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# Effect of Growth Enhancer on Growth and Productivity of Maize (*Zea mays* L.)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The experiment was conducted during *Rabi* 2021 at Zonal Agricultural Research. Station, GKVK, Bangalore to study the efficacy of a Growth Enhancer (GE) as a foliar nutrient source for enhancing maize growth and yield. The field investigation was carried out using Randomized Complete Block Design (RCBD) having eleven. treatments viz., $T_1$**:** GE 10.0 ml per litre + 50 % RDF, $T_2$**:** GE 10.0 ml per litre + 75 % RDF, $T_3$**:** GE 10.0 ml per litre + 100 % RDF, $T_4$**:** GE 20.0 ml per litre + 50 % RDF, $T_5$**:** GE 20.0 ml per litre + 75 % RDF, $T_6$**:** GE 20.0 ml per litre + 100 % RDF, $T_7$**:** Urea spray - 0.5 % + 100 % RDF, $T_8$**:** Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P&K, $T_9$**:** Nano N & P two sprays at 30 and 60 DAS + 50% RDNP and 100% K, $T_{10}$**:** RDF with FYM, and $T_{11}$**:** Only RDF with three replications. The results of the study revealed that among different treatments application of growth enhancer 20 ml per litre of water with 100 % RDF was recorded a significantly higher plant height, dry matter accumulation in leaves, stem, cob and total dry matter accumulation, cob

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length, cob girth,, number of kernels $cob^{-1}$ and weight of kernels $cob^{-1}$, kernel and stover yield in comparison to all other treatments. Similarly higher gross returns, net returns and benefit cost ratio were obtained with the application of GE 20.0 ml per litre + 100 % RDF.

*Keywords: Maize; growth enhancer; RDF; growth; yield parameters and yield.*

## 1. INTRODUCTION

Maize is the most important cereal crop after rice and wheat in the world. It is recognized as the "Queen of Cereals" due to its enormous yield potential and adaptability among cereals. It is cultivated in more than 166 nations worldwide, from sea level to 3000 m altitude, in tropical, subtropical and temperate climates. Nearly 197 m ha area is under cultivation, producing 1148mt and productivity of 5823.8 kg $ha^{-1}$ in a wider range of environmental factors like soil, climate, biodiversity and farming techniques, and making up 37 % of the world's total grain production [1]. In India, maize cultivation spans an extensive area of 9.9 million hectares, yielding a substantial production of 30 million metric tons in the 2020-2021 season [2]. The state of Karnataka plays a significant role in this, devoting approximately 1.32 million hectares of land to maize cultivation, resulting in a remarkable output of 4.58 million metric tons with an impressive productivity of 3470 kg $ha^{-1}$. The state's maize area under cultivation and production are increasing very year due to the huge demand for poultry and animal feed, also due to ease of cultivation provided by mechanization.

Maize is a crop that requires high levels of nutrients, and its potential yield is significantly influenced by the management of these nutrients. However, the efficiency of nutrient utilization when applied to the soil is relatively low due to various climatic and soil factors. Besides traditional soil application, there are notable advantages to providing essential nutrients through foliar spray at appropriate timings. These benefits include rapid and effective crop responses, reduced quantity requirements, and reduced reliance on specific soil conditions [3].

