Original Research Article

Effect of Phosphorus and Zinc on Growth and Yield of Baby corn (*Zea mays* L.)

Abstract

A field experiment was conducted during *Zaid* 2021/22 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: 50 kg/ha Phosphorus + 5 kg/ha Zinc, T_2: 50 kg/ha Phosphorus + 15 kg/ha Zinc, T_3: 50 kg/ha Phosphorus + 25 kg/ha Zinc, T_4: 60 kg/ha Phosphorus + 5 kg/ha Zinc, T_5: 60 kg/ha Phosphorus + 15 kg/ha Zinc, T_6: 60 kg/ha Phosphorus + 25 kg/ha Zinc, T_7: 70 kg/ha Phosphorus + 5 kg/ha Zinc, T_8: 70 kg/ha Phosphorus + 15 kg/ha Zinc, T_9: 70 kg/ha Phosphorus + 25 kg/ha Zinc are used. The results showed that application of 70 kg/ha Phosphorus + 25 kg/ha Zinc was recorded significantly Plant height (158.17 cm), Plant dry weight (105.37 g/plant), crop growth rate (18.17 $g/m^2/day$), Cobs/Plant (1.46), Length of Cob/plant (17.30 cm), Girth of Cob/plant (7.28 cm), Cob weight with husk (63.01 g), cob weight without husk (20.65 g), cob yield with husk (13.30 t/ha), Cob yield without husk (5.16 t/ha) was obtained in the treatment of 70 kg/ha Phosphorus + 25 kg/ha Zinc as compared to other treatments.

Key words: Phosphorus, Zinc, Growth and yield.

.

Introduction

Baby corn is the young, finger-length de-husked corn young ear of female inflorescence, harvested within 2-3 days of silk emergence but prior to fertilization and is crisp and sweet in taste**.** We can say the shank with un-pollinated silk is baby corn. Baby corn ears are light yellow colour with regular row arrangement, 10-12 cm long and a diameter of 1.0-1.2 cm are preferred in the market. Baby corn is a vegetable crop that can potentially improve the economic status of farmers. It is a profitable crop that allows a diversification of production, aggregation of value, and increased income (**Sadiq et al. 2007).** It is highly remunerative and farmers can get a high return in a short period of 45-60 days. Its short duration, adoptability in different cropping systems, suitability to cultivate in all the seasons and eco-friendly cultivation practices made it a special choice for cultivation in non-traditional corn growing areas. The other advantage of growing baby corn is its remaining biomass (green fodder) after harvesting **(Kar 2014).**

Phosphorus is the second important key element after nitrogen as a mineral nutrient in terms of quantitative plant requirement. Although abundant in soils, in both organic and inorganic forms, its availability is restricted as it occurs mostly insoluble forms. It is needed for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division, fat and albumen formation. Energy from photosynthesis and the metabolism of carbohydrates is stored in phosphate compounds for later use in growth and reproduction **(Arya et al. 2001)**.

Zinc deficiency is more prevalent in developing countries of the world **(Gibbson, 2006).** It is required for a number of metabolic processes. Therefore, Zn deficiency can result in a number of health problems like diarrhoea, low birth weight, and stunted growth in children **(Brown, 2003; Rivera et al., 2003)**. Recommended intake of dietary Zn ranges from 1.1 to 11.2 mg day-1 in children and 3.0–19.0 mg day-1 in adults **(FAO/WHO, 1996; Imtiaz et al., 2010).** Recent studies indicated that it is possible to increase Zn concentration in maize grain by either soil Zn application or seed priming with Zn in South Asia **(Harris et al., 2007; Hossain et al., 2008).** Maize seed priming with 1% $ZnSO_4$ not only enhanced plant growth but also increased the final grain yield and seed Zn contents in plants grown on soil with limited Zn availability.

Materials and Methods

The present examination was carried out during *Zaid* 2021/22 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: 50 kg/ha Phosphorus + 5 kg/ha Zinc, T_2: 50 kg/ha Phosphorus + 15 kg/ha Zinc, T_3: 50 kg/ha Phosphorus + 25 kg/ha Zinc, T_4: 60 kg/ha Phosphorus + 5 kg/ha Zinc, T_5: 60 kg/ha Phosphorus + 15 kg/ha Zinc, T_6: 60 kg/ha Phosphorus + 25 kg/ha Zinc, T_7: 70 kg/ha Phosphorus + 5 kg/ha Zinc, T_8: 70 kg/ha Phosphorus + 15 kg/ha Zinc, T_9: 70 kg/ha Phosphorus + 25 kg/ha Zinc are used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, plant dry weight are recorded. The yield parameters like No. of cobs/plant, Length of cob, Girth of cob, Cob weight, Cob yield were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height

Significantly highest plant height (158.17 cm) was observed in the treatment with 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the other treatments. However, the treatments with application of 60 kg/ha Phosphorus + 25 kg/ha Zinc (157.73 cm) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (157.54 cm) which were found to be statistically at par with treatment 70 kg/ha Phosphorus + 25 kg/ha Zinc.

