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Effect of Integrated Nutrient Management Practices in Sustainable Cotton Production

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A B S T R A C T

Field experiments were conducted in farmer's field at Lathuvadi village, Thalaivasal Taluk of Salem district to study the integrated nutrient management practices for sustainable cotton production in north western zone of Tamil Nadu during 2021. The experiments were laid with seven treatments and three replications in Randomized block design. 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. 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.

Introduction

Cotton (*Gossypium hirsutum* L.), is one of the most ancient and important commercial crops next to food grains. Cotton 'the king of apparel fibers' is an important cash crop and it supplies a major share of raw material for the textile industry and playing a key role in the economic and social affairs of the world (Anonymous, 2010; Hosamani *et al.*, 2013). It is grown chiefly for its fiber which is used in the manufacture of cloths, making of threads and extraction of oil from cotton seed (Deshmukh *et al.*, 2013). India is one of the largest producers of cotton accounts 37 percent of world area under cotton cultivation which contributing 23 percent of world the cotton production. In India total area under cotton cultivation is 12.6 m ha with a total production of 33.0 M bales with a productivity of 489 kg ha^{-1} (Anonymous, 2019). While in Tamil Nadu total area under cotton cultivation is 1.40 lakh ha with a production of 6.00 lakh bales with a productivity of 728 kg ha^{-1} (Anonymous, 2018).

Hybrid cotton production area is increasing year by year but not productivity. The reasons for decreasing productivity are due to decreasing of soil fertility especially microelements, imbalanced fertilizer use, and physiological disorders. Among these, imbalanced use of major and micronutrients is considered as major problem for sustainable production and soil health. These nutrients are more important because in hybrid cotton synchronized boll development altered the source-sink relationship due to rapid translocation of saccharides and nutrients from leaves to the developing bolls (Hebbar *et al.*, 2007).

The maximum yield potential of hybrid cotton can only be achieved with good agronomic practices like plant geometry, balanced use of fertilizer and integrated nutrient management over the years. Most often soils in cotton growing areas are not only thirsty but also hungry (Basha *et al.*, 2017). It is a well established fact that adequate quantities of nutrients are to be supplied for achieving higher yields. The nutrient management in cotton is a complex phenomenon due to its long duration and indeterminate growth habit where simultaneous production of vegetative and reproductive structures during the active growth phase. A cotton plant being a heavy feeder, needs a proper supply of plant nutrients for its successive cultivation (Ravikiran and Halepyati, 2013).

The use of appropriate and conjunctive application of suitable nutrients through organic and inorganic solely or in combination can provide the solutions to the problems such as an increase in the price of inorganic fertilizers and deterioration effect of soil fertility and productivity. Hence, judicious application of these combinations can sustain the soil fertility and productivity (Singh *et al.*, 2020). Vermicompost is organic material broken down by interaction between micro-organism and earthworms in a hemophilic process, to produce fully stabilize organic soil amendments with a low C:N ratio. Vermicompost contains a considerable amount of plant nutrients in available form and used by the farmers in growing crops because of the easy availability of nutrients to the plants.

Although only small amounts of zinc are removed from the field by a cotton crop (0.5 ounces per bale), zinc is critical for several key enzymes in the plant. Most notable are the enzymes that convert carbon di-oxide with bicarbonate, allow respiration in root tips during anaerobic conditions (lack of oxygen) and build proteins. Historically zn has been associated with low levels of IAA the hormone responsible for mainstem growth. Although zn deficient plants are generally stunted, the relationship between Zn and IAA is not clear (Derrick Oosterhuis *et al.*, 1991). Magnesium is an essential secondary nutrient for a cotton plant. It is necessary for the normal growth and development of the cotton plant and is a central element in the chlorophyll molecule. In cotton plants magnesium deficiency occurs with the symptom of reddening and the plant becomes stunted in appearance and yield will be reduced profusely. Keeping the above fact in consideration, the experiment was planned to study the integrated nutrient management practices for sustainable cotton production in north western zones of Tamil Nadu.

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 in north western zone of Tamil Nadu during 2021. The soil of the experimental field is sandy clay loam with 0.6% of organic matter and pH of 8.2. The nutrient status of the experimental field is low in nitrogen content, medium in phosphorus and high in potassium. 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 this study. The plant samples were collected for estimation of dry matter production at different growth stages. The data were analyzed statistically with five percent probability level.