Growth enhancers (GE) are materials that typically are added to soil, plants, or the plant-growth environment to enhance plant growth. These include fertilizers, compost, sludge, manure, microbes, additives, hydrolysates, and others or combinations thereof. Foliar feeding has been used to administer additional doses of minor and major nutrients, plant hormones, stimulants and other advantageous substances. Foliar nutrition has been shown to increase yields, improve drought tolerance, increase pest and disease resistance and improve crop quality. Species, fertilizer type, concentration, frequency of application and stage of plant growth all affect how a plant will react to. Fish hydrolysates have superior physical, chemical and functional characteristics when compared to their synthetic counterparts. The literature has reported on characteristics like anti-oxidative activity, anti-hypertensive activity, antimicrobial activity and anti-anemia activity Mendis et al. [4]. In general, many farmers are not well-informed about the benefits of foliar spray of growth enhancers. However, in addition to the standard basal application of fertilizers, utilizing foliar sprays with growth enhancers at the appropriate time can significantly enhance nutrient utilization efficiency, leading to increased grain yield and cost savings on fertilizers. Earlier research has shown promising outcome in terms of improved growth, yield, and quality in some cereals, food crops, and vegetables when using foliar application of growth enhancers [5]. In light of these findings, the present investigation aims to examine the impact of foliar nutrition with growth enhancers on the growth and productivity of maize.

## 2. MATERIALS AND METHODS

A field study was carried out during *Rabi*, 2021 in red loamy soil at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bangalore, situated at 13º 05' N latitude and 77º 34' E longitude and at 924 m above mean sea level which is situated Eastern Dry Zone of Karnataka (ACZ- V). During the crop growing period i.e *Rabi* 2021-2022, the actual total rainfall recorded was 86.5 mm, which was higher than the normal rainfall of 88.2 mm. The mean maximum temperature fluctuated between 26.4 °C and 33.5 °C, while the minimum temperature ranged from 14.6 °C to 20.6 °C. In terms of relative humidity, the highest value of 90 % was recorded in December 2021 The maximum actual sunshine hours and mean wind speed were observed in the month February (8.7 hr $day^{-1}$ and 6.0 km $hr^{-1}$) respectively during

2022. Composite soil samples were taken at random from top 15 cm layer in the experimental area and were analyzed for the soil physic-chemical properties by using different methods were furnished in Table 1 and composition of growth enhancer in Table 2.

Experiment was laid out in Randomized Complete Block Design (RCBD) having eleven treatments replicated thrice, with 19.44 $m^2$ plot size (5.4 m × 3.6 m) each. The details of treatment are **$T_1$:** GE 10.0 ml per litre + 50% RDF, **$T_2$:** GE 10.0 ml per litre + 75% RDF, **$T_3$:** GE 10.0 ml per litre + 100% RDF, **$T_4$:** GE 20.0 ml per litre + 50% RDF, **$T_5$:** GE 20.0 ml per litre + 75% RDF , **$T_6$:** GE 20.0 ml per litre + 100% RDF ,**$T_7$:** Urea spray - 0.5 % + 100% RDF, **$T_8$:** Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P&K, **$T_9$:** Nano N & P two sprays at 30 and 60 DAS + 50% RDNP and 100% K, **$T_{10}$:** RDF with FYM, **$T_{11}$:** Only RDF. In the experiment, a well-decomposed farm yard manure was applied at a rate of 10 tons per hectare to all treatments except treatment $T_{11}$ where only recommended dose of fertilizers (NPK) was applied as per treatments. Three weeks before sowing, this manure was uniformly spread. At the time of sowing, 50% of the required nitrogen and entire dose of phosphorus, and potassium were applied to respective plots as per recommended dose of fertilizers (RDF). Urea, Diammonium Phosphate (DAP), and Muriate of Potash (MOP) fertilizers were applied to the crop rows and thoroughly mixed into the soil before sowing. Foliar spray of growth enhancer (GE) were administered at 30 and 60 DAS according to the specific treatment requirements. The Recommended Dose of Nitrogen (RDN) was split into three applications, with one at sowing, and the other two at the knee height (30 DAS) and tasseling stage (60 DAS).

