RESEARCH ARTICLE

INTEGRATED NUTRIENT MANAGEMENT IN HYBRID MAIZE (*ZEA MAYS*)

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Abstract: A field experiment was conducted to evaluate the effect of Integrated Nutrient Management in Hybrid Maize (NK 6240). Field experiment was conducted during kharif season with thirteen different treatments which were replicated thrice in Randomized Block Design (RBD). The influence of Beema green granules, Uphaar as organic foliar spray, Tracel as inorganic foliar spray on the growth, yield, nutrient uptake, and availability of nutrients in soil was observed. The application of RDF + Beema green granules (25 kg ha^{-1}) soil application + Uphaar (250gm ha^{-1}) and Tracel (3.75kg ha^{-1}) foliar spray has shown an increase in plant height (292.16 cm), dry matter production (16505 kg ha^{-1}), cob length (25.25 cm), cob diameter (6.25 cm), grain numbers cob^{-1} (448), grain yield (6260.50 kg ha^{-1}) and stover yield (8840 kg ha^{-1}). Uptake of nutrients *viz*., Nitrogen, Phosphorus and Potassium was found maximum while the available status of NPK was minimum under the above treatment.

Keywords: Maize, Yield, Organic and inorganic nutrient, Foliar spray

INTRODUCTION

Maize (*Zea mays*) is one of the most important cereal crops showing wider adaptability and can be grown under varied Agro-Climatic conditions. Popularly called as the "Queen of cereals" due to its high yielding capacity. It is considered as a very important crop in the agricultural economy as it serves as both food and fodder crop (Singh *et al.*, 2019). Maize is the third most important cereal crop in India after Rice and Wheat. In India, Maize occupies an area of 9.47 m ha with a production of 28.72 million tonnes and the productivity is 3.032 t ha^{-1}. In Tamil Nadu it is cultivated in an area of 0.34 m ha with a production of 2.64 million tonnes and the productivity is 7.74 t ha^{-1} (Agriculture Statistics at a Glance 2018). Tamil Nadu ranks fourth in production and first in productivity among the states in India. Maize is mostly cultivated by the farmers of India as it adapts and survive in all the agro-climatic zones of India.

Being a C_4 plant, maize possess tremendous yield potential and responds well to applied inputs and brings out its maximum yield potential when accompanied with proper management practices. Among the various agronomic management practices nutrient management plays a vital role for higher productivity of maize particularly in a country like India. Micro-nutrients are equally as important as major nutrients as they cause same level damage by their deficiencies. Hence application of micronutrients through foliar spray confirmed a positive effect in the yield of maize as it eliminates the factors hindering nutrient absorption from soil applied fertilizers (Adarsha *et al.*, 2019). Hence, a holistic approach towards the integrated nutrient management of maize is needed. It is proved that foliar fertilization is possessing almost 20 percent more efficiency on comparison with soil applied fertilizers (Aref *et al*., 2011). Beema green granules are the organic humic granules which contains humic acid, fulvic acid, amino acid and micronutrients. Soil application of Beema green granules along with recommended RDF tends to increase the plant characteristics in terms of growth and yield (Manimaran and Prakash, 2018).

Enhanced uptake of nutrients was noticed by the application of fortified humic acid along with RDF by soil application was reported by Elayaraja *et al*. (2011). Tracel is a scientifically blended micronutrient mixtures particularly for foliar applications. A notable increase in the nutrient content and plant uptake was may be due to increase in yield which was mainly associated with higher uptake of all the micronutrients (Khan *et al*., 2014).

A relatively small increase in yield may be sufficient to have a good return highest profit of micronutrient fertilization, especially when commodity prices are high. Unfortunately, little research has so far been carried out to appraise the effectiveness of soil application of slow release organic granules and foliar application of organic and inorganic nutrients along with inorganic fertilizer in hybrid maize in coastal Tamil Nadu. Hence, by taking the above facts into account, an attempt has been made to test the integrated nutrient management in maize.

