



Production and Economics of Hybrid Maize (*Zea mays* L.) under Integrated Nutrient Management Practices

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ABSTRACT

Background: Integrated nutrient management is considered as one of the major tools in agricultural production worldwide. Occupying 3.5% of gross cropped area (GCA), maize accounts for 2.3% of total fertilizer consumption. Despite its soil status, little is known about the application and dosage of integrated nutrient in the experimental hybrid maize crop in the region. Any strategy against this nutrient deterioration must have a good knowledge of the composition and application of integrated nutrient source utilized. The field study aimed to study the integrated nutrient management in hybrid maize of this region to evaluate the performance in growth, yield and nutrient related problems.

Methods: A field experiment was conducted during *rabi* season of 2018, at experimental farm, Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India. Thirteen treatments with three replications were laid out in randomized block design. The treatments combinations were T_1 : Recommended dose of fertilizer (RDF) 135:62.5:50 kg N:P₂O₅:K₂O 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 (250 gm ha⁻¹) as foliar spray twice, T_5 : RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm ha⁻¹) foliar spray twice, T_6 : 75% RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm ha⁻¹) foliar spray twice, T_7 : RDF + Tracel (3.75 kg ha⁻¹) foliar spray twice, T_8 : RDF + Beema green granules (25 kg ha⁻¹) soil application + Tracel (3.75 kg ha⁻¹) foliar spray twice, T_9 : 75% RDF + Beema green granules (25 kg ha⁻¹) soil application + Tracel (3.75 kg ha⁻¹) foliar spray twice, T_{10} : RDF + Uphaar (250 gm ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray, T_{11} : RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray, T_{12} : 75% RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray, T_{13} : RDF + water spray twice. The collected samples were statistically analyzed for cob length, cob diameter, grain no. /cob, grain yield, stover yield, available Nitrogen, Phosphorus and Potassium and Post-harvest nutrient status of Nitrogen, Phosphorus and Potassium.

Result: Our investigation in the maize hybrid crop has confirmed us with unique results. Among the treatments RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray (T_{11}) was highly significant with increased yield and yield attributes and was best in gross and net returns too. The present work will be a contribution to the comprehensive study of the integrated nutrient management in hybrid maize.

Key words: Granules, Maize, Net return, Nutrient, Organic and inorganic foliar spray, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is the most versatile crop with wider adaptability in varied agro-climatic conditions. Maize has a high genetic potential than any other cereal crop and there is no cereals on earth which has so immense potential and hence referred to as "Queen of cereals" or miracle crop (Ratuary *et al.* 2013).

In India maize is the third most important food crop, cultivated in an area of 9.47 million ha with a production of 28.72 mt having productivity 3.03 t/ha. Tamil Nadu ranks fourth in production (0.34 million ha) and first in productivity (7.74 t/ha) among the states in India (Agriculture Statistics at a Glance, 2018).

Maize being a C₄ plant has tremendous yield potential and responds well to applied inputs however, its potential could not be exploited fully due to lack of proper management practices. Among the various agronomic management practices nutrient management plays a vital role for higher productivity of maize (Prasanna Kumar *et al.* 2007). It has been the practices of farmers to supply these nutrients

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mainly through inorganic fertilizers. Continuous use of inorganic fertilizers causes several hazards to soil health by heavy withdrawal of nutrients. Supplying plants with micronutrients, either through soil application, foliar spray or seed treatment improves yield and quality and macronutrient use efficiency up to 50% (Malakouti, 2008). For maximum production of hybrid maize judicious management is very much important. Manure and fertilizer management is one of the most

important factors for securing good yield of maize. Furthermore integrated use of organic and inorganic manures sustains the productivity of soil and crops in an integrated cropping system. This approach restores and sustains soil health and productivity in the long run, besides meeting the nutritional needs of crop (Maidul Hasan *et al.* 2018). Among these, declining soil fertility, due to continuous cultivation with low input is a major limitation to crop production and productivity in smallholder farms (Habtamu *et al.* 2019).

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.

Objective of the study

To study the effect of different treatments on yield and yield attributes and economics of hybrid maize in coastal Tamil Nadu.

