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Effect of Gibberellic acid and magnesium on growth and yield of maize (*Zea mays* L.)

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Abstract

A field experiment was conducted during *kharif* season 2025 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Sciences and Technology. To determine “Effect of Gibberellic acid and Magnesium on Growth and Yield of Maize (*Zea mays* L.)”. The experiment was laid out in RBD with 10 treatment and replicated thrice. The result revealed that Treatment-T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha) recorded significantly taller plant height (187.12 cm), maximum plant dry weight (106.63 g) and yield attributing parameters higher number of cobs/plant (2.7), number of row/cob (17.5) and maximum number of grains/row (45.13), higher cob length (20.13 cm), grain yield (6.33 t/ha), cob yield (8.86 t/ha), stover yield (15.01 t/ha) were recorded in Treatment-T₉ (Gibberellic acid 75 ppm + Magnesium 25 kg/ha), was found to be productive as well as economically feasible. Maximum gross return (INR 2, 38, 970.00/ha), net return (INR 1, 58, 920.00/ha) and B:C (1.99) were also recorded in Treatment 9 (Gibberellic acid 75 ppm + Magnesium 25 kg/ha).

Keywords: Maize, economics, growth. Gibberellic acid, magnesium, and yield

Introduction

Maize (*Zea mays* L.) is a vital grain crop cultivated globally, which ranks third after wheat and rice. Its consumption in Egypt is primarily for human food, livestock and poultry feed, and raw materials for industrial products, such as, oil and starch. The main environmental factors that limit crop productivity worldwide include salinity, drought, and nutrient imbalance. Plant Growth regulators (PGR), such as, gibberellic acid (GA₃) and mepiquat chloride (M.C), reduce the dramatic impacts of salinity and drought on crop growth and yield. This experiment sought to verify the influence of foliar spray application of GA₃ and M.C as growth regulators on the growth metrics, chemical components, and maize harvest cultivated in calcareous soil under salinity during the summer of 2021 and 2022, respectively. Nowadays, phytohormones have been found to play an important role in plants development. Plant growth regulators have plentiful applications in agriculture such as delaying or accelerating maturity, stimulation, flowering, abscission, controlling weeds and so on. Gibberellins induce flowering in long-day plants which require chilling (Harkess & Lyons, 1994) [1].

Gibberellic acid (GA₃) has been extensively studied for its role in enhancing plant growth under both normal and stress conditions. It is involved in the regulation of gene expression, enzyme synthesis, and cell elongation. According to Islam *et al.* (2014) [2], exogenous application of GA₃ significantly increased plant height, leaf area index, and dry matter accumulation in maize. This increase in vegetative growth ultimately leads to improved yield components such as cob length, number of grains per cob, and grain weight. Furthermore, GA₃ plays a significant role in improving seed germination and early seedling vigor. It activates hydrolytic enzymes such as α -amylase, which convert stored starch into soluble sugars, providing energy for seedling growth. Mousavi and Arefi (2012) [3] reported that the application of gibberellic acid enhanced germination percentage and seedling growth in maize, resulting in better crop establishment. In addition to its growth-promoting effects, GA₃ also helps plants to tolerate abiotic stresses such as salinity and drought. It enhances antioxidant enzyme activity, reduces oxidative damage, and maintains cellular homeostasis under stress conditions.

Navya *et al.* (2021) ^[4] observed that foliar application of GA₃ improved chlorophyll content, relative water content, and overall plant health under stress conditions, leading to better yield performance.