Results and Discussion

Growth attributes

The integrated nutrient management practices significantly influenced the growth attributes of hybrid cotton (Table 1). Among the various treatments investigated in this study, treatment (T_6) with application of 50% of RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray on 45 and 75 DAS exhibited significantly higher growth attributes viz., plant height(156 cm), leaf area index(4.42), and dry matter production(6149 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) recorded plant height(149.20 cm), leaf area index(4.39), and dry matter production(5677 kg ha^{-1}). Lower plant growth attributes were observed in control T_1(100% RDF). INM with organic (vermicompost) and inorganic (chemical fertilizers) nutrient sources with foliar spraying of micro nutrients (Mg & Zn) had its positive effect on growth attributes through enhanced soil physical, chemical and biological properties, sustainable supply of plant nutrients (macro & micro) and plant hormones such as gibbrellic acid, IAA, NAA and cytokinin (Gabaly, 2011). Decomposition of vermicompost produced some organic acids which inhibits enzymes like IAA oxidase, this enhanced the IAA production leads to higher plant growth. Application of Zn as a foliar spray improved the auxine production (Ahamad *et al.,* 2016; Rao *et al.,* 2020). Application of micro nutrients such as Zn, Mg created enhanced effect on plant physiology and bio chemical process such as, photosynthesis, enzyme production and respiration (Putra *et al.,* 2012).

Yield attributes and Seed cotton yirld (SCY)

Yield attributes of hybrid cotton were significantly influenced by integrated nutrient management with vermicompost and micro nutrient (Mg & Zn) foliar spray (Table 2). Among the various treatments evaluated, application of 50% of RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray on 45 and 75 DAS registered significantly higher yield attributes and seed cotton yield viz., number of monopodial branches $plant^{-1}$ (3.17), sympodial branches $plant^{-1}$ (24.28), number of bolls $plant^{-1}$ (44.25), boll weight (5.77 g) and seed cotton yield (3262 kg ha^{-1}). However, this was on par with T_5 (75% RDN + 25% N through Vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray) registered value of number of monopodial branches $plant^{-1}$ (3.09), sympodial branches $plant^{-1}$ (23.12), number of bolls $plant^{-1}$ (44.11), boll weight (5.53 g) and seed cotton yield (3194 kg ha^{-1}). Lower yield attributes were registered by control (T_1). Improved yield attributes and SCY might be due to the enzymatic activities of vermicompost impart physico-chemical and biological activities of soil resulting in more photosynthates assimilation and subsequent conversion of assimilates into yield attributes. These findings were consonant with the results of the study of Nemade *et al.,* (2013) in sorghum. Application of N through both inorganic chemical fertilizers and organic vermicompost, this provided a balanced nutrient release pattern to plants throughout the crop period. Vermicompost provided a highly available form of macro and micro nutrients with a high mineralization rate (Laekemariam and Gidago, 2012). Application of 1% $MgSO_4$ and 0.5% of $ZnSO_4$ greatly influenced yield attributes. This might be due to the greater availability of the nutrient which resulted in increased growth attributes that contributed positively to yield attributes.

Table.1 Effect of INM on Growth attributes in hybrid cotton (pooled value)

Treatments	Plant height At harvest (cm)	LAI At flowering	Dry matter production At harvest (kg ha^{-1})
T_1	103.50	3.47	4296.00
T_2	121.00	3.96	4794.20
T_3	125.00	4.00	5005.00
T_4	111.90	3.77	4532.00
T_5	149.20	4.39	5677.00
T_6	156.00	4.42	5899.00
T_7	135.00	4.16	5336.00
SEm±	2.61	0.04	82.91
CD (p=0.05)	8.15	0.15	258.32

Table.2 Effect of INM on yield attributes and seed cotton yield (SCY) in hybrid cotton(pooled value)

Treatments	No. of Monopodial branches Plant^{-1}	No. of Sympodial Branches Plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
T_1	1.95	14.00	37.91	3.88	2376
T_2	2.52	17.72	40.95	4.24	2746
T_3	2.54	18.25	41.01	4.61	2838
T_4	2.22	16.01	39.44	4.78	2566
T_5	3.09	23.12	44.11	5.53	3194
T_6	3.17	24.28	44.25	5.77	3262
T_7	2.82	21.41	42.56	5.14	3016
SEm±	0.07	0.54	0.43	0.11	56.73
CD (p=0.05)	0.24	1.70	1.35	0.35	176.75

An adequate amount of micronutrients are absorbed and utilized by plants to promote plant growth and yield of seed cotton through foliar feeding (Ali, 2012). The number of sympodial branches, number of bolls, boll weight were influenced by INM with vermicompost. It favoring more utilization of nutrients by plants and enhanced the translocation of photosynthates towards the sink and increase seed cotton yield. (Hemalata Chitte *et al.*, 2016).

Based on the observation of growth, yield attributes and seed cotton yield(SCY), it can be concluded that, application of 50% of RDN + 50% N through vermicompost + 1% $MgSO_4$ + 0.5% $ZnSO_4$ foliar spray on 45 and 75 DAS as a better option for getting higher growth, yield attributes and SCY with sustained soil health.

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