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Effect of phosphorus and zinc levels on growth and yield of greengram (*Phaseolus radiata* L.)

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Abstract
A field experiment was conducted during *Zaid* (summer) season of 2023 at Crop Research Farm Department of Agronomy. The experiment was laid out in a Randomized Block Design with 10 treatments and replication thrice. The treatments consisted of 3 levels of Phosphorus (40, 50 and 60 kg/ha) and 3 levels of zinc (2.5, 4 and 5.5 kg/ha) along with recommended doses of nitrogen, phosphorus and potash and a control (20-40-20 kg N-P-K/ha). Application of phosphorus at 60/ha in combination with Zinc at 5.5kg/ha (treatment 9) recorded maximum plant dry weight (9.72 g), more number of Pods/plant (9.64), Seeds/pod (10.49), test weight (39.95 g), and seed yield (1456.86 kg/ha).

Keywords: Greengram, phosphorus, zinc, growth and yield

Introduction

In India, Pulses hold significant economic importance in India, ranking just below cereals and oilseeds. They cover nearly 30 million hectares of land, yielding around 23 million tonnes, with an average productivity of 735 kg per hectare. Greengram cultivation spans across several states including Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Maharashtra, Rajasthan, Bihar, Gujarat, and Orissa. In India, it is cultivated in area about 3.00 million hectares and producing 2.5 million tonnes with productivity 320 kg/ha. The area, production and productivity of green gram in Gujarat is 138.32 thousand hectares, 88.75 thousand tonnes and 642.11 kg/ha, respectively (Anon., 2020) [2].

Phosphorus is one of 17 essential nutrients crucial for plant growth. As its functions cannot be performed be any other nutrient. An adequate supply of phosphorus is imperative for optimum growth and reproduction, making it a vital important nutrient secondary nitrogen. In Indian agriculture phosphorus comes from fertilizers, organic manures and to a very small extent from crop residues. Being is legume crop, requirement on nitrogen was less on the other compare on phosphorus. It play i important role in early crop development and growth thereby helping to establish seedlings quickly seedlings. It is a component of nucleic acids, phytin, and phospholipids. Additionally, phosphorus is an essential constituent of enzymes involved in energy transformation during carbohydrate and fat metabolism and respiration in plants. Soil application of phosphorus aids in increasing grain yield, improving seed quality, regulating photosynthesis, governing physio-biochemical processes, and promoting root development and nodulation, as highlighted (Kadam *et al*. 2014) [6].

Zinc plays crucial role in plant growth and development by regulating metabolic reactions, such as oxidation reduction reaction involved in of chlorophyll formation and influence the synthesis of certain growth hormones. It also act as catalyses in the biosynthesis of indole acetic acid, acting as metal of the enzyme activator and ultimately boosting crop yield. Additional zinc maintain the balance between CO_2, water and carbonic 3 acid in plant metabolism, contributes the balance between in synthesis of nucleic acids, proteins and stimulates seed formation (Ranpariya *et al*. 2017) [10].

Materials and Methods

The experiment was conducted in the Zaid season of 2023 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, part of Sam Higginbottom University of Agriculture, Technology, and Sciences, located in Prayagraj (U.P.). The farm's coordinates are approximately 250 39” 42” N latitude and 810 67” 56” E longitude, with an altitude of 98 meters above sea level. The soil type in the experimental area was identified as sandy loam, characterized by a pH of 8.0, Organic Carbon content of 0.42%, and available nutrient levels of 180.58 kg/ha for nitrogen, 15.54 kg/ha for phosphorus, and 198.67 kg/ha for potassium. The experiment included various treatments involving different levels of phosphorus (40, 50, and 60 kg/ha) and zinc (2.5, 4, and 5.5 kg/ha), alongside recommended doses of nitrogen, phosphorus, and potash, as well as a control group receiving 20-40-20 kg N-P-K/ha. Seeds were sown at a spacing of 30×10 cm², with a seed rate of 15 kg/ha. Data collected on various crop parameters, including growth and yield attributes, underwent statistical analysis using the analysis of variance method (Gomez and Gomez, 1976) [16], supplemented by economic data analysis through mathematical methods.

Results and Discussion

Plant dry weