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Effect of phosphorous and zinc on growth and yield of field pea (*Pisum sativum* L.)

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Abstract
A field experiment was conducted Effect of phosphorus and zinc on growth and yield of field pea (*Pisum* sativum) during the *rabi* season of 2021-22 with 9 treatments (*viz*., P at 55, 60, 65kg/ha respectively and Zn at 10, 15, 20 kg/ha respectively) at the CRF (Crop Research Farm) SHIATS, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The treatments comprised T1 – 55 kg P/ha + 10 kg Zn/ha, T2 – 55 kg P/ha + 15 kg Zn/ha, T3 – 55 kg P/ha + 20 kg Zn/ha, T4 – 60 kg P/ha + 10 kg Zn/ha, T5 – 60 kg P/ha + 15 kg Zn/ha, T6 – 60 kg P/ha + 20 kg Zn/ha, T7 – 65 kg P/ha + 10 kg Zn/ha, T8 – 65 kg P/ha + 15 kg Zn/ha, T9 – 65 kg P/ha + 20 kg Zn/ha. Application of 65 kg P/ha + 20 kg Zn/ha recorded highest plant height (94.16 cm), plant dry weight (15.28 g/plant), number of branches/plant (9.56), number of pods/plant (20.09), length of pod (7.34 cm), seed index (126.08 g), seed yield (2.41 t/ha), stover yield (3.33 t/ha), gross returns (144600 INR/ha), net returns (99910 INR/ha) and B:C ratio (2.23).

Keywords: Economics, growth, field pea, phosphorus, zinc, yield

Introduction
Pea is one of the six major pulse crops cultivated globally and it is second highest yielding legume in the world after common bean (*Phaseolus vulgaris*) (FAO, 2010). Field pea is an important pulse crop in India, covering an area of 0.498 million ha with production of 4.81 million tones (Anonymous, 2017). Field pea (*Pisum sativum*) is a popular pulse crop of India. India is the second largest producer of pea in the world after Russia. Pea is rich in protein, carbohydrates, vitamin A and C, calcium and phosphorus. In 2017, a total of 8,141,031 hectares of field pea were harvested globally, with the top producers consisting of Canada, Russia, China, India, and the United States (FAOSTAT, 2019) however, this is only aa minimal fraction compared to cereal production. Cultivated land acreage for field pea and other pulses has been in steady decline over the past 30 years**.** Average yields have increased about 70-084% since 1974 for staple legumes, such as soybean, lentil, chickpea, and groundnut; in contrast, yields for field pea have increased but resulted in no net production gains due to decreasing land acreage**.** Pea is one of the world's oldest domesticated crops. In addition, it is also important vegetable crop due to its high nutritive value, particularly proteins 7.2 g/100g (Singh *et al.* 2007) [8]. Phosphorus deficiency is usually the most important factor for poor nodulation and low yield of leguminous crops. An adequate supply of phosphorus has been reported beneficial for better growth, yield, quality and economics nodule formation in legume. The production of pea on more than 30% of the world arable land is limited by P availability (Tesfaye *et al.* 2007) [9]. Zinc plays an outstanding role in synthesis of chlorophyll, protein and also regulates water absorption. Moreover, it also plays role in carbohydrates metabolism and activation of various enzymes which help in inducing alkalinity tolerance in crops by enhancing Na/K and Na/Ca ratio. Zinc plays a vital role in metabolism and it is involved in N-fixation through nodule formation (Patel *et al.* 2011) [7].

Materials and Methods
The experiment was conducted during *Rabi* season of 2021-22. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.1) with low level of organic carbon (0.28%), available N (225 Kg/ha), P (19.50 kg/ha) and higher level of K (92.00 kg/ha). The treatment combinations are T_1 –P 55kg/ha + Zn 10 kg/ha, T_2 55 kg/ha + Zn 15 kg/ha, T_3P 55 kg/ha+ Zn 20 kg/ha, T_4 –P 60kg/ha + Zn 10 kg/ha, T_5 –P 60kg/ha + Zn

15 kg/ha, T_6 P 60kg/ha + Zn 20 kg /ha, T_7 -65kg/ha + Zn 10 kg/ha, T_8 -P 65kg/ha + Zn 15 kg/ha, T_9 -P 65 kg/ha + Zn 20 Kg/ha. The observations were recorded on different growth parameters at harvest *viz*. plant height (cm), number of branches per plant, plant dry weight, Number of pods per plant, number of seeds per pod, test weight, seed yield and stover yield.

Results and Discussion

A. Growth Attributes

At 60 DAS highest plant height (58.24 cm) was recorded with treatment 65 kg P/ha + 20 kg Zn/ha, whereas treatment 65 kg P/ha + 15 kg Zn/ha reported statistically at par with the treatment 65 kg P/ha + 20 kg Zn/ha. At 60 DAS more number of branches/plant (5.72) was recorded with treatment 65 kg P/ha + 20 kg Zn/ha, whereas treatment 65 kg P/ha + 15 kg Zn/ha reported statistically at par with the treatment 65 kg P/ha + 20 kg Zn/ha. At 60 DAS highest plant dry weight (8.67 g) was recorded with treatment 65 kg P/ha + 20 kg Zn/ha, whereas treatment 65 kg P/ha + 15 kg Zn/ha reported statistically at par with the treatment 65 kg P/ha + 20 kg Zn/ha. Gupta *et al.* (2011).