The crop variety Beeja Raja Maize Hybrid (BRMH-8) is a hybrid released by the Varietal Research & Development Center (VRDC) in Dharwad. It is characterized by semi-dent kernels with a yellow grain color. This hybrid exhibits wide adaptability throughout all regions of Karnataka and holds a promising yield potential of 32-35 quintals per acre. The maturity period for BRMH-8 maize hybrid is between 110 to 120 days and responds exceptionally well to fertilizer applications. Maize hybrid (BRMH-8)

**Table 1. Physico-chemical Properties of soil in experimental area at ZARS, GKVK, UAS, Bangalore**

| Particular | Methods | Values |
|---|---|---|
| A. Physical properties | | |
| Mechanical analysis (oven dry weight basis) | | |
| Coarse sand (%) | International pipette method (Piper, [6]) | 53.4 |
| Fine sand (%) | | 14.4 |
| Silt (%) | | 16.2 |
| Clay (%) | | 15.2 |
| Soil textural class | Red sandy loam | |
| B. Chemical properties | | |
| pH (1:5) | Potentiometric method, pH meter (Piper, [6]) | 5.61 |
| EC (dS $m^{-1}$) | Conductometry (Jackson, [7]) | 0.189 |
| Available N (kg $ha^{-1}$) | Alkaline permanganate method (Subbiah and Asija,[8]) | 441.18 |
| Available $P_2O_5$ (kg $ha^{-1}$) | Brays method (Jackson, [7]) | 36.25 |
| Available $K_2O$ (kg $ha^{-1}$) | Neutral normal ammonium acetate method (Jackson,[7]) | 280.62 |

*Note : Composite soil samples in the experimental area and were analyzed in the Soil Science and Agriculture Chemistry laboratory at College of Sericulture, Chintamani.*

**Table 2. Composition of growth enhancer**

| SL. No | Components | Foliar spray (%) |
|---|---|---|
| 1. | Moisture | 82.02 |
| 2. | Protein | 10.88 |
| 3. | Fat | 3.15 |
| 4. | Ash | 1.40 |
| 5. | Nitrogen | 1740 |
| 6. | Phosphorous | 2126 |
| 7. | Potassium | 1117 |
| 8. | Calcium | 1782 |
| 9. | Boron | 0.16 |
| 10. | Zinc | 5.40 |

seeds were dibbled in pre irrigated plots at 5 cm depth in the first week of December, 2021 at 60 cm x 30 cm spacing. After sowing, the seeds were covered with a thin layer of soil firmly and the plots were given light irrigation after sowing and thereafter at an interval of 5-6 days during cropping period depending on the soil moisture conditions. Gap filling was done in the rows where the seeds failed to germinate 10 days after sowing (DAS) to ensure uniform plant distribution. In cases where multiple seedlings appeared in a single hill, thinning was done to retain one healthy seedling per hill at 15 DAS. Two hand weeding at 15 and 30 DAS was carried out to keep plots weed and earthing up was done at 30 DAS. Biometric Observations on growth parameters and yield were recorded adopting standard procedure at 30, 60, 90 days after sowing and at harvest.

Experimental data collected was statistically analysed by adopting Fisher's method of Analysis of Variance (ANOVA) as suggested by Gomez and Gomez [9]. Whenever the 'F' test was found significant at 5 per cent level Critical Difference (CD) values were calculated. The price of the inputs, wage of the labour and the other cost incurred in cultivating the maize crop during the experimental period were considered for the cost of cultivation. Gross return was calculated by multiplying the total grain yield with price that was prevailing in the market at the time of harvest and was expressed in ₹ ha$^{-1}$ and net return was calculated treatment wise by subtracting the total cost of cultivation from gross returns and expressed in ₹ ha$^{-1}$.

