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INM practices with Zn & Mg for sustainable production, nutrient uptake and economics of cotton

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Abstract
During 2021 field experiments were conducted to study the integrated nutrient management practices for sustainable cotton production at Lathuvadi village, Thalaivasal Taluk of Salem. The experiments were laid with seven treatments and three replications. The treatments were viz., T_1 - 100% RDF, T_2 - 75% RDN + 25% N through Vermicompost, T_3 - 50% RDN + 50% N through vermicompost, T_4 - 25% RDN + 75% N through vermicompost, T_5 - 75% RDN + 25% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray, T_6 - 50% RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ $ZnSO_4$ foliar spray and T_7 - 25% RDN + 75% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ $ZnSO_4$ foliar spray. The application of organic manure and inorganic fertilizers along with the foliar application of micronutrients (Zn and Mg) to cotton significantly influenced the growth characters, yield attributed and yield of cotton. Among the various integrated nutrient management practices evaluated, application of 50% RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ $ZnSO_4$ foliar spray (T_6) resulted the enhanced growth characters viz., plant height, leaf area index, and dry matter production, Yield attributing characters viz., number of monopodial branches plant^{-1}, sympodial branches plant^{-1}, number of bolls plant^{-1}, boll weight and heigher seed cotton yield. This was on par with T_5 (75% RDN + 25% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray). Hence, the application of 50% RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray (T_6) considered better way to get a better yield with sustained soil health.

Keywords: Cotton, nitrogen, vermicompost, $ZnSO_4$, $MgSO_4$, SCY, nutrient uptake, economics

Introduction
Cotton (*Gossypium hirsutum* L.) is one of the most important fiber crops in India. Cotton is an important commercial crop grown in Tamil Nadu. It is also known as "white gold". Cotton production play a important role in the social and economic welfare of the farmers (Anonymous, 2010) [1]. The area and productivity of this crop is on the declined due to several biotic and abiotic factors. The use of mineral fertilizers is the fastest and definite way to improve improving crop productivity. However, the increases in cost and associated environmental hazards as well as lack of sustainability in yields under application of such fertilizers are constraints in cotton production. Low soil organic matter coupled with deficiencies of nutrients and continuous cotton cropping and management practices are the main reasons for lack of sustainability. This has renewed the interest in the use of organic fertilizers along with inorganic fertilizers. High and sustainable productivity of cotton is associated with balanced nutrition and availability of nutrients in the soil. Nutrient supply systems can be improved by adopting Integrated Nutrient Management (INM) practices. Integration of organics and inorganics needs to be incorporated in cotton manurial schedule. Vermicompost, which is a treasure house of nutrients, not only supplies major nutrients but also improves the soil structure.
Under such a situation it was imperative to evolve and adopt the strategy of integrated nutrient management by making judicious use of chemical fertilizers and organic manures, which will not only increase the production but will also, improve soil health ultimately sustaining the productivity of cotton.

Materials and Methods
Field experiments were conducted at farmer's field of Lathuvadi village, Thalaivasal Taluk, of Salem district to study the integrated nutrient management practices for sustainable cotton production during 2021. The soil of the experimental field is sandy clay loam with 0.6% of organic matter and pH of 8.2. The field soil contained 202.54, 21.61, 373.5 kgs of NPK ha^{-1}.

The experiments were laid in Randomized Block Design (RBD) with three replication. Seven treatments were imposed with different combination of organic and inorganic nutrient sources and micronutrient (Zn & Mg) foliar nutrition. The fertilizers were applied to the experimental field as per the treatment schedule. The popular cotton hybrid of RCH 659 taken for the study. The plant sample collected for estimation of dry matter production at harvest stage also used for chemical analysis to estimate the uptake of nutrients by cotton. The data regarding the different attributes in the investigation were analyzed statistically with five percent probability level.