Yield Attributes

Treatment with application of P 65 kg/ha + Zn 20 Kg/ha was recorded maximum number of pods per plant (20.09) which was significantly superior over all other and treatment with application of P 65kg/ha + Zn 15 Kg/ha(19.76) which was statistically at par with the treatment with application of P 65 kg/ha + Zn 20 Kg/ha.Treatment with application of P 65 kg/ha + Zn 20 Kg/ha was recorded maximum number of seeds per pod (6.85) which was significantly superior over all other and treatment with application of P 65kg/ha + Zn 15 Kg/ha (6.72) which was statistically at par with the treatment with application of P 65 kg/ha + Zn 20 Kg/ha. Treatment with application of P 65 kg/ha + Zn 20 Kg/ha was recorded maximum test weight (126.08) which was significantly superior over all other and treatment with application of P 65 kg/ha + Zn 15 Kg/ha (125.28) which was statistically at par with the treatment with application of P 65kg/ha + Zn 20 Kg/ha.Treatment with application of P 65 kg/ha + Zn 20 Kg/ha was recorded maximum seed yield (2.41) which was significantly superior over all other and treatment with application of P 65kg/ha + Zn 15 Kg/ha (2.35) which was statistically at par with the treatment with application of P 65kg/ha + Zn 20 Kg/ha.

Treatment with application of P 65kg/ha + Zn 15 Kg/ha was recorded maximum harvest index (41.87) which was significantly superior over all other and treatment with application of P 65 kg/ha +Zn 20 kg/ha (41.80). which was statistically at par with the treatment with application of P 65 kg/ha + Zn 15 kg/ha.

Table 1: Effect of phosphorous and Zinc on growth attributes of Field Pea

Treatments	Plant height(cm)	Number of	Plant dry weight (g/plant)
	60 DAS	branches/plant at 60 DAS	At 60 DAS
Phosphorus 55 kg/ha+ Zinc 10 kg/ha	54.39	4.84	7.71
Phosphorus 55 kg/ha + Zinc 15 kg/ha	54.61	4.93	7.81
Phosphorus 55 kg/ha + Zinc 20 kg/ha	55.85	5.14	8.04
Phosphorus 60 kg/ha + Zinc 10 kg/ha	55.51	5.03	7.94
Phosphorus 60 kg/ha + Zinc 15 kg/ha	56.56	5.37	8.35
Phosphorus 60 kg/ha + Zinc 20 kg/ha	57.14	5.51	8.44
Phosphorus 65 kg/ha + Zinc 10 kg/ha	56.35	5.27	8.17
. Phosphorus 65 kg/ha + Zinc 15 kg/ha	57.72	5.62	8.5
Phosphorus 65 kg/ha + Zinc 20 kg/ha	58.24	5.72	7.71
F-Test	S	S	S
S.Em+	1.1	0.04	0.06
CD (P=0.05)	3.29	0.12	0.19

Table 2: Effect of Phosphorus and Zinc on yield attributes of Field Pea

Treatments	Number of	Length of seed	Number of seeds	Test	Seed	Harvest
	pods/plants	pod(cm)	per pod	Weight (g)	Yield (kg/ha)	Index (%)
Phosphorus 55 kg/ha+ Zinc 10 kg/ha	16.83	5.93	5.93	120.28	1.67	38.51
Phosphorus 55 kg/ha + Zinc 15 kg/ha	17.34	6.08	6.08	121.14	1.78	39.42
Phosphorus 55 kg/ha + Zinc 20 kg/ha	18.31	6.54	6.25	122.8	1.98	40.07
Phosphorus 60 kg/ha + Zinc 10 kg/ha	17.78	6.33	6.14	121.91	1.88	39.98
Phosphorus 60 kg/ha + Zinc 15 kg/ha	18.87	6.87	6.54	124	2.12	40.00
Phosphorus 60 kg/ha + Zinc 20 kg/ha	19.15	7.04	6.63	124.68	2.25	41.10
Phosphorus 65 kg/ha + Zinc 10 kg/ha	18.46	7.21	6.4	123.24	2.07	40.06
Phosphorus 65 kg/ha + Zinc 15 kg/ha	19.76	6.72	6.72	125.28	2.35	41.80
Phosphorus 65 kg/ha + Zinc 20 kg/ha	20.09	7.34	6.85	126.08	2.41	41.87
F-Test	S	NS	S	S	S	S
S.Em+	0.18	0.07	0.05	0.3	0.03	0.38
CD (P=0.05)	0.53	0.21	0.15	0.89	0.08	1.14

Conclusion

Treatment 9 (65 kg P/ha + 20 kg Zn/ha) recorded highest seed yield (2.41 t/ha), gross return (144600 INR/ha), highest net return (99910 INR/ha) and benefit: cost ratio (2.23) which may be more preferable for farmers. Since it is economically more profitable and also achieved statistical parity with 65 kg P/ha + 20 kg Zn/ha regarding grain yield of field pea and hence, can be recommended to the farmers.

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