MATERIALS AND METHODS

The field experiment carried out at experimental farm, Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu during (*rabi*) October 2018. The experimental site was located between 11°24' N, 79°44' E longitude at an altitude of +5.79 meters above mean sea level. The soil of the experimental site was clay loam in texture with pH 7.2 and has 0.75% organic carbon and 14 kg/ha available P and 201.5 kg/ha mineralizable N and 174 kg/ha available K. The meteorological observatory of the Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu revealed that maximum mean monthly temperature ranged from 31°C to 32°C and minimum from 24°C to 26°C during the *rabi* season, year of experimentation. The relative humidity ranged between 67 per cent to 83 per cent with an average daylight of 11.9 hr. A total amount of rainfall 230 mm was received during the cropping season.

The experiment was conducted with thirteen treatments were arranged in 3 replications using randomized block design. The treatments includes, T_1 : Recommended dose of fertilizer (RDF) 135:62.5:50 kg N:P₂O₅:K₂O 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 (250 g ha⁻¹) as foliar spray twice, T_5 : RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 gm 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 (3.75 kgha⁻¹) foliar spray twice, T_8 : RDF + Beema green granules (25 kg ha⁻¹) soil application + Tracel (3.75 kg ha⁻¹) foliar spray twice, T_9 : 75% RDF + Beema green granules (25 kg ha⁻¹) soil application + Tracel (3.75 kg ha⁻¹) foliar spray twice, T_{10} : RDF + Uphaar (250 gm ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray, T_{11} : RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of

Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray, T_{12} : 75% RDF + Beema green granules (25 kg ha⁻¹) soil application + Uphaar (250 g ha⁻¹) first and Tracel (3.75 kg ha⁻¹) second foliar spray, T_{13} : RDF + water spray twice were evaluated for *rabi* season 2018.

Farm yard manures (FYM: 0.53% N, 0.15% P and 0.56% K) were applied to the field 1 month before sowing of the crop as per the treatment. Maize hybrid NK 6240 was sown with using the seed rate of 20 kg/ha and row spacing of 60 cm × 20 cm. A recommended dose of fertilizers *i.e.* 135 kg N, 62.5 kg P and 50 kg K/ha was applied as per treatment. Full doses of P and K and half of N were applied basal and remaining N were top dressed in 2 equal splits at knee high and tassel-emergence stages. Gap-filling and thinning were done within 15 days after sowing (DAS) of crop to maintain the optimum plant population.

The cob length, cob diameter, grains per cob, parameters were collected at harvest from random selected 5 plants. The nutrient uptake and available nutrients after harvest were analysed as per the standard procedures. Grain and stover yields of maize were recorded in kg/ha.

The data obtained from this study were analysed statistically following randomized block design as per the procedure given by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Yield attributes

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

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, 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}) recorded the highest cob length of 25.25 cm during *rabi* 2018-2019. The rest of the treatments *viz.*, T_{10} , T_{12} , T_8 , T_7 , T_9 , T_2 , T_1 , T_{13} , T_5 , T_4 and T_6 stood next in the order of ranking. The least cob length of 11.30 cm was recorded under T_3 . This may be attributed to higher water regime and better water balance, which lead to vigorous growth and more yield attributes produced (Sharma *et al.* 2010). Dash *et al.* (2010) reported that INM source has significantly increased the availability of nitrogen in soil and thus result in increasing the yield attributes like Cob length, cob diameter, Number of grains cob⁻¹ were increased in maize. Similar findings were reported by Rakesh Kumar (2015). These results suggested that adequate supply of nutrients throughout vegetative growth was necessary for proper cob development in maize as reported by Samsani (2016).

