International Journal of Plant & Soil Science

Volume 35, Issue 7, Page 78-83, 2023; Article no.IJPSS.98022
ISSN: 2320-7035

Effect of Plant Growth Regulators and Zinc on Growth and Yield of Baby Corn (*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.

Article Information

DOI: 10.9734/IJPSS/2023/v35i72865

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/98022

Original Research Article

Received: 20/01/2023
Accepted: 23/03/2023
Published: 27/03/2023

ABSTRACT

The field experiment was conducted during *Zaid* mid of March – April 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The treatments consisted of three Plant growth regulators (Mepiquat chloride 180ppm, Naphthalene acetic acid 30ppm, Putrescine 40ppm) and three levels of Zinc sulphate (10, 20, 30 kg/ha $ZnSO_{4)}$ respectively. The experiment was laid out in randomized block design with ten treatments and were replicated thrice. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.48%) available N (171.48 kg/ha), available P (13.6 kg/ha) and available K (215.4 kg/ha). Results defined that maximum plant height (181.62 cm), dry weight (92.31 g/plant), Green fodder yield (32.7 t/ha) were significantly influenced

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with treatment-6 Naphthalene acetic acid 180ppm along with Zinc sulphate 30 kg/ha and Maximum No. of cobs/plant (3 cobs/plant), length of cob/plant (21.8 cm), girth of cob (9.3 cm), cob weight with husk (49.84 g), cob weight without husk (12.11 g), Cob yield (11.03 t/ha) were significantly influenced with the treatment-3 Mepiquat chloride 30ppm along with Zinc sulphate 30 kg/ha. Minimum parameters were recorded in treatment-10 control plot which is application of recommended dose of fertilizers 100:60:40 kg/ha NPK.

Keywords: Plant growth regulators; zinc levels; growth and yield; baby corn.

1. INTRODUCTION

"Baby corn (*Zea mays* L.) being one of the most important dual purpose crop is grown widely round the year for its cob as well as green fodder in India. It has an edge over the other cultivated fodder crops due to its higher production potential, wider adaptability, fast growing nature and excellent fodder quality free from toxicants. Baby corn production has been directly integrated with dairying farms in different countries because only 13-20% of fresh ear weight is used as human food and the rest (silk, husk and green stalk) can be used as excellent feed materials for milch ruminants to improve their productivity" [1]. "Baby corn is dehusked maize ear, harvested young especially when the silk have either not emerged or just emerged and no fertilization has taken place or we can say the shank with unpollinated silk is baby corn. Baby corn ears in light yellow colour with regular row arrangement, 10 to 12 cm long and a diameter of 1.0 to 1.5 cm arrangement are preferred in the market" [2]. "The economic product is harvested just after silk emergence (1 to 2 cm long). Currently, Thailand and China are the world leaders in baby corn production. In India, baby corn is being cultivated in Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka and Andhra Pradesh" [3]. "Recently baby corn has gained popularity in Uttar Pradesh, Haryana, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Rajasthan of India which is grown in 943 million hectares with the production of 24.35 million tonnes" [4].

"Plant growth regulators, also known as plant hormones, are organic compounds that regulate various aspects of plant growth and development. Maize crop growth and development is influenced by several plant growth regulators, including: Auxins, Gibberellins, cytokinin's, abscisic acid (ABA), and ethylene. NAA, being an auxin, promote vegetative growth by active cell division, cell enlargement and cell elongation and thus, helped in improving growth characteristics and in stimulating reproductive growth. NAA application significantly enhanced the fodder yield over other treatments. Increase in fodder yield due to NAA spray might be due to increase in plant height, leaf area index and total biomass, which might be due to increased cell division, cell enlargement and elongation. Growth regulators spray had positive influence on green cob yield of baby corn. The increase in yield due to mepiquat chloride spray has been attributed to increased yield attributes, which in turn resulted from effective translocation of photosynthesis from source to sink due to the shortening of distance between source and sink. Since mepiquat chloride is a growth retardant, it resulted in reduced plant height and dry matter production and finally reduction in fodder yield. Cob yield increases due to increased mobilization of reserve food materials to developing sink through increase in hydrolyzing and oxidizing enzyme activities" [2].