Phosphorus encourage formation of new cells, promote plant vigour and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes, **Noonari *et al*. (2016)**.

Increase in plant height might be the involvement of micronutrients in different physiological processes like enzyme activation, electron transport, chlorophyll formation, stomatal regulation, etc. With the increase in levels of zinc the plant height gradually increased, which might be attributable to greater photosynthetic activity and chlorophyll synthesis due to zinc fertilization resulting into better vegetative growth. The results were in accordance to **Arab *et al.* (2018).**

Plant dry weight (g/plant)

Treatment with 70 kg/ha Phosphorus + 25 kg/ha Zinc was recorded with significantly maximum dry weight (105.37 g/plant) over all the treatments. However, the treatments with 60 kg/ha Phosphorus + 25 kg/ha Zinc (105.14 g/plant) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (104.65 g/plant) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

The plants attained more vigour with phosphorus, due to adequate supply and availability of nitrogen, phosphorus, potassium and spacing in balanced combination, resulting in increased dry weight of the plant. The application of Phosphorus 70 kg/ha to baby corn significantly increased dry matter production. The results were in accordance with **Hirpara *et al*. (2017).**

The highest of biomass increase was observed because of increasing levels of zinc. Although the application of zinc as basal dose to sweet corn increased its dry matter significantly, High dry matter in those treatments is due to long plant height, high stem girth, and high root weights **Palai *et al.* (2018).**

Yield attrubutes and Yield

Number of cobs/plant

Significantly Maximum cobs/plant (1.46) was recorded with the treatment of application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments 60 kg/ha Phosphorus + 25 kg/ha Zinc (1.41) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (1.37) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

Application of P increased the number of cobs per plant might be due to the enhanced early vegetative growth in terms of higher leaf area, dry matter accumulation and vigorous root system consequently increased the number of pod bearing branches significantly. Similar findings were observed by **Masood *et al*. (2011).**

Length of cob

Significantly Maximum Length of Cob/plant (17.30 cm) was recorded with the treatment of application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments 60 kg/ha Phosphorus + 25 kg/ha Zinc (17.15 cm) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (17.06 cm) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

Zinc plays a very important role in the metabolism of the plant process by influencing the activity of growth enzymes as well as it is involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, and regulation of auxin synthesis and pollen formation which resulted in higher number and length of cobs. The findings were found to be similar with **Anjum *et al.* (2017).**

Girth of cob

Significantly Maximum Girth of Cob/plant (7.28 cm) was recorded with the treatment of application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments 60 kg/ha Phosphorus + 25 kg/ha Zinc (7.18 cm) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (7.05 cm) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

Cob weight (g)

A) With husk

Significantly Maximum Cob weight (63.01 g) was recorded with the treatment of application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments 60 kg/ha Phosphorus + 25 kg/ha Zinc (62.84 g) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (62.49 g) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

B) Without husk

Significantly Maximum Cob weight (20.65 g) was recorded with the treatment of application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments 60 kg/ha Phosphorus + 25 kg/ha Zinc (20.39 g) and 70 kg/ha Phosphorus + 15 kg/ha Zinc (20.14 g) which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

Higher vigour and growth attained by the plants due to sufficient absorption of nutrients might have resulted in higher cob weight. The results were found to be similar with **Hadiya and Shah (2014).**

Production of photosynthates and their translocation to sink depends upon availability of mineral nutrients whose availability has increased the zinc uptake also. Most of the photosynthetic pathways are dependent on enzymes and co-enzymes, which are synthesized by mineral nutrients and application of zinc was caused by higher chlorophyll contents, synthesis of metabolites and growth-regulating substances, oxidation and metabolic activities and ultimately better growth and development of crop, which led to increase in yield attributes of baby corn. These results are in agreement with the findings **Arab *et al.* (2018)** and **Naik *et al.* (2020).**

Cob yield (t/ha)

a) With husk

Significantly highest Cob yield (13.30 t/ha) was recorded with the treatment application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments with

(13.16 t/ha) in 60 kg/ha Phosphorus + 25 kg/ha Zinc and with (13.09 t/ha) in 70 kg/ha Phosphorus + 15 kg/ha Zinc which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

a) Without husk

Significantly highest Cob yield (5.16 t/ha) was recorded with the treatment application of 70 kg/ha Phosphorus + 25 kg/ha Zinc over all the treatments. However, the treatments with (5.01 t/ha) in 60 kg/ha Phosphorus + 25 kg/ha Zinc and with (4.83 t/ha) in 70 kg/ha Phosphorus + 15 kg/ha Zinc which were found to be statistically at par with 70 kg/ha Phosphorus + 25 kg/ha Zinc.