Net returns (₹ ha$^{-1}$) = Gross returns (₹ ha$^{-1}$) – Cost of cultivation (₹ ha$^{-1}$)

Benefit-cost ratio was obtained from the ratio between gross returns and cost of cultivation.

$$\text{B: C ratio} = \frac{\text{Gross returns (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Foliar Application of Growth Enhancer on Growth of Maize

Application of growth enhancer at various concentrations significantly affected the plants height, accumulation of dry matter in leaves, stem, cob and total dry matter accumulation at the time of harvest (Table 3). Significantly higher plant height, dry matter accumulation in leaves, stem, cob and total dry matter accumulation was observed in treatment GE 20.0 ml per litre + 100% RDF in comparison to other treatments in the experimentation but found at par with GE 10.0 ml per litre + 100 % RDF. This might be due to the combined effect of the recommended dose of NPK plus the foliar sprays of organic preparations. This combination contains macronutrients, micronutrients, vitamins, cytokinin, auxins and microorganisms might have positively influenced growth parameters due to enhanced cell division, protein synthesis and mobilization of nutrients. These results are in accordance with Devi et al. [10]. Shoot length increase probably due to the effect on early cell division and cell expansion Saifuddin et al. [11].

The ability of the plant to photosynthesize is dependent upon the amount of accumulated dry matter in its leaves, which in turn is dependent on the amount dry matter is produced. The higher leaf dry matter production was noted as a result of increased plant height, having more and larger leaves in a plant due to sufficient availability of nutrients. These outcomes are consistent with the conclusions of Rani et al. [12]. After 30 DAS the plant height and comprehensive vegetative growth of the plant was increased with the application of a growth promoter that was quickly absorbed by the leaf, produced more leaf area, which intercepted more sunlight for the production of photosynthates, in turn increased the accumulation of photosynthates in stems to strengthen the crop. These results were found similar to the results of [13]. This was mainly because more leaf area was produced, which intercepted more sunlight for the production of photosynthates. The similar results found with Mallikarjuna [14] and Rajesh [13]. as plants age after 60 DAS, the accumulation of dry matter in leaves decreases, primarily because photosynthates are transferred from the leaves to the sink portion (cob) of the plant These results observed were found similar to the results of [13,14].

The precise application of foliar sprays during crucial crop growth stages, such as the eighth leaf stage, grand growth period, tassel emergence, and dough stage in sync with the nutrient requirements of the crop has led to enhanced uptake, translocation, and assimilation of essential nutrients like nitrogen (N) and potassium (K). As a result, maize plants have exhibited remarkable improvements in their overall dry matter yield. At the silking stage, the plant has produced about half of its final dry weight. At around 60 DAS, maximum leaf weight, leaf area and stem stalk was attained. The dry weight of the stem and leaves was equal at the same time. Eventually, leaf growth abruptly ceased. Additionally, the stem and cob at maturity had accumulated higher dry matter. The higher total dry matter production was attributed to better plant growth, which led to higher accumulation of dry matter in leaves and stem at early growth stages and better translocation to cob during later stages. These results were found similar to the findings of [15,16].

### 3.2 Effect of Foliar Application of Growth Enhancer on Maize Yield Parameters

The economic output of a plant results from a range of coordinated biological processes, encompassing biochemical, physiological, and morphological changes. These transformations take place as the plant grows and responds to the occurrence of nutrients, light, water, and other environmental influences. Significant changes were noticed in yield components *viz.,* cob length and girth, kernels per cob, kernel weight per cob and 100 kernel weight (Table. 4)

The impact of treatments on number of cobs per plant was found non-significant and the number of cobs per plant remained one for all plants supplied with different concentration of growth enhancer along with nutrients. However the impact of growth enhancer application on cob girth was found significant (Table 4) where higher cob girth was found in plants supplied with GE 20.0 ml per litre + 100% RDF over GE 10.0 ml per litre + 50% RDF GE 20.0 ml per litre + 50% RDF and nano N & P two sprays at 30 and 60 DAS + 50% RDN and 100% P & K. However, it was found at par with all other treatments.

Significantly longer cobs and higher number of kernels per cob were produced in the foliar spray of GE 20.0 ml per litre + 100 % RDF over all other treatments but found on par with GE 10.0 ml per litre + 100 % RDF and nano N & P two sprays at 30 and 60 DAS + 50 % RDNP and 100% K. The significantly lesser cob length was noticed with GE 10.0 ml per litre+50% RDF and only RDF.