"Among field crops, Maize is highly susceptible to zinc deficiency and it can be used as an indicator plant for zinc deficiency. Maize occupies the third rank in demand for zinc next to rice and wheat, respectively" [4]. "Micronutrient deficiency in Indian soils has emerged as one of the essential constraints to crop productivity. Deficiency of micronutrients over the last three decades has grown in both, magnitude and extent due to current practices like increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity". (Manojlovic et al. 2019). "The rising micronutrient deficiencies more particularly of zinc (Zn) is claimed to be the major reason for the declining land and water productivity of crops" [1]. "Human dependence upon cereals with a poor Zn status, especially in developing countries, deepens the gap between the available amount, and the amount required for good health, which is 40–50 ppm" [5]. "Low dietary intake of Zn and very little dietary diversity appear to be the major reasons for the widespread occurrence of Zn deficiency in human populations" [6]. "Diets consumed predominantly in the developing world are based on cereals which are poor in the amount and bioavailability of Zn. Enrichment of cereal crops with Zn is, therefore, an important global challenge and a high-priority research area. Hence, if Zn-deficient soils are used for cultivating cereals, then their availability in the harvested produce is decreased to many folds. Therefore, it is essential to sustain a satisfactory level of Zn in the soil. In modern agriculture, keeping in mind status of the soil health, it is well recognized that application of micronutrients is in a need with macro nutrients. Most research on soil and foliar application of zinc focused on alleviating its deficiencies, particularly on wheat and rice cultivated in semiarid or arid regions of the world" [7,5].

2. MATERIALS AND METHODS

The experiment was conducted during the *Zaid* mid of March – April 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25^0 39" 42" N latitude, $81^0$67"56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the Yamuna River by the side of Prayagraj-Rewa road about 5 km from the city. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.48%) available N (171.48 kg/ha), available P (13.6 kg/ha) and available K (215.4 kg/ha). The experiment was laid out in randomized block design comprised of levels of Plant growth regulators and Zinc with ten treatments and each were replicated thrice viz. Application of Plant growth regulators at 30& 45 DAS and Zinc sulphate as basal dose. Observations were recorded 15 days interval (15,30,45,60 DAS). The collected data was subjected to statistical analysis by analysis of variance method [8]. T_1 (MC 180 ppm + $ZnSO_4$ 10 kg/ha), T_2 (MC 180 ppm + $ZnSO_4$ 20 kg/ha), T_3 (MC 180 ppm + $ZnSO_4$ 30 kg/ha), T_4 (NAA 30 ppm + $ZnSO_4$ 10 kg/ha), T_5 (NAA 30 ppm + $ZnSO_4$ 20 kg/ha), T_6 (NAA 30 ppm + $ZnSO_4$ 30 kg/ha), T_7 (Putrescine 40 ppm + $ZnSO_4$ 10 kg/ha), T_8 (Putrescine 40 ppm + $ZnSO_4$ 20 kg/ha), T_9 (Putrescine 40 ppm + $ZnSO_4$ 30 kg/ha), T_{10} (Control 100:60:40 kg/ha N P K).

3. RESULTS AND DISCUSSION

3.1 Growth Attributes of Baby Corn

3.1.1 Plant height

At 60 DAS treatment-6 Naphthalene acetic acid 30ppm with Zinc 30 kg/ha significantly got higher plant height (181.62 cm). However, treatment-9 Putrescine 40ppm along with zinc sulphate 30 kg/ha (178.58 cm) was found to be statistically par to treatment-6. Minimum plant height were observed in treatment-10 control (150.36 cm). "Enhancement in growth parameters with NAA application might be due to cell wall extensibility and cell wall loosening and increased cell division and elongation in the presence of endogenous GA" [2]. "Zinc involved directly and indirectly as co-enzyme in photosynthetic