Magnesium is key component of several biological processes (CO₂) fixation photosynthesis, photophosphorylation, protein and chlorophyll synthesis, phloem loading, and translocation of assimilates) in leaves (Cakmak and Yazici, 2010) ^[5]. The photosynthetic assimilates from leaves are transported to the sink organs (such as roots, shoot tips, and seeds), and stored as starch or converted to hexoses to increase crop yield under sufficient Mg status. Sucrose transport from source to sink tissues occurs through phloem by invertase and sucrose synthase enzymes. Hence, appropriate Mg concentration in leaves is essential to ensure activities of enzymes involved in source to-sink transport of Mg and sugars, which can be achieved by planting proper species as well as managing Mg fertilizer rates (White and Broadley, 2009) ^[6]. Mg²⁺ and closely related sugar production in leaves are of utmost importance for biomass accumulation and grain development. Mg²⁺ also promotes assimilate partitioning and translocation to source tissues. Magnesium is a component of the chlorophyll molecule. Therefore, it is essential for photosynthesis. As might be expected, plants that are deficient in Mg have an overall light green color. Despite the well-known role of Mg for various critical functions, there is surprisingly little research activity on the role of Mg nutrition in crop production and quality. Hence, Mg is often considered a “forgotten element”. However, Mg deficiency is increasingly becoming an important limiting factor in intensive crop production systems, especially in soils fertilized only with N, P, and K. In particular, Mg depletion in soils is a growing concern for high-productivity agriculture. Based on the above perspectives, the present investigation was carried to find out the “Effect of Gibberellic acid and Magnesium on the growth and yield of maize”. Similarly, Dixit *et al.* (2018) ^[15] observed that the application of micronutrients along with growth regulators resulted in better plant growth, higher chlorophyll content, and improved yield. This indicates that the interaction between plant hormones and nutrients plays a crucial role in determining crop performance. Along with plant growth regulators, mineral nutrition is a key factor in determining crop productivity. Magnesium (Mg) is an essential secondary macronutrient required for various physiological and biochemical functions in plants. It is the central atom of the chlorophyll molecule and plays a vital role in photosynthesis. Magnesium is also involved in enzyme activation, protein synthesis, and energy transfer reactions. According to Marschner (2012) ^[12], magnesium is indispensable for plant growth as it participates in several metabolic processes, including ATP formation and carbohydrate metabolism.

Materials and Methods

This experiment was carried out during kharif 2025 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. This area situated on the right side of the Yamuna River by the side of Allahabad Rewa Road about 5 km away

from Prayagraj city. All the facilities required for crop cultivation were met out from the department. thrice. The plot size of each treatment was 3m x 3m. The factors are Gibberellic acid (25 ppm, 50 ppm, 75 ppm) and (Magnesium-5 kg/ha, 15 kg/ha, 25 kg/ha). The treatment combinations are T₁, Gibberellic acid 25 ppm + Magnesium 5 kg/ha, T₂ Gibberellic acid 25 ppm + Magnesium 15 kg/ha, T₃. Gibberellic acid 25 ppm + Magnesium 25 kg/ha, T₄., Gibberellic acid 50 ppm + Magnesium 5 kg/ha, T₅., Gibberellic acid 50 ppm + Magnesium 15 kg/ha, T₆ Gibberellic acid 50 ppm + Magnesium 25 kg/ha, , T₇., Gibberellic acid 75 ppm + Magnesium 5 kg/ha, T₈., Gibberellic acid 75 ppm + Magnesium 15 kg/ha, T₉., Gibberellic acid 75 ppm + Magnesium 25 kg/ha, T₁₀., (Control) NPK-120-60-40 kg/ha, . Maize Seeds were sown in line manually. Seeds were covered with soil immediately after sowing. The Maize crop was sown on 21 July 2025. Harvesting was done by taking 1 m² area from each. And from it five plants were randomly selected for recording growth and yield parameters. The observations were recorded for plant height, dry weight, crop growth rate, relative growth rate, cob length (cm), Number of cobs/plants, Number of grains/rows, Number of row/cobs, grain yield(t/ha), cob yield(t/ha), stover yield(t/ha) harvest index. The data was subjected to statistical analysis by Analysis of variance method. Economics was calculated viz., cost of cultivation, gross return, net return, benefit cost ratio were calculated.