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

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

| Treatments | 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) | 19.05 | 5.05 | 403 | 5174.00 | 7764 |
| T ₂ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 19.40 | 5.15 | 406 | 5210.00 | 7815 |
| T ₃ - 75% RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 11.30 | 3.55 | 348 | 4056.50 | 6419 |
| T ₄ - RDF + foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 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 | 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 | 12.85 | 3.85 | 359 | 4255.00 | 6690 |
| T ₇ - RDF + foliar application of Tracel @ 3.75 kg ha ⁻¹ twice | 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 | 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 | 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 | 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 | 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 | 23.35 | 5.90 | 433 | 5900.00 | 8565 |
| T ₁₃ - RDF + water spray | 18.83 | 5.02 | 404 | 5170.00 | 7745 |
| SEd | 0.235 | 0.033 | 3.819 | 89.14 | 13.371 |
| CD (p=0.05) | 0.471 | 0.066 | 7.638 | 187.14 | 26.743 |

season. Among the treatments, RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray (T₁₁) recorded the highest cob diameter of 6.25 cm. The rest of the treatments viz., T₁₀, T₁₂, T₈, T₇, T₉, T₂, T₁, T₁₃, T₅, T₄ and T₆ stood next in the order of ranking. The least cob diameter of 3.55 cm was registered under T₃. Pinjari (2007) reported that yield attributes of maize viz., girth and length of cobs grain cob⁻¹ and shelling percentage remarkably improved because of increased levels of N and P. Our results confirm those of Kumar *et al.* (2012). These results suggested that adequate supply of nutrients from both organic and inorganic source was necessary for proper cob diameter in maize as reported by Chapagain (2010) and Samsani (2016).

Grains number cob⁻¹

The grain number cob⁻¹ was significantly influenced by levels of fertilizer + soil application of Beema green granules and foliar application of nutrients. Among the treatments, the treatment RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray (T₁₁) recorded the higher grain number cob⁻¹ of 448. It was followed by T₁₀ and T₁₂ with the value of 436 and 433. The above treatment was followed by T₈ with value of 426. The treatments T₇ and T₉ were on par with each other and ranked next in order. The rest of the treatments viz., T₂, T₁, T₁₃, T₅, T₄

and T₆ stood next in the order of ranking. The least grain number cob⁻¹ of 348 was observed under T₃. This increase might be due to better nutrient uptake and development of the plant and cob due to combined application of mineral fertilizer and organic manure as reported by Prasad *et al.* (2003). Integrated use of nutrients significantly influenced the yield and yield attributing characters viz., grain weight/cob, number of grain/cob and test weight (Ravikumar, 2009).

Yield

Grain yield

Application of RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray (T₁₁), registered the highest grain yield of 6260 kg ha⁻¹. The rest of the treatments viz., T₂, T₁, T₁₃, T₅, T₄ and T₆ stood next in the order of ranking. The least grain yield of 4056.50 kg ha⁻¹ was observed under T₃. Further grain yield of maize mainly depends upon the final plant population and yield of individual plant, the latter in turn depends upon the number of ears per plant and the weight of grains per cob which resulted in higher grain yield in maize. Similar results were also reported by Saini and Kumar (2014) and Nasab *et al.* (2015).

Stover yield

The stover yield was significantly influenced by levels of fertilizer soil application of Beema green granules and foliar

Table 2: Effect of different treatments on nutrient uptake by maize and soil nutrient status after harvest.

| Treatments | Nutrient uptake by maize (kg/ha) | | | Nutrient status in soil after harvesting (kg/ha) | | |
|--|-------------------------------------|------------|-----------|---|------------|-----------|
| | Nitrogen | Phosphorus | Potassium | Nitrogen | Phosphorus | Potassium |
| T ₁ - Recommended dose of fertilizers (RDF) | 154.40 | 54.70 | 61.33 | 217.06 | 29.08 | 83.67 |
| T ₂ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 154.59 | 55.10 | 62.82 | 217.41 | 29.04 | 82.18 |
| T ₃ - 75% RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 132.55 | 45.00 | 43.66 | 239.45 | 39.05 | 101.34 |
| T ₄ - RDF + foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 146.54 | 51.30 | 54.43 | 225.46 | 33.02 | 90.57 |
| T ₅ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 150.17 | 53.00 | 57.83 | 221.83 | 31.05 | 87.17 |
| T ₆ - 75% RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 138.38 | 47.90 | 47.29 | 233.62 | 36.06 | 97.71 |
| T ₇ - RDF + foliar application of Tracel @ 3.75 kg ha ⁻¹ twice | 158.30 | 56.40 | 64.82 | 213.07 | 28.01 | 80.18 |
| T ₈ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Tracel @ 3.75 kg ha ⁻¹ twice | 162.20 | 58.10 | 68.32 | 209.08 | 26.04 | 76.68 |
| 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 | 158.23 | 56.00 | 64.54 | 213.77 | 28.05 | 80.46 |
| T ₁₀ - RDF + foliar application of Uphaar @ 250 gm ha ⁻¹ and foliar application of Tracel @ 3.75 kg ha ⁻¹ | 166.10 | 59.80 | 71.68 | 205.09 | 24.07 | 73.32 |
| 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 | 170.00 | 60.50 | 75.29 | 202.00 | 24.00 | 69.71 |
| 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 | 166.10 | 59.50 | 71.15 | 205.09 | 25.00 | 73.85 |
| T ₁₃ - RDF + water spray | 154.23 | 54.30 | 60.99 | 217.77 | 30.02 | 84.01 |
| SED | 1.786 | 0.338 | 0.303 | 2.072 | 0.867 | 2.016 |
| CD (p=0.05) | 3.573 | 0.677 | 0.606 | 4.144 | 1.734 | 4.033 |