Increased nitrogen uptake supplied in the form of growth enhancer resulted in development of superior amount of source, which ensures sufficient production of photosynthates which later transferred from the source to the sink, which resulted in enhanced girth of the cob and length of cob. The increase in girth and length of the cob may be due to favourable influence of nutrients in increasing the source size and establishing an appropriate source to sink relationship, respectively Samui et al. [17]. Similar outcome were recorded by Rajesh [13], Ajith kumar et al. [18], Reddy et al. [19] and Yasser et al. [20]. Maximum number of kernels per cob due to 100% RDF with foliar application of GE @ 20.0 ml per litre was mainly due to increased cob length, cob girth, rows per cob and kernels per row. The similar findings were also recorded by Al-Saray and Faiz, [21], Ajith kumar et al. [18] and Reddy et al. [19].

Data pertaining to kernel weight per cob presented in the Table 4, shows that significantly higher kernel weight per cob was produced in combined application GE 20.0 ml per litre + 100% RDF in comparison to other treatments but found non significant with GE 10.0 ml per litre + 100% RDF. However, GE 10.0 ml per litre + 50 % RDF recorded significantly lower kernels weight per cob. The higher kernel weight per cob with GE 20.0 ml per litre + 100% RDF was mainly due to significant increase in number of kernels per cob. The more number of kernels per cob was on mainly an account of more number of rows per cob (16.0) and number of kernels per row (40.33). The number of rows per cob and kernel per row were due to increased cob length (21.8 cm) and girth of cob (17.1 cm). These results are in confirmation with findings of [22]. A larger cob size may be the resultent of increased photosynthetic activity, efficient uptake of applied N, efficient transfer of metabolites, and accumulation of these metabolites in the cob Brar et al. [23].

Numerically significantly high test weight was noticed in GE 20.0 ml per litre + 100 % RDF over other treatments but found at par with application of GE 10.0 ml per litre + 100 % RDF (34.5 g), RDF with FYM (34.3 g), nano N & P two sprays at 30 and 60 DAS + 50% RDNP and 100% K), nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P & K and GE 20.0 ml per litre + 75% RDF.

### 3.3 Effect of Foliar Application of Growth Enhancer on Maize Yield

A perusal of data in Table 5 indicates that kernel yield and stover yield was significantly higher with foliar nutrition of GE 20.0 ml per litre and 100 % RDF (7485 kg $ha^{-1}$) in comparision to other treatments in the experiment, except GE

10.0 ml per litre + 100 % RDF (7183 kg $ha^{-1}$) and RDF with FYM (6418 kg $ha^{-1}$), which were found statistically on par with GE 20.0 ml per litre + 100 % RDF. However, statistically least kernel yield was recorded in the treatment GE 10.0 ml per litre + 50 % RDF (4903 kg $ha^{-1}$) over other treatments. It indicates that the optimum kernel yield can be achieved with foliar nutrition of growth enhancer with soil application of recommended dose of NPK.

Higher kernel yield and stover yield in plants treated with GE 20.0 ml per litre + 100 % RDF is mainly attributable to synergistic effect of conventional soil applied urea and foliar applied nutrients which enhanced the uptake of nitrogen Chandana *et al*. [24] and its being a component of many amino acids helped in production of more photosynthetic surface area which in-turn increased the total dry matter accumulation in plants. The higher leaf area and delaying senescence of leaves increased the dry matter production and translocation of photosynthates from source to sink and also better source to sink relationship resulted in higher number of kernels per row, number of rows per cob and kernel weight per cob resulted in increased kernel yield. The similar results has been recorded by Kumar et al. [25]. El-Gewely et al. [26], Rajesh [13], Reddy et al. [19], Samui et al. [17], and Yasser et al. [20]. Significant increase in stover yield with application of GE 20.0 ml per litre+100% RDF was attributed to increased growth parameters *viz*., plant height, stem diameter, leaf area index led to higher total dry matter production per plant over other treatments. The results are in line with Asghar et al. [27] who noticed the higher stover yield of maize by foliar nutrition of multi-nutrient solutions over RDF alone. Addition of nitrogen has greater role in increasing the vegetative growth of the plant; thus, increasing the activity of photosynthesis resulting in greater accumulation of dry matter in the grain and nitrogen has its role in prolonging the period of full-grain and delaying senescence of leaves (El-Gewely et al. [26]. Progressive significant increase in dry matter accumulation was mainly attributed to increase in growth factors like plant height. Harvest index presented in Table 5 indicated that treatments in the experiment with respect to soil and foliar nutrition were failed to register significant differences in harvest index.