Results and Discussion

Plant Height (cm): The Plant height of Maize was observed from 20 DAS to 100 DAS and plant height was observed at 100 DAS. Effect of Gibberellic acid and Magnesium on increasing plant height was observed among the treatments. The significantly higher plant height (187.12 cm) was recorded in treatment T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha) and the However, T₈ were found statically at par with T₉ (Gibberellic acid 75ppm and Magnesium 25 kg/ha). lowest value (118.81 cm) in the treatment T₁ (Gibberellic acid 25 ppm and Magnesium 5 kg/ha).

Significant taller plant height was observed with the application of Gibberellic acid as it a crucial component of protein and chlorophyll and also involved in cell division and enlargement directly contributing to increased plant height. Similar findings were also reported by Navya *et al.* (2021) ^[4]. Further optimum spacing increased plant height which might be due to the effect of utilization of water and nutrient which results in cell division, elongation and expansion due to spacing.

Similarly, the application of magnesium also contributed significantly to increased plant dry weight. Magnesium is a central component of chlorophyll and plays a vital role in photosynthesis, thereby enhancing carbohydrate synthesis and translocation within the plant. It also acts as an activator of several enzymes involved in energy metabolism and protein synthesis, leading to improved vegetative growth and biomass accumulation (Cakmak and Yazici, 2010; White and Broadley, 2009) ^[5, 6].

Plant dry weight (g/plant): The Plant dry weight of Maize was observed from 20 DAS to 100 DAS and plant dry

weight was observed at 100 DAS. Effect of Gibberellic acid and Magnesium on increasing plant dry weight was observed among the treatments. The significantly higher plant dry weight (106.63 g) was recorded in treatment T₉ (Gibberellic acid 75ppm and Magnesium 25 kg/ha) and the However, T₇ and T₈ were found statically at par with T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha). the lowest value (80.21 g) in the treatment T₁ (Gibberellic acid 25 ppm and Magnesium 5 kg/ha).

Increased plant population due to closer spacing and double seedlings/hill increased the plant dry matter production. Improvement of leaves might have increased the photosynthetic efficiency of Maize and have induced to produce more plant dry matter production This was in accordance with the earlier findings of Islam *et al.* (2014)^[2]. Magnesium plays a crucial role in chlorophyll synthesis, photosynthesis and enzyme activation, which enhances carbohydrate production and translocation, resulting in increased dry matter accumulation and biomass production (Mengel and Kirkby, 2001)^[18].

Yield attributes and Yield

No. of cob/plant: There was significant difference among different treatments. Significant maximum No. of cob/plant as influenced by different treatment combination between Gibberellic acid and Magnesium was recorded in T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha) with (2.7). However, T₈, were found statically at par with T₉ (Gibberellic acid 75ppm and Magnesium 25 kg/ha).

Maximum no. of cobs/plant might be due to application of Gibberellic acid increases the fertility of flowers and increase in leaf area and duration and resulted into increase in supplying assimilates for the sink (Navya *et al.* (2021)^[4].

Cob length (cm): There was significant difference among different treatments. Significant maximum Cob length as influenced by different treatment combination between Gibberellic acid and Magnesium was recorded in T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha) with (20.13 cm). However, T₇ and T₈ were found statically at par with T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha). Higher length of cob might be due to application of Gibberellic acid increases the fertility of flowers and increase in leaf area and duration and resulted into increase in supplying assimilates for the sink (Mousavi SGR, Arefib R. 2012)^[3].

Also, these results are in confirmatory with the finding of Bhutada *et al.* (2019)^[14] and Dixit *et al.* (2005)^[7].

No. of grains/row: There was significant difference among different treatments. Significant maximum No. of grains/row as influenced by different treatment combination between Gibberellic acid and Magnesium was recorded in T₉ (Gibberellic acid 75ppm and Magnesium 25 kg/ha) with (45.13). However, T₈ were found statically at par with T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha).

Significant and maximum number of grains/rows was observed with the application of Gibberellic acid resulting in greater meristematic activities and growth thereby improvement in plant growth and yield attributes particularly number of grains/row (Gadi *et al.* (2017)^[16].

