of nitrogen applied. It was computed using the formula as given below.

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

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).

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

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

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

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

All the above parameters of N use efficiencies were worked out.

The statistical analysis was done as per procedure suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Nutrient uptake

The study revealed that significantly the highest uptake of total nitrogen, phosphorous and potassium by cotton crop was noticed in with the application of VC @ 2.5 t ha^{-1} +BF+50% RDF +Panchagavya 3% (2 sprayings) (T_6). This increase was mainly owing to an increase in dry-matter production and yields of cotton through higher application of the respective nutrients. (Marwan Manea *et al.*, 2015). Sobhana *et al.*, 2012 also observed higher content and removal of N. P and K with increasing levels of applied nutrient. This could be attributed to the increased dehydrogenase activity and higher nutrient supply by Vermicompost along with BF, foliar spray which recorded the higher nutrients uptake by cotton. Similar findings were earlier reported by Nurhidayati *et al.* (2018).

However, the increase in uptake of nutrients with foliar spray of panchagavya was ascribed to increased biological efficiency of crop plants and creating greater source and sink in the plant system Patel *et al*. (2018); Ananda *et al.* (2018); Gopal Lal Choudhary *et al.* (2017), this might have contributed for greater absorption of the nutrients. This increase in uptake of nutrients may be attributed to higher total dry matter production. These results are in accordance with the findings of Kasturikasen Beura and Rakshit (2011), Hosmath, 2011; Blaise (2013) Lu *et al*., (2013) ,Thimmareddy *et al*., (2013) and Vani *et al.,* (2020). The increased uptake of N, P and K were due to the consequence of better nutritional environment offered through cumulative effect of organic and inorganic source of nutrients, bio-fertilizer and foliar spraying of Panchagavya increased N accumulation. Its consequence colonization of bacteria and bacterial reductace activity in roots and availability of N to the plants due to fixation of this bacteria might have enhanced mineral uptake especially N. The higher removal of N, P and K by cotton crop is closely correlated with the increased availability in soil by fertilization due to increase in yield as well as increased content of nutrients. Maximum removal of nutrients may be attributed to greater biomass production. The maximum build up of nitrogen and potassium was observed due to inclusion of legume. (Angrej Singh and Thakar Singh, 2015). The least uptake of N, P and K were registered under control (T_1) which could be attributed to poor availability of plant nutrients during the growing period, which in-turn registered low DMP, poor nutrient concentration in tissues, which ultimately resulted in poor nutrient uptake, as it was only the multiplication of DMP with nutrient content. These results are in conformity with the findings of Sujatha *et al.* (2018).

Post harvest soil available nutrients

The post harvest soil available nitrogen (N) was markedly influenced by integrated nutrient management practices. Among the treatments, VC 2.5 t ha^{-1} +BF+RDF +Panchagavya @ 3% foliar spray (T_6) recorded significantly lower soil available N of 187.66 kg ha^{-1}. However, this treatment was next with VC 2.5 t ha^{-1} +BF+RDF +Dasagavya @ 3 % (2 sprayings) (T_8). The highest soil available N of 227.56 kg ha^{-1} was registered under control (T_1). The aforesaid treatment (T_6) recorded significantly lower soil available P of 13.14 kg ha^{-1}. However, this treatment was followed by T_7. Control (T_1) registered the highest soil available P of 17.50 kg ha^{-1}.In respect of soil available potassium, the trend was similar to that observed in the soil available of N and P.

Nitrogen use efficiency

Agronomic efficiency (AE) and Apparent N recovery (ANR).

Integrated nutrient management practices had marked influence on agronomic efficiency and apparent N recovery. Among the treatments, VC 2.5 t ha^{-1} +BF+RDF +Panchagavya @ 3 % (2 sprayings) (T_6) registered the higher agronomic efficiency and apparent N recovery of 15.19 and 34.42 respectively. The next best in order was VC 2.5 t ha^{-1} +BF+RDF +Dasagavya @ 3% (2 sprayings) (T_7).

CONCLUSION

The results and discussion of the above study concluded that application of VC @ 2.5 t ha^{-1} +BF+RDF +Panchagavya @ 3% (2 sprayings) resulted in the highest nutrient uptake of N, P and K. As it holds a promise as an combination for improved crop production and also for maintenance of soil fertility and highly favourably increased the nutrient uptake and NUE. Besides it offers a great scope in effective utilization of organic sources in Agriculture.

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Treatments	Nutrient uptake (kg ha^{-1})			Post harvest soil available nutrients (kg ha^{-1})			NUE	
	N	P	K	N	P	K	Agronomic efficiency	Apparent N recovery
T_1	58.83	15.21	62.13	**227.56**	**17.5**	**180.29**	-	-
T_2	67.39	19.69	74.28	200.99	14.82	163.33	9.21	20.12
T_3	68.88	19.72	76.34	200.97	14.81	163.31	9.58	22.05
T_4	72.63	19.75	80.70	200.93	14.76	163.27	11.50	25.11
T_5	70.16	19.73	78.12	200.95	14.79	163.29	11.05	24.25
T_6	**79.33**	**21.55**	**89.15**	187.63	13.41	154.80	**15.19**	**34.42**
T_7	76.86	21.11	86.68	187.66	13.43	154.85	14.61	33.65
T_8	63.29	18.34	69.25	214.27	16.16	171.76	1.78	3.98
T_9	63.11	18.33	67.12	214.29	16.17	171.79	1.66	3.69
S.Ed	1.28	0.45	1.69	4.35	0.43	2.76		
CD (p=0.05)	3.75	1.33	4.95	13.26	1.32	8.41		