Table 1. Effect of Plant growth regulators and Zinc levels on growth attributes of Baby Corn

S. No.	Treatment combinations	AT 60 DAS	
		Plant Height (cm)	Dry Weight (gm/plant)
1.	Mepiquat chloride 180 ppm + $ZnSO_4$ 10 kg/ha	157.18	78.25
2.	Mepiquat chloride 180 ppm + $ZnSO_4$ 20 kg/ha	161.40	80.59
3.	Mepiquat chloride 180 ppm + $ZnSO_4$ 30 kg/ha	166.84	86.05
4.	Naphthaleneacetic acid (NAA) 30 ppm + $ZnSO_4$ 10 kg/ha	172.67	80.91
5.	Naphthaleneacetic acid (NAA) 30 ppm + $ZnSO_4$ 20 kg/ha	175.16	86.64
6.	Naphthaleneacetic acid (NAA) 30 ppm + $ZnSO_4$ 30 kg/ha	181.62	92.31
7.	Putrescine 40 ppm + $ZnSO_4$ 10 kg/ha	165.53	82.06
8.	Putrescine 40 ppm + $ZnSO_4$ 20 kg/ha	169.39	83.75
9.	Putrescine 40 ppm + $ZnSO_4$ 30 kg/ha	178.58	90.49
10.	Control (100:60:40 kg/ha NPK)	150.36	75.55
	F-test	S	S
	SEm(±)	1.11	0.59
	CD (p=0.05%)	3.32	1.77

Table 2. Effect of Plant growth regulators and Zinc levels on Yield Attributes of Baby Corn

S. No.	Treatment combinations	Number of cobs per plant	Length of cob (cm)	Girth of cob (cm)	Cob weight with husk (gm)	Cob weight without husk (gm)
1.	Mepiquat chloride 180 ppm + $ZnSO_4$ 10 kg/ha	1.33	19.3	7.7	45.48	10.56
2.	Mepiquat chloride 180 ppm + $ZnSO_4$ 20 kg/ha	1.67	20.0	8.9	47.87	11.83
3.	Mepiquat chloride 180 ppm + $ZnSO_4$ 30 kg/ha	2.13	21.8	9.3	49.84	12.11
4.	NAA 30 ppm + $ZnSO_4$ 10 kg/ha	1.27	17.8	6.6	42.08	9.77
5.	NAA 30 ppm + $ZnSO_4$ 20 kg/ha	1.40	18.2	7.0	44.50	10.26
6.	NAA 30 ppm + $ZnSO_4$ 30 kg/ha	1.87	21.0	8.3	47.64	11.46
7.	Putrescine 40 ppm + $ZnSO_4$ 10 kg/ha	1.53	17.7	6.8	40.28	8.64
8.	Putrescine 40 ppm + $ZnSO_4$ 20 kg/ha	1.60	18.6	7.8	42.38	9.72
9.	Putrescine 40 ppm + $ZnSO_4$ 30 kg/ha	1.93	19.4	8.5	45.11	10.67
10.	Control (100:60:40 kg/ha NPK)	1.40	17.3	5.4	39.23	8.53
	F-test	S	S	S	S	S
	SEm (±)	0.13	0.39	0.36	1.16	0.54
	CD (p=0.05%)	0.38	1.16	1.09	3.45	1.63