Results and Discussion

Seed cotton yield (SCY)

Seed cotton yield of hybrid cotton was significantly influenced by integrated nutrient management practices. Among various treatments tested in experiments, treatment T_6 (50% RDN + 50% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray) recorded higher seed cotton yield of 3262 kg ha^{-1}. However, this was on par with treatment T_5 (75% RDN + 25% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray) SCY of 3194 kg ha^{-1}. The lower seed cotton yield was registered in T_1 control. Increased seed cotton yield by INM due to vermicompost sustained nutrients supplied by chemical fertilizers in bulk quantity. It helped to provide a require quantity of nitrogen at peak period of nutrient requirement. At early stages growth of cotton could stimulated by chemical fertilizers, meanwhile, vermicompost supply a nutrients to cotton at later stage of nutrient demand (Jinjala *et al*., 2016) [4]. Vermicompost not only supplied a essential plant nutrients, also provided all micro nutrients in trace quantity and it created a better pathway to plant to forage the nutrients from soil by altering soil physical and chemical properties (Sudhanshu, 2013) [9]. Application of 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray improved SCY when combined with vermicompost and chemical fertilizers through their synergetic and cumulative effect. INM practices enhanced SCY by cumulative effect of growth and yield attributes (Ramesh *et al*., 2013; Rao *et al*., 2020) [6, 7].

Nutrient uptake

Various INM practices exhibited perceptible variations in nitrogen, phosphorous and potassium uptake. Among the various INM practices imposed, T_6(50% RDN + 50% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray) registered higher nutrient uptake 109.72, 31.28 and 95.21 kg ha^{-1} of N, P and K respectively. T_6 was on par with T_5 (75% RDN + 25% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray) recorded uptake of 92.10, 22,24 and 83.10 kg ha^{-1} of N, P and K respectively. Lower uptake was noticed in contro (T_1) treatment. Improved nutrient uptake might be due to preventing fixation, oxidation, leaching of nutrients and making it available for crop plants by chelating action (Gudadhe, 2015) [3]. Increased N uptake with combined application of organic and inorganic fertilizers. This might be due to a steady supply of N and losses of nitrogen were reduced. Higher uptake of P due to mobilization of P by organic acids produced during decomposition of vermicompost and p fixation was reduced due to release of phosphate ions and hydrous oxides. Higher k uptake was noticed by solubilization of native K through organic acids produced during vermicompost decomposition (Mahapatra *et al*., 2018) [5].

Economics

INM practices greatly influenced on economics. Based on the economic analysis of various INM treatments, T_6 registered higher gross income (Rs. 212030) and net income (Rs. 126171). With regarding BCR T_5 registered higher rate of 2.49. This might be due to influence of cost of vermicompost with respective of treatments. Lower values of gross income, net income and BCR was regictered in T_1 control.

Table 1: Effect of INM in seed cotton yield (SCY) and nutrient uptake of hybrid cotton (pooled data)

Treatments	Seed cotton yield (SCY) (kg ha^{-1})	Nutrient uptake (kg ha^{-1})		
		N uptake	P uptake	K uptake
T_1	2376	61.09	14.05	59.23
T_2	2746	78.23	17.65	73.05
T_3	2838	84.27	18.22	76.51
T_4	2566	70.30	15.44	66.57
T_5	3194	103.43	30.35	91.34
T_6	3262	109.72	31.28	95.21
T_7	3016	92.10	22.24	83.10
SEm±	56.73	2.61	0.43	2.18
CD (p=0.05)	176.75	8.15	1.36	6.79

Table 2: Effect of INM in economics of hybrid cotton production (pooled data)

Treatment	Cost of cultivation (Rs. ha^{-1})	Cost of manuring (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Benefit cost ratio
T_1	71350	7465	78815	154440	75625	1.96
T_2	71350	10071	81421	178490	97069	2.19
T_3	71350	12683	84033	184470	100437	2.16
T_4	71350	15290	86640	166790	80150	1.93
T_5	71350	11897	83247	207610	124363	2.49
T_6	71350	14509	85859	212030	126171	2.47
T_7	71350	17116	88466	196040	107574	2.21

Conclusion

This study revealed that application of 50% RDN + 50% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray could be a better option for getting higher SCY, uptake and also could sustain the soil fertility through integration of organic and inorganic nutrient sources.

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