Further, significant and maximum number of grains/row was observed with optimum Magnesium which might be due to plant Magnesium with 25 kg/ha provides favorable microclimate to crop for Optimal utilization of available moisture, nutrient and its early adoption leads to better partitioning of sugars to reproductive parts there by recording better growth and yield attributes.

Grain yield (t/ha): Significant and higher grain yield (6.33 t/ha) was recorded in treatment 9 [Gibberellic acid 75 ppm and Magnesium 25 kg/ha]. However, treatment 8 [Gibberellic acid 75 ppm and Magnesium 15 kg/ha], and treatment 10 [RDF120-60-40 N-P-K kg/ha] were statistically at par with Treatment 9[Gibberellic acid 75 ppm and Magnesium 25 kg/ha].

Significant and higher grain yield was observed with the application of Gibberellic acid has direct role in protein synthesis and is also a structural component in protein structure and thus results in higher grain yield. in Maize. Further, Significant and higher grain yield was observed with the adoption of optimum Magnesium which might be due to its Wider spacing and adequate supply of plant nutrient helps in better photosynthesis and growth of finger millet which helps in higher grain yield in Maize. (Gadi *et al.* (2017)^[16]

Stover Yield (t/ha): Significant and higher stover yield (15.01 t/ha) was recorded in treatment 9 [Gibberellic acid 75ppm and Magnesium 25 kg/ha]. However, T₈ were statistically at par with Treatment 9 [Gibberellic acid 75ppm and Magnesium 25 kg/ha].

Significant and higher stover yield was observed with the application of Gibberellic acid which might be due to its role in enzyme activity and Gibberellic acid metabolism produced significantly higher protein yield over control. The variations in protein yield were largely associated with grain and stover yield Kumawat *et al.* (2010)^[17]. Further, Significant and higher stover yield was observed with optimum Magnesium which might be due to its role increased grain yield and stover yield may be due to the cumulative effect of increased translocation to the sink, resulting in higher levels of yield components.

Harvest index (%): There was no significant difference among the treatments statistically highest harvest index (38.10%) was recorded in treatment 9 [Gibberellic acid 75 ppm and Magnesium 25 kg/ha].

Economic analysis: The Highest benefit cost ratio (1.99) was recorded in T₉ (Gibberellic acid 75 ppm and Magnesium 25 kg/ha) as compared to other treatments.

Table 1: Effect of Gibberellic acid and Magnesium on growth attributes of Maize (*Zea mays* L.).

S.N.	Treatments	Plant Height (cm)	Dry Weight (g/plant)
1	Gibberellic acid 25 ppm + Magnesium 5 kg/ha	118.81	80.21
2	Gibberellic acid 25 ppm + Magnesium 15 kg/ha	126.45	84.86
3	Gibberellic acid 25 ppm + Magnesium 25 kg/ha	155.60	88.02
4	Gibberellic acid 50 ppm + Magnesium 5 kg/ha	157.93	89.89
5	Gibberellic acid 50 ppm + Magnesium 15 kg/ha	162.90	94.94
6	Gibberellic acid 50 ppm + Magnesium 25 kg/ha	165.40	96.83
7	Gibberellic acid 75 ppm + Magnesium 5 kg/ha	168.80	100.64
8	Gibberellic acid 75 ppm + Magnesium 15 kg/ha	173.06	103.47
9	Gibberellic acid 75 ppm + Magnesium 25 kg/ha	187.12	106.63
10	RDF (120-60-40 kg/ha N-P-K Control)	129.70	82.87
F-Test		S	S
S.Em (±)		7.54	2.69
CD (p = 0.05)		22.41	7.98

Table 2: Effect of Gibberellic acid and Magnesium on yield attributes and yield of Maize (*Zea mays* L.).