### 3.4 Influence of growth enhancer on economics of maize production

The primary determinant of a technology's acceptance and wide-scale adoption is its cost. In every production system, net returns and the B:C ratio, among other economic efficiency measures, have a greater impact on the practical usability and adoption of technologies by farmers. The data on cultivation costs (₹ $ha^{-1}$), gross returns (₹ $ha^{-1}$), net returns (₹ $ha^{-1}$) and benefit cost ratio as influenced by various levels of foliar application growth enhancer and recommended dose of fertiliser are furnished Table 6.

The cost of cultivation varied due to different fertilizer levels along with growth enhancer and nano fertilizer spray. It was observed that GE 20.0 ml per litre + 100 % RDF recorded a higher cost of cultivation (₹ 58816 $ha^{-1}$), followed by GE 10.0 ml per litre + 100 % RDF (₹ 57273 $ha^{-1}$). Lower cost of cultivation was observed in only RDF (₹ 47730 $ha^{-1}$) due to the absence of cost on FYM and application of growth enhancer. The higher cost of cultivation recorded in GE 20.0 ml per litre + 100 % RDF was mainly due to the higher cost incurred on growth enhancer, FYM and fertilizer application. The results are in accordance with the findings of Rajesh [13] and Mallikarjuna [14] in maize.

Net returns, Gross returns and B:C ratio were maximum with the application of GE 20.0 ml per litre + 100 % RDF (₹ 88213 $ha^{-1}$), followed by GE 10.0 ml per litre + 100 % RDF. It was due to higher gross returns obtained, because of higher kernel and stover yield as compare to other treatments. Lower net returns were recorded in GE 10.0 ml per litre + 50 % RDF. The findings are consistent with Parasuraman et al. [28], who observed a 28.19 percent increase in maize's net income when using foliar fertilization of multi-nutrients compared to the application of 100 percent soil-applied fertilizers. Asghar et al. [27] found that foliar fertilization resulted in a significant 40.06 percent increase in maize's gross returns compared to the application of 100 percent recommended dose of fertilizers. The higher gross returns were obtained in GE 20.0 ml per litre + 100 % RDF application this is contributed for achieving higher B:C ratio. These findings align with the results of Kumar et al. [25], Ajithkumar et al [18], Mallikarjuna [14] and Rajesh [13] in maize.