application of nutrients. Among the treatments, RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray (T₁₁) was superior and recorded the highest stover yield of 8840 kg ha⁻¹. The rest of the treatments viz., T₂, T₁, T₁₃, T₅, T₄ and T₆ stood next in the order of ranking. The treatment T₃ registered the lowest stover yield of 6419 kg ha⁻¹. Saini and kumar (2014) have shown that substitution may be because of slow release of nutrient from them due to slow mineralization.

Nutrient uptake and post-harvest soil nutrient status

There was significant effect of different sources of nutrients on the Nutrient uptake of maize (Table 2).

Nutrient uptake

Highest uptake of N, P and K was observed with application of RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250 gm ha⁻¹) (30 DAS) and Tracel (3.75kg ha⁻¹) (40 DAS) foliar spray (T₁₁), excelled other treatments by recording the highest nutrient uptake of 170.00 kg of N and 60.50 kg P₂O₅ and 75.29 kg K₂O. The rest of the treatments viz., T₁₀, T₁₂, T₇, T₉, T₈, T₂, T₁₃ and T₁ stood next in the order of ranking. The treatments T₅

and T₄ were next in order. The least uptake of nutrients was observed under T₃ with a value of 132.55 kg of N, 45.40 kg P₂O₅ 43.66 kg K₂O ha⁻¹ respectively. The application of organic and inorganic fertilizers significantly influenced the nutrient uptake by maize (Meena *et al.* 2006). Moreover many authors like Shukla and Tyagi (2009) and Verma *et al.* (2006) also reported that balance and integrated nutrient supply caused significantly higher uptake of primary nutrients. This increase in nutrient uptake might be due to adequate moisture that influenced the nutrient uptake of N, P and K. This result was also confirmed by Mudalagiriappa *et al.* (2012) in sorghum. The higher nutrient uptake was due to granules that help its availability in rhizosphere as reported by Rao and Shaktawat (2002). Similar findings were reported by Rakesh Kumar (2015).

Soil available NPK after harvest

The data on post-harvest soil available NPK status are given in Table 2. All the treatments showed significant difference on post-harvest soil available nitrogen, phosphorus, and potassium Among the treatments, 75% RDF + Beema green granules (25 kg ha⁻¹) as soil application (T₃) recorded a highest post-harvest soil available N of 239.45 kg ha⁻¹, P of 39.05 kg ha⁻¹ and K of 101.34 kg ha⁻¹ during *rabi* 2018. The rest of

Table 3: Effect of integrated nutrient management on productivity and economics of maize.