S. No.	Treatments	Number of cobs/plant	Number of row/cob	Number of grain/row	Cob length (cm)	Cob yield (t/ha)	Grain yield (t/ha)	Stover yield (t/ha)	HI (%)
1	Gibberellic acid 25 ppm + Magnesium 5 kg/ha	1.3	13	31.46	15.57	4.69	6.57	10.94	31.14
2	Gibberellic acid 25 ppm + Magnesium 15 kg/ha	1.7	14	33.4	16.3	4.84	6.78	11.78	31.50
3	Gibberellic acid 25 ppm + Magnesium 25 kg/ha	1.3	14.9	35.27	17.2	5.05	7.07	12.89	32.30
4	Gibberellic acid 50 ppm + Magnesium 5 kg/ha	1.4	15.7	35.33	17.6	5.25	7.35	13.37	33.25
5	Gibberellic acid 50 ppm + Magnesium 15 kg/ha	1.5	15.8	36.6	18.5	5.47	7.66	13.75	33.55
6	Gibberellic acid 50 ppm + Magnesium 25 kg/ha	1.6	16	38.67	18.53	5.66	7.92	14.30	34.04
7	Gibberellic acid 75 ppm + Magnesium 5 kg/ha	2.3	16.9	39.47	19.4	6.03	8.44	14.75	34.21
8	Gibberellic acid 75 ppm + Magnesium 15 kg/ha	2.5	17.2	40.53	19.67	6.17	8.64	14.98	36.83
9	Gibberellic acid 75 ppm + Magnesium 25 kg/ha	2.7	17.5	45.13	20.13	6.33	8.86	15.01	38.10
10	RDF (120-60-40 kg/ha N-P-K Control)	1.7	12.9	30.47	16.2	3.01	4.21	8.02	31.20
	F-Test	S	S	S	S	S	S	S	NS
	S.Em(±)	0.10	0.14	1.06	0.52	0.05	0.25	0.31	1.27
	CD (p = 0.05)	0.30	0.42	3.15	1.55	0.26	0.75	1.75	-

Table 3: Effect of Gibberellic acid and Magnesium on economic of production of Maize (*Zea mays* L.).

S. No	Treatment combination	Cost of Cultivation (INR/ha)	Gross return (INR/ha)	Net Return (INR/ha)	B:C ratio
1.	Gibberellic acid 25 ppm + Magnesium 5 kg/ha	59700	167260	107560	1.80
2.	Gibberellic acid 25 ppm + Magnesium 15 kg/ha	63900	175060	111160	1.74
3.	Gibberellic acid 25 ppm + Magnesium 25 kg/ha	69450	185650	116200	1.67
4.	Gibberellic acid 50 ppm + Magnesium 5 kg/ha	71850	198130	126280	1.76
5.	Gibberellic acid 50 ppm + Magnesium 15 kg/ha	73750	194750	121000	1.64
6.	Gibberellic acid 50 ppm + Magnesium 25 kg/ha	76500	207340	130840	1.71
7.	Gibberellic acid 75 ppm + Magnesium 5 kg/ha	78750	218470	139720	1.77
8.	Gibberellic acid 75 ppm + Magnesium 15 kg/ha	79900	222980	143080	1.79
9.	Gibberellic acid 75 ppm + Magnesium 25 kg/ha	80050	238970	158920	1.99
10	RDF (120-60-40 kg/ha N-P-K Control)	40658.2	84169.91	71681.8	1.76

Conclusion

It is concluded that for obtaining higher yield components with better quality of Maize, application of Gibberellic acid 75 ppm and Magnesium 25 kg/ha was recorded significantly higher plant height (187.12 cm), maximum plant dry weight (106.63 g/plant), and yield attributing parameters higher number of cobs/plant (2.7), number of row/cob(17.5), cob length (20.13 cm) higher cob yield (6.33 t/ha), and maximum number of grains/row (45.13), higher grain yield (6.33 t/ha), higher stover yield (15.01 t/ha) and benefit cost ratio (1.99) as compared to other treatments. Since, the findings based on the research done in one season.

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Competing Interests

Authors have declared that no competing interests exist.

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