Table 3. Effect of Plant growth regulators and Zinc levels on Yield of Baby Corn

S. No	Treatment Combinations	Cob yield (t/ha)	Green fodder yield (t/ha)
1.	Mepiquat chloride 180 ppm + $ZnSO_4$ 10 kg/ha	8.73	24.7
2.	Mepiquat chloride 180 ppm + $ZnSO_4$ 20 kg/ha	9.44	28.3
3.	Mepiquat chloride 180 ppm + $ZnSO_4$ 30 kg/ha	11.03	30.7
4.	NAA 30 ppm + $ZnSO_4$ 10 kg/ha	7.97	29.3
5.	NAA 30 ppm + $ZnSO_4$ 20 kg/ha	9.16	31.7
6.	NAA 30 ppm + $ZnSO_4$ 30 kg/ha	10.55	32.7
7.	Putrescine 40 ppm + $ZnSO_4$ 10 kg/ha	7.50	29.0
8.	Putrescine 40 ppm + $ZnSO_4$ 20 kg/ha	8.59	29.7
9.	Putrescine 40 ppm + $ZnSO_4$ 30 kg/ha	10.10	31.0
10.	Control (100:60:40 kg/ha NPK)	6.17	24.0
	F-test	S	S
	SEm (±)	0.16	0.66
	CD (p=0.05%)	0.48	1.98

process which provide substrate for growth and development which seemed to be the reason behind the favorable influence on all the growth attributes of baby corn" (Swathi et al. 2021). "Significant variation in the plant height is due to in time availability of the nutrients to the plant at the important growth stages and application of zinc has led to production of IAA resulting in increased plant height" [9].

3.1.2 Plant dry weight

At 60 DAS treatment-6 Naphthalene acetic acid 30ppm with Zinc 30 kg/ha shows Significantly higher plant dry weight (92.31 g/plant) in baby corn due to favorable increase in dry matter of baby corn through zinc involvement in auxin synthesis, photosynthetic activity of the crop. However, treatment-9 Putrescine 40ppm along with zinc sulphate 30 kg/ha (90.49 g) was found to be statistically par to treatment-6. Minimum plant height were observed in treatment-10 control (75.55 g). The present study is in accordance with the findings of Palai et al. (2018). Growth regulator application had significant influence on dry matter production (DMP) of baby corn at all growth stages. Baby corn sprayed with NAA @ 40 ppm produced higher values of growth parameters whereas Mepiquat chloride @ 200 ppm significantly reduced all growth parameters over other treatments [2].

3.1.3 Yield and Yield attributes

Maximum Number of cobs per plant (3 cobs/plant), cob length (21.8 cm), Girth of cob (9.3 cm), cob weight with husk (49.84 g/cob) and cob weight without husk (12.11 g/cob), Cob yield (11.03 t/ha) was significantly higher in Treatment 3 Mepiquat chloride 180ppm with Zinc 30 kg/ha. While treatment 6 Naphthalene acetic acid 30ppm with zinc 30 kg/ha got significantly higher green fodder yield (32.7 t/ha). Minimum parameters attain in the treatment-10 Control plot (Number of cobs per plant (2 cob/plant), cob length (17.3 cm), Girth of cob (5.4 cm), cob weight with husk (39.23 g/cob) and cob weight without husk (8.53 g/cob), Cob yield (6.17 t/ha), green fodder yield (24.0 t/ha)**.** Increase in corn yield might be due to favorable influence of applied zinc on physiological and metabolic process of the plants, which ultimately enhanced corn yield. "The increase in yield due to Mepiquat chloride spray might be due to increased yield attributes which in turn resulted from effective translocation of photosynthates from source to sink due to the shortening of distance between source and sink. Cob yield increased due to increased mobilization of reserve food materials to developing sink through increase in hydrolyzing and oxidizing enzyme activities. NAA application significantly enhanced the fodder yield over other treatments. Increase in fodder yield due to NAA spray might be due to increase in plant height, leaf area index and total biomass which might be due to increased cell division, cell enlargement and elongation" [2, 10-18].

4. CONCLUSION

From the results, it was concluded that with the application of Mepiquat chloride 180ppm + Zinc sulphate 30 kg/ha (treatment-3), has performs positively and improves better yield parameters. Maximum number of cobs per plant, length of cob, girth of cob, cob weight with husk, cob weight without husk, and cob yield with husk were recorded with the application of Mepiquat chloride 180ppm + Zinc sulphate 30 kg/ha (treatment-3). Minimum parameters were recorded in treatment-10 control plot which is application of recommended dose of fertilizers 100:60:40 kg/ha NPK.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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