The increase in cob yield due to phosphorus application is attributed to source and sink relationship. It appears that greater translocation of photosynthates from source to sink might have increased cob yield. Phosphorus increases yield due to its well-developed root system, increased N fixation and its availability to the plants and favourable environments in the rhizosphere. Similar results were found by **Hirpara *et al*. (2017).**

Application of Zinc to sweet corn crop generally improves fruit growth by synthesizing tryptophan and auxin. The enhancement effect on cobs/plant and their length and weight attributed to the favourable influence of the Zn application to crops on nutrient metabolism, biological activity and growth parameters and hence, applied zinc resulted in taller and higher enzyme activity which in turn encourage more cobs and resulted in higher cob yield. Similar finding were reported earlier by **Naik *et al.* (2020).**

CONCLUSION

It is concluded that application of treatment 70 kg/ha Phosphorus + 25 kg/ha Zinc was recorded significantly higher Cob yield (5.16 t/ha), as compared to other treatments. Since, the findings based on the research done in one season.

REFERENCES

Anjum, S. A., Saleem, M. F., Shahid, M., Shakoor, A., Safeer, M., Khan, I., Farooq, A., Ali, I. and Nazir, U. 2017. Dynamics of soil and foliar applied boron and zinc to improve maize productivity and profitability. *Pakistan Journal of Agricultural Research,* **30**(3): 294- 302.

Arab, G.M., Dina A. Ghazi and El-Ghamry, A.M. 2018. Effect of zinc application on maize grown on alluvial soils. *J. Soil Sci. and Agric. Eng., Mansoura Univ*. **9**(9): 419-426.

Arya, K.C. and Singh, S.N. 2001. Effect of different levels of phosphorus and zinc on yield and nutrients uptake of maize (*Zea mays* L.) with and without irrigation. *Indian J. Agri. Sci.,* **71**: 57-59.

Brown KH. Commentary: Zinc and child growth. *International Journal of Epidemiology*. 2003; **32**:1103- 1104.

Gibbson RS. Zinc: The missing link in combating micronutrient malnutrition in developing countries. Proceedings of the Nutrition Society. 2006; 65:51-60.

Hadiya V. H. and Shah K. A. 2014. Effect of Phosphorus and Potassium Management on Growth Attributes, Yield Attributes, Yields and Quality Parameters of Summer Sweet Corn. *Trends in Biosciences.,***11**(11): 2169-2173.

Harris D, Rashid A, Miraj G, Arif M, Shah H. 'On-farm' seed priming with zinc sulphate solution – a cost effective way to increase the maize yields of resource poor farmers. *Field Crops Research*. 2007; **102**:119-127.

Hirpara, D.V., Sakarvadia, H.L., Savaliya, C.M., Ranpariya, V.S. and Modhavadiya, V.L. (2017) Effect of different levels of boron and molybdenum on growth and yield of summer groundnut (*Arachis hypogaea* L.) under medium black calcareous soils of south Saurashtra region of Gujarat. *International Journal of Chemical Studies*, **5**(5), 1290-1293.

Hossain MA, Jahiruddin M, Islam MR, Mian MH. The requirement of zinc for improvement of crop yield and mineral nutrition in the maize–mung bean–rice system. *Plant and Soil*. 2008; 306:13-22

Imtiaz M, Rashid A, Khan P, Memo MY, Aslam M. The role of micronutrients in crop production and human health. *Pakistan Journal of Botany*. 2010; **42**(4):2565- 2578.

Kar, Ram V. Performance of baby corn under the influence of in situ green manuring and phosphorus in acid soil of Meghalaya. *Journal of crop and weed*. 2014;**10**(2):488-49.

Masood, T., R. Gul, F. Munsif, F. Jalal, Z. Hussain, N. Noreen, H. Khan, N. Din and H Khan. 2011. Effect of different phosphorus levels on the yield and yield components of maize. *Sarhad J. Agric*. **27**(2): 167-170.

