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Effect of phosphorus and zinc on yield and economics of baby corn (*Zea mays* L.)

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Abstract
A field experiment was conducted during *Zaid* 2021 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 higher 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). However, gross returns (Rs.95303.33/ha), net return (Rs.64363.21/ha) and benefit cost ratio (2.08) was obtained in the treatment of 70 kg/ha Phosphorus + 25 kg/ha Zinc as compared to other treatments.

Keywords: Economics**,** phosphorus, zinc, 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) [17]**.** 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) [12].

Baby corn consists of utilizing husk, silk, and Stover as green herbage for feeding ruminants and swine; only 13 to 20% of fresh ear weight is for human use (Raskar *et al.*, 2012) [15]. The baby corn is highly nutritious and its nutritive value is comparable with several high priced vegetables like cauliflower, cabbage, French beans, spinach, lady finger, tomato, radish etc. It is a low caloric, low cholesterol and high fibre product which is free from residual effect of pesticides because it is harvested as young cob wrapped up tightly with husk and well protected from disease and insect pest attack. Further nutritious green fodder is the most valuable by-product of baby corn crop.

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) [3]. It is readily translocated within the plants, moving from older to younger tissues as the plant forms cells and develops roots, stems and leaves.

Adequate Phosphorus results in rapid growth and earlier maturity and improves the quality of vegetative growth. Phosphorus deficiency is responsible for crooked and missing rows as kernel twist and produce small ears nubbins in maize.
Zinc deficiency is more prevalent in developing countries of the world (Gibbson, 2006) [5]. It is required for a number of metabolic processes. Therefore, Zinc 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) [4, 16]. Recommended intake of dietary Zinc 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) [11]. Recent studies indicated that it is possible to increase Zinc concentration in maize grain by either soil Zinc application or seed priming with Zinc in South Asia (Harris *et al*., 2007; Hossain *et al*., 2008) [8, 10]. Maize seed priming with 1% ZincSO4 not only enhanced plant growth but also increased the final grain yield and seed Zinc contents in plants grown on soil with limited Zinc availability.

Materials and Methods

A field experiment was conducted during *Zaid* season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25º 24' 42" N latitude, 81º 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of Phosphorus and Zinc in yield and Economics of Baby corn. The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m. The treatment are categorized as with recommended dose of nitrogen through urea and potash through Muriate of Potash, in addition with Phosphorus through DAP and Zinc through $ZincSO_4$ where applied in combinations as follows, 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. The crop was harvested treatment wise at harvesting maturity stage and after harvesting the cobs were separated from each net plot. The yield was calculated per ha and computed and expressed in tonnes per hectare. The data was computed and analysed by following statistical method of Gomez and Gomez (1984). The benefit cost ratio was worked after price value of cobs yield and total cost included in crop cultivation.

Results and Discussion

The Yield and Yield parameters of Baby corn were tabulated in Table 1

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 cobs bearing branches significantly. Similar findings were observed by Masood *et al*. (2011) [13].

Length of Cob/plant (cm)

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) [1].

Girth of Cob/plant (cm)

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) [7]. 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) [2] and Naik *et al.* (2020) [14].

Cob yield (t/ha)

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.

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) [9]. 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 Zinc 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) [14].

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

S. 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
10	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

Economics

Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments were present in Table 2.

Higher Gross returns have been recorded with the 70 kg/ha Phosphorus + 25 kg/ha Zinc (Rs.95303.33/ha) over rest of the treatments followed by 60 kg/ha Phosphorus + 25 kg/ha Zinc (Rs.90180.00/ha) whereas minimum gross return was recorded with 50 kg/ha Phosphorus + 5 kg/ha Zinc (Rs.64151.66/ha).

Higher Net returns have been recorded with the treatment 70 kg/ha Phosphorus + 25 kg/ha Zinc (Rs.64363.21/ha) over rest of the treatments followed by 60 kg/ha Phosphorus + 25 kg/ha Zinc (Rs.59802.38/ha) whereas minimum Net returns was recorded with 50 kg/ha Phosphorus + 5 kg/ha Zinc (Rs.35852.47/ha).

Higher Benefit cost ratio have been recorded with the treatment 70 kg/ha Phosphorus + 25 kg/ha Zinc (2.08) over rest of the treatments followed by 60 kg/ha Phosphorus + 25 kg/ha Zinc (1.97) whereas lower Benefit cost ratio was recorded with 50 kg/ha Phosphorus + 5 kg/ha Zinc (1.27).

Table 2: Effect of Phosphorus and Zinc on Economics of Baby corn.

Sr. No	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
1.	50 kg/ha Phosphorus + 5 kg/ha Zinc	28299.19	64151.66	35852.47	1.27
2.	50 kg/ha Phosphorus + 15 kg/ha Zinc	29057.55	67483.33	38425.78	1.32
3.	50 kg/ha Phosphorus + 25 kg/ha Zinc	29815.12	80640.00	50824.88	1.70
4.	60 kg/ha Phosphorus + 5 kg/ha Zinc	28861.69	71140.00	42278.31	1.46
5.	60 kg/ha Phosphorus + 15 kg/ha Zinc	29620.05	82800.00	53179.95	1.80
6.	60 kg/ha Phosphorus + 25 kg/ha Zinc	30377.62	90180.00	59802.38	1.97
7.	70 kg/ha Phosphorus + 5 kg/ha Zinc	29424.19	77400.00	47976.81	1.63
8.	70 kg/ha Phosphorus + 15 kg/ha Zinc	30182.55	87000.00	56817.45	1.88
9.	70 kg/ha Phosphorus + 25 kg/ha Zinc	30940.12	95303.33	64363.21	2.08

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), higher gross returns (Rs.95303.33/ha), net return (Rs.66363.21/ha) and benefit cost ratio (2.08) as compared to other treatments. 70 kg/ha Phosphorus + 25 kg/ha Zinc may be more preferable and can be recommended to the farmers.

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