**Table 3. Effect of foliar application of growth enhancer on plant height of maize**

| | Plant height (cm) | Partitioning of Dry matter accumulation (g plant$^{-1}$) | | | |
|---|---|---|---|---|---|
| | | **Leaf** | **Stem** | **cob** | **Total dry matter** |
| $T_1$: GE 10.0 ml per litre + 50 % RDF | 237.1 | 33.9 | 92.8 | 198.1 | 324.8 |
| $T_2$:GE 10.0 ml per litre + 75 % RDF | 266.2 | 41.1 | 126.2 | 217.8 | 385.1 |
| $T_3$: GE 10.0 ml per litre + 100 % RDF | 283.3 | 78.7 | 186.6 | 257.2 | 522.6 |
| $T_4$: GE 20.0 ml per litre + 50 % RDF | 251.7 | 33.9 | 133.7 | 226.4 | 394.0 |
| $T_5$: GE 20.0 ml per litre + 75 % RDF | 270.1 | 59.5 | 148.9 | 243.8 | 452.2 |
| $T_6$: GE 20.0 ml per litre + 100 % RDF | 285.5 | 80.7 | 190.4 | 259.3 | 530.3 |
| $T_7$: Urea spray - 0.5 % + 100 % RDF | 254.4 | 60.1 | 147.1 | 232.7 | 439.9 |
| $T_8$: Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P&K | 263.8 | 66.7 | 149.2 | 231.8 | 447.6 |
| $T_9$: Nano N&P two sprays at 30 and 60 DAS + 50% RDNP and 100% K | 274.3 | 70.0 | 153.0 | 244.5 | 467.5 |
| $T_{10}$: RDF with FYM | 278.6 | 72.8 | 170.0 | 252.5 | 495.4 |
| $T_{11}$: Only RDF | 267.9 | 66.0 | 158.5 | 230.1 | 454.6 |
| S.Em ± | 8.77 | 2.15 | 5.28 | 8.18 | 15.61 |
| C.D. at 5% | 25.90 | 6.34 | 15.59 | 24.12 | 46.05 |

**Table 4. Effect of foliar application of growth enhancer on yield attributes of maize**

| Treatments | Number of cobs plant$^{-1}$ | Cob length (cm) | Cob girth (cm) | Number of kernels cob$^{-1}$ | Kernels weight cob$^{-1}$ (g cob$^{-1}$) | Test weight (g) |
|---|---|---|---|---|---|---|
| $T_1$: GE 10.0 ml per litre + 50% RDF | 1.0 | 15.8 | 15.2 | 416.0 | 136.9 | 30.2 |
| $T_2$:GE 10.0 ml per litre + 75% RDF | 1.0 | 18.0 | 15.8 | 450.3 | 141.3 | 32.2 |
| $T_3$: GE 10.0 ml per litre + 100% RDF | 1.0 | 21.1 | 16.6 | 558.7 | 187.7 | 34.5 |
| $T_4$: GE 20.0 ml per litre + 50% RDF | 1.0 | 18.5 | 15.4 | 463.3 | 147.8 | 31.9 |
| $T_5$: GE 20.0 ml per litre + 75% RDF | 1.0 | 19.0 | 16.0 | 492.0 | 157.0 | 32.9 |
| $T_6$: GE 20.0 ml per litre + 100% RDF | 1.0 | 21.8 | 17.1 | 568.0 | 195.6 | 35.9 |
| $T_7$: Urea spray - 0.5 % + 100% RDF | 1.0 | 19.0 | 16.3 | 492.0 | 173.2 | 31.9 |
| $T_8$: Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P & K | 1.0 | 17.0 | 15.4 | 495.7 | 161.5 | 32.9 |
| $T_9$: Nano N & P two sprays at 30 and 60 DAS + 50% RDNP and 100% K | 1.0 | 20.6 | 16.1 | 525.7 | 164.5 | 33.7 |
| $T_{10}$: RDF with FYM | 1.0 | 19.7 | 16.5 | 538.0 | 177.0 | 34.28 |
| $T_{11}$: Only RDF | 1.0 | 15.8 | 14.5 | 472.3 | 147.8 | 31.2 |
| S.Em ± | 0 | 0.65 | 0.48 | 17.05 | 5.82 | 1.07 |
| C.D. at 5% | - | 1.93 | 1.42 | 50.28 | 17.19 | 3.16 |