| Treatments | Cost of cultivation | Gross return (Rs ha ⁻¹) | Net return (Rs ha ⁻¹) | Return rupee ⁻¹ invested |
|--|----------------------|-------------------------------------|-----------------------------------|-------------------------------------|
| T ₁ - Recommended dose of fertilizers (RDF) | 24614 | 76318 | 51704 | 2.10 |
| T ₂ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 27077 | 76420 | 49343 | 1.82 |
| T ₃ - 75% RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ | 25328 | 59993 | 34665 | 1.36 |
| T ₄ - RDF + foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 24913 | 69219 | 43306 | 1.77 |
| T ₅ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Uphaar@250 gm ha ⁻¹ twice | 27375 | 73456 | 46090 | 1.68 |
| T ₆ - 75% RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Uphaar @ 250 gm ha ⁻¹ twice | 25627 | 62915 | 37288 | 1.45 |
| T ₇ - RDF + foliar application of Tracel @ 3.75 kg ha ⁻¹ twice | 25618 | 80134 | 54516 | 2.12 |
| T ₈ - RDF + soil application of Beema green granules @ 25 kg ha ⁻¹ and foliar application of Tracel @ 3.75 kg ha ⁻¹ twice | 28081 | 83979 | 55898 | 1.99 |
| 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 | 26332 | 79215 | 52883 | 2.00 |
| T ₁₀ - RDF + foliar application of Uphaar @ 250 gm ha ⁻¹ and foliar application of Tracel @ 3.75 kg ha ⁻¹ | 25917 | 87865 | 61948 | 2.39 |
| 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 | 28380 | 97060 | 68680 | 2.42 |
| 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 | 26631 | 86882 | 60251 | 2.26 |
| T ₁₃ - RDF + water spray | 24940 | 76252 | 51312 | 2.05 |
| Men labour : Rs.280 | Seed cost : Rs. 250 | Urea : Rs. 5.36 | | |
| Women labour : Rs.100 | Produce cost: Rs. 14 | SSP : Rs. 8.4 | | |
| | | MOP : Rs. 16.4 | | |
| Uphaar : Rs. 530 | | | | |
| Tracel : Rs. 220 | | | | |
| Beema green granules : Rs. 87 | | | | |

the treatments viz., T_6 , T_4 , T_5 , T_{13} , T_1 and T_2 stood next in the order of ranking. The least post-harvest soil available N of 202 kg ha⁻¹, P of 24.00 kg ha⁻¹ and K of 69.71 kg ha⁻¹ respectively was recorded under T_{11} . The above result is in similar position with Sharma and Banik (2012) who reported that integration of organic and inorganic sources of nutrient improved soil fertility status. The result obtained is in line with Chaudhry *et al.* (2009).

Economics

The data on the economics of different treatments are presented in Table 3.

The economics parameters such as gross return, net return and return rupee⁻¹ invested were calculated based on the prevailing market price. The highest gross return of Rs 97,060 and net return of Rs 28380 were obtained under T_{11} . The least gross return (Rs 59,993) and net return (Rs 34665) were obtained with T_3 . The highest return rupee⁻¹ invested of Rs 2.42 was obtained under RDF + Beema green granules (25 kg ha⁻¹) (20 DAS) soil application + foliar application of Uphaar (250gm ha⁻¹) (30 DAS) and Tracel (3.75 kg ha⁻¹) (40 DAS) foliar spray (T_{11}), might be owing to increase in yields of maize. Similar findings were also reported in maize by Sharma *et al.* (2011). Our results confirm with Rakesh Kumar (2015). This is followed by T_{10} and T_{12} . On the other hand the least return rupee⁻¹ invested was obtained under T_3 with a value of Rs 1.36.

CONCLUSION

The explosions of Indian population enhance the demand of maize. The high human population needs maize production for satisfying the nutritive requirements. Maize is an exhaustive crop requires all types of macro and micro nutrients for better growth and yield potential. The main advantages of organic fertilizer are ecological balance, low cost of cultivation, clean environment and nutritious food without reducing the human health. The integrated use of organic and inorganic fertilizers not only increase mutual efficiency but also helps in the substitution of costly chemical fertilizers. Integrated use of fertilizers and organic manures not only makes higher yields possible but also provides greater quality stability. Thus significant recommended dose of 135:62.5:50 kg N:P₂O₅:K₂O ha⁻¹ + Beema green granules (25 kg ha⁻¹) at 20 DAS + Uphaar (250 g ha⁻¹) and Tracel (3.75 kg ha⁻¹) foliar spray of 30th and 40th DAS recorded highest cob length and grain numbers cob⁻¹. Such treatment also recorded highest grain and stover yield of 6260 kg ha⁻¹ and 8840 kg ha⁻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 was recorded.

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