MATERIALS AND METHODS

A field experiment was conducted during July to October (Kharif) 2018 in the experimental farm, Department of Agronomy, Annamalai University. The clay loam soil possess pH of 7.2. The initial soil available nitrogen content was low, while available phosphorus was medium and potassium was low.

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The experiment was conducted with thirteen treatments and replicated thrice in a randomized block design. The treatments includes, T_1: Recommended dose of fertilizer (RDF) 135:62.5:50 kg N:P_2O_5:K_2O ha^{-1}, T_2: RDF + Beema green granules (25 kg ha^{-1}) as soil application, T_3: 75% RDF + Beema green granules (25 kg ha^{-1}) as soil application, T_4: RDF + Uphaar (250gm ha^{-1}) as foliar spray twice, T_5: RDF + Beema green granules (25 kg ha^{-1}) soil application + Uphaar (250gm ha^{-1}) foliar spray twice, T_6: 75% RDF + Beema green granules (25 kg ha^{-1}) soil application + Uphaar (250gm ha^{-1}) foliar spray twice, T_7: RDF + Tracel (3.75kgha^{-1}) foliar spray twice, T_8: RDF + Beema green granules (25 kg ha^{-1}) soil application + Tracel (3.75kg ha^{-1}) foliar spray twice, T_9: 75% RDF + Beema green granules (25 kg ha^{-1}) soil application + Tracel (3.75kg ha^{-1}) foliar spray twice, T_{10}: RDF + Uphaar (250gm ha^{-1}) first and Tracel (3.75kg ha^{-1}) second foliar spray, T_{11}: RDF + Beema green granules (25 kg ha^{-1}) (20 DAS) soil application + foliar application of Uphaar (250gm ha^{-1}) (30 DAS) and Tracel (3.75kg ha^{-1}) (40 DAS) foliar spray, T_{12}: 75% RDF + Beema green granules (25 kg ha^{-1}) soil application + Uphaar (250gm ha^{-1}) first and Tracel (3.75kg ha^{-1}) second foliar spray, T_{13}: RDF + water spray twice. Half dose of N and full dose of P_2O_5 and K_2O were applied basal to maize crop. The remaining N was applied as top dressing at 25 and 45 DAS in two equal splits. The fertilizers used were urea (46 % N), super phosphate (16 % P_2O_5) and muriate of potash (60 % K_2O). The Hybrid maize NK 6240 was dibbled at a depth of 4 cm with a spacing of 60 cm x 20 cm.

RESULTS AND DISCUSSION

Growth Components

Plant height

The data pertaining to average plant height of maize at different stages of crop growth (30, 60, 90 DAS and at harvest) were revealed that treatments in the experiment significantly influenced the plant height of maize. Among the treatments adopted, the highest plant height was observed under the treatment T_{11} – RDF + Beema green granules @ 25 kg ha^{-1} (20 DAS) soil application + foliar application of Uphaar @ 250gm ha^{-1} (30 DAS) and Tracel @ 3.75kg ha^{-1} (40 DAS) foliar spray, that recorded a height of 292.16 cm that was followed by T_{10} with 281.33 cm and T_{12} (281.00 cm). Increase in plant height might be pertained to internodal distance as reported by Haghi *et al.* (2016). The least plant height was recorded under T_3 (201.16 cm).

Dry matter production

The data taken for DMP was recorded at 30, 60 DAS and at harvest respectively. Rate of dry matter accumulation directly influences the plant growth. The accumulated dry matter possess a major reflection on the economic yield as they are the source which turns into the efficiency of plant yield majorly called as the sink. A Significant increase in dry matter production was observed in the treatment, application of RDF + Beema green granules @ 25 kg ha^{-1} (20 DAS) soil application + foliar application of Uphaar @ 250gm ha^{-1} (30 DAS) and Tracel @ 3.75kg ha^{-1} (40 DAS) foliar spray -T_{11} with 16505 kg ha^{-1} and was followed by the treatment T_{10}, (16015 kg ha^{-1}).The least DMP was recorded under the treatment with 75% RDF + Beema green granules (25 kg ha^{-1}) as soil application, T_3 (11335 kg ha^{-1}).

Yield attributes: The data on yield attributes and yield are given in Table 1.

Table 1. Effect of integrated nutrient management practices on hybrid maize

Treatments	Plant height at harvest (cm)	DMP at harvest (kg ha^{-1})	Cob length (cm)	Cob diameter (cm)	Grain number cob^{-1}	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1 – Recommended dose of fertilizers (RDF)	249.50	14085	19.05	5.05	403	5174.00	7764
T_2 – RDF + soil application of Beema green granules @25 kg ha^{-1}	252.66	14125	19.40	5.15	406	5210.00	7815
T_3 – 75 % RDF + soil application of Beema green granules @25 kg ha^{-1}	201.16	11335	11.30	3.55	348	4056.50	6419
T_4 –RDF + foliar application of Uphaar@250 gm ha^{-1} twice	229.83	12805	15.95	4.45	381	4686.50	7230
T_5 – RDF + soil application of Beema green granules @25 kg ha^{-1} and foliar application of Uphaar@250 gm ha^{-1} twice	239.50	13295	17.50	4.75	392	4980.00	7490
T_6 – 75 %RDF + soil application of Beema green granules @25 kg ha^{-1} and foliar application of Uphaar@250 gm ha^{-1} twice	210.83	11825	12.85	3.85	359	4255.00	6690

T_7– RDF + foliar application of Tracel@3.75 kg ha^{-1} twice	261.83	14785	20.45	5.35	414	5437.50	8033
T_8– RDF + soil application of Beema green granules @25 kg ha^{-1} and foliar application of Tracel@3.75 kg ha^{-1} twice	271.16	15280	22.15	5.65	426	5702.50	8302
T_9– 75 % RDF + soil application of Beema green granules @25 kg ha^{-1} and foliar application of Tracel@3.75 kg ha^{-1} twice	260.33	14741	20.03	5.31	414	5372.50	8015
T_{10}– RDF + foliar application of Uphaar@250 gm ha^{-1} and foliar application of Tracel@3.75 kg ha^{-1}	281.33	16015	23.70	5.95	436	5970.00	8571
T_{11}– RDF + soil application of Beema green granules@ 25 kg ha^{-1} + foliar application of Uphaar@250 gm ha^{-1} and foliar application of Tracel@3.75 kg ha^{-1}	**292.16**	**16505**	**25.25**	**6.25**	**448**	**6260.50**	**8840**
T_{12}– 75 % RDF + soil application of Beema green granules@ 25 kg ha^{-1} + foliar application of Uphaar@250 gm ha^{-1} and foliar application of Tracel@3.75 kg ha^{-1}	281.00	15970	23.35	5.90	433	5900.00	8565
T_{13}– RDF + water spray	249.33	14043	18.83	5.02	404	5170.00	7745
S.Ed	4	25.733	0.235	0.033	3.819	89.14	13.371
CD (p=0.05)	8.36	51.466	0.471	0.066	7.638	187.14	26.743

Cob length: The cob length was significantly influenced by levels of fertilizers and soil application of Beema green granules with organic and inorganic foliar nutrients in the season. Among the treatments, T_{11} (RDF + Beema green granules @ 25 kg ha^{-1} (20 DAS) soil application + foliar application of Uphaar @ 250gm ha^{-1} (30 DAS) and Tracel @ 3.75kg ha^{-1} (40 DAS) foliar spray) recorded the highest cob length of 25.25 cm during *kharif* 2018. The increase in cob length was the result of the additive effect of various nutrient elements on photosynthesis that were applied through foliar and soil application. The least cob length of 11.30 cm was recorded under T_3.

Cob diameter: The cob diameter was significantly influenced by levels of fertilizer + soil application of Beema green granules and foliar application of organic and inorganic nutrients in the season. Among the treatments practiced, T_{11} recorded the highest cob diameter of 6.25 cm. Cob diameter is directly proportional towards the source sink ratio. When dmp of crop is more, its photosynthetic activity is more efficient and thus a better source sink ratio is observed. The least cob diameter of 3.55 cm was registered under T_3.

Grains number cob^{-1}: The grain number cob^{-1} was significantly influenced by levels of fertilizer along with soil application of Beema green granules and foliar application of organic and inorganic nutrients. Among the treatments, the treatment T_{11} recorded the higher grain number cob^{-1} of 448. It was followed by T_{10} and T_{12} with the value of 436 and 433. As the requirement of both macro and micro nutrients of the plant gets satisfied, under favourable circumstances, there is an effective conversion of source to sink *i.e*., grains. By the application of micronutrients, yield was influenced directly. Similar observation was noticed in the study of Tariq *et al.* (2014). The least grain number cob^{-1} of 348 was observed under T_3.

Yield

Grain yield: Application of RDF + Beema green granules (25 kg ha^{-1}) (20 DAS) soil application + foliar application of Uphaar (250gm ha^{-1}) (30 DAS) and Tracel (3.75kg ha^{-1}) (40 DAS) foliar spray – T_{11}, registered the highest grain yield of 6260 kg ha^{-1}. Application of Beema green granules (humic acid) is known to influence the mechanisms like cell respiration, photosynthesis, protein synthesis, nutrient uptake, water uptake and enzyme activities, thereby increasing the yield of crops (Arjumend *et al.* 2015). Studies of Daur and Bakhashwain (2013) stated that, after the application of humic substances, maize had more leaves which in turns gave higher dry mass and thereby the yield. The least grain yield of 4056.50 kg ha^{-1} was observed under T_3.

Stover yield: The stover yield was significantly influenced by levels of fertilizer soil application of Beema green granules and foliar application of nutrients. Among the treatments, T_{11} (Application of RDF + Beema green granules @ 25 kg ha^{-1} (20 DAS) soil application + foliar application of Uphaar @ 250gm ha^{-1} (30 DAS) and Tracel @ 3.75kg ha^{-1} (40 DAS) foliar spray) was superior and recorded the highest stover yield of 8840 kg ha^{-1}. Increased DMP as a result of micronutrient application directly plays a key role in getting higher stover yield. Similar results were noticed in the studies of (Adarsha *et al*., 2018). The treatment T_3 registered the lowest stover yield of 6419 kg ha^{-1}.

CONCLUSION

The explosions of human and livestock population enhanced the demands for both grain and stovers in maize. Maize is an exhaustive crop requires all types of macro and micro nutrients for better growth and yield potential. The integrated use of organic and inorganic fertilizers not only increases the mutual efficiency but also helps in reducing the chemical fertilizer use. Integrated use of fertilizers and organic manures not only makes higher yields possible but also provides greater quality. Thus recommended dose of 135:62.5:50 kg $N:P_2O_5:K_2O$ ha^{-1} + Beema green granules (25 kg ha^{-1}) at 20 DAS + Uphaar (250g ha^{-1}) and Tracel (3.75 kg ha^{-1}) foliar spray of 30 and 40 DAS recorded highest plant height, DMP, cob length and grain numbers cob^{-1}. The treatment also recorded the highest grain and stover yield of 6260 kg ha^{-1} and 8840 kg ha^{-1} as a result of increased plant growth parameters viz., plant height, dry matter production and yield parameters like cob length, diameter and number of grains per cob^{-1}. The highest gross return of Rs. 97,060 and net return of Rs. 28380 were obtained with the highest return $rupee^{-1}$ invested of Rs. 2.42.

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