Naik, C., Meena, M. K., Ramesha, Y. M., Amaregouda, A., Ravi, M. V. and Dhanoji, M. M. 2020. Morpho-physiological impact of growth indices to Biofortification on growth and yield of sweet corn (*Zea mays* L. *Saccharata*). *Bulletin of Environment, Pharmacology and Life Sciences*, **9**(3): 37-43.

Noonari, S., Ali, K. S., Ali, A., Amanullah, M., Raza, S., Munnesr, A., Fayaz, A. S. S., Ullah, B. S. (2016). Effect of Different levels of Phosphorus and Method of Application onGrowth and Yield of Wheat. *Natural Science.* Vol. **8**, pp:305-314.

Palai, J. B., Sarkar, N.C. and Jena, J. 2018. Effect of zinc on growth, yields, zinc use efficiency and economics in baby corn. *Journal of Pharmacognosy and Phytochemistry*, **7**(2): 1641-1645.

Rivera JA, Hotz C, Gozales-Cossio T, Neufeld L, GarciaGuerra, A. The effect of micronutrient deficiencies on child growth: A review of results from community-based supplementation trials. *Journal of Nutrition.* 2003; **133**:4010-4020.

Sadiq G, Khan AA, Inamullah Rab A, Fayyaz H, Naz G, Nawaz H et al. Impact of phosphorus and potassium levels on yield and yield components of maize. 2017;**6**(3):1071-1078.

Table 1: Effect of Phosphorus and Zinc on growth attributes of Baby corn

Sr.no	Treatments	Plant height (cm)	Dry weight (g/plant)
1.	50 kg/ha Phosphorus + 5 kg/ha Zinc	153.70	102.72
2.	50 kg/ha Phosphorus + 15 kg/ha Zinc	154.24	103.04
3.	50 kg/ha Phosphorus + 25 kg/ha Zinc	156.25	104.10
4.	60 kg/ha Phosphorus + 15 kg/ha Zinc	155.19	103.42
5.	60 kg/ha Phosphorus + 5 kg/ha Zinc	156.80	104.26
6.	60 kg/ha Phosphorus + 25 kg/ha Zinc	157.73	105.14
7.	70 kg/ha Phosphorus + 5 kg/ha Zinc	155.84	103.71
8.	70 kg/ha Phosphorus + 15 kg/ha Zinc	157.54	104.65
9.	70 kg/ha Phosphorus + 25 kg/ha Zinc	158.17	105.37
	F- test	S	S
	S Em (±)	0.26	0.25
	C D (P = 0.05)	0.77	0.74

Table 2. Effect of Phosphorus and Zinc on Yield attributes and Yield of Baby corn

Sr.no	Treatments	No. of Cobs/plant	Length of Cob/plant (cm)	Girth of Cob/plant (cm)	Cob weight (g)		Cob yield (t/ha)	
					With Husk	Without Husk	With Husk	Without Husk
1.	50 kg/ha Phosphorus + 5 kg/ha Zinc	1.12	15.66	5.79	60.93	17.63	11.75	3.73
2.	50 kg/ha Phosphorus + 15 kg/ha Zinc	1.16	15.90	6.07	60.75	18.42	12.03	3.93
3.	50 kg/ha Phosphorus + 25 kg/ha Zinc	1.29	16.54	6.60	61.78	19.47	12.72	4.48
4.	60 kg/ha Phosphorus + 5 kg/ha Zinc	1.21	16.09	6.18	61.06	18.79	12.28	4.14
5.	60 kg/ha Phosphorus + 15 kg/ha Zinc	1.33	16.86	6.84	62.20	19.78	12.88	4.60
6.	60 kg/ha Phosphorus + 25 kg/ha Zinc	1.41	17.15	7.18	62.84	20.39	13.16	5.01
7.	70 kg/ha Phosphorus + 5 kg/ha Zinc	1.25	16.25	6.43	61.42	19.17	12.48	4.30
8.	70 kg/ha Phosphorus + 15 kg/ha Zinc	1.37	17.06	7.05	62.49	20.14	13.09	4.83
9.	70 kg/ha Phosphorus + 25 kg/ha Zinc	1.46	17.30	7.28	63.01	20.65	13.30	5.16
	F test	**S**	**S**	**S**	**S**	**S**	**S**	**S**
	S Em (±)	0.03	0.08	0.09	0.21	0.18	0.07	0.12
	CD (P = 0.05)	0.09	0.25	0.28	0.63	0.55	0.21	0.36