**Table 5. Effect of foliar application of growth enhancer on kernel yield, stover yield and harvest index of maize**

| Treatments | Kernel yield (kg ha$^{-1}$) | Stover yield (kg ha$^{-1}$) | Harvest index |
|---|---|---|---|
| $T_1$: GE 10.0 ml per litre + 50% RDF | 4904 | 6822 | 0.41 |
| $T_2$: GE 10.0 ml per litre + 75% RDF | 5580 | 7394 | 0.43 |
| $T_3$: GE 10.0 ml per litre + 100% RDF | 7183 | 8289 | 0.46 |
| $T_4$: GE 20.0 ml per litre + 50% RDF | 4975 | 6953 | 0.42 |
| $T_5$: GE 20.0 ml per litre + 75% RDF | 5634 | 7417 | 0.43 |
| $T_6$: GE 20.0 ml per litre + 100% RDF | 7485 | 8556 | 0.47 |
| $T_7$: Urea spray - 0.5 % + 100% RDF | 5101 | 7100 | 0.42 |
| $T_8$: Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P & K | 5854 | 7133 | 0.45 |
| $T_9$: Nano N & P two sprays at 30 and 60 DAS + 50% RDNP and 100% K | 6182 | 7478 | 0.45 |
| $T_{10}$: RDF with FYM | 6418 | 7816 | 0.45 |
| $T_{11}$: Only RDF | 5926 | 7391 | 0.44 |
| S.Em ± | 376.67 | 255.6 | 0.02 |
| C.D. at 5% | 1111.19 | 754.1 | NS |

**Table 6. Economics of foliar application of growth enhancer in maize cultivation**

| Treatments | Cost of cultivation (₹ ha$^{-1}$) | Gross returns (₹ ha$^{-1}$) | Net returns (₹ ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|
| $T_1$: GE 10.0 ml per litre + 50 % RDF | 50943 | 97546 | 46603 | 1.91 |
| $T_2$:GE 10.0 ml per litre + 75 % RDF | 55608 | 110624 | 55016 | 1.99 |
| $T_3$: GE 10.0 ml per litre + 100 % RDF | 57273 | 141175 | 83902 | 2.46 |
| $T_4$: GE 20.0 ml per litre + 50 % RDF | 55486 | 98991 | 43504 | 1.78 |
| $T_5$: GE 20.0 ml per litre + 75 % RDF | 57151 | 111646 | 54495 | 1.95 |
| $T_6$: GE 20.0 ml per litre + 100 % RDF | 58816 | 147029 | 88213 | 2.50 |
| $T_7$: Urea spray - 0.5 % + 100 % RDF | 52129 | 101469 | 49340 | 1.95 |
| $T_8$: Nano N two sprays at 30 and 60 DAS + 50% RDN and 100% P&K | 56287 | 115432 | 59145 | 2.05 |
| $T_9$: Nano N&P two sprays at 30 and 60 DAS + 50% RDNP and 100% K | 55224 | 121845 | 66621 | 2.21 |
| $T_{10}$: RDF with FYM | 55730 | 126359 | 70629 | 2.27 |
| $T_{11}$: Only RDF | 47730 | 117022 | 69292 | 2.45 |

## 4. CONCLUSION

Based on the results of the experiment, it can be concluded that the application of the growth enhancer (GE) at a rate of 20 ml per liter of water, combined with 100% recommended dose of fertilizer (RDF), resulted in significantly better outcomes compared to all other treatments.

- Plant growth: The treatment with GE 20 ml per litre + 100% RDF showed a significantly higher plant height, indicating better overall growth.
- Dry matter accumulation: The same treatment led to higher dry matter accumulation in leaves, stem, cob, and total dry matter, indicating increased biomass production and potential for better crop yields.
- Cob characteristics: The treatment with GE 20 ml per litre + 100% RDF resulted in longer and thicker cobs, indicating improved cob development.
- Kernel yield: The treatment showed higher numbers of kernels per cob and higher kernel weight per cob, indicating increased kernel yield.
- The application of GE 20 ml per liter + 100% RDF resulted in higher economic returns such as gross returns, net returns and the benefit-cost ratio suggesting that this treatment was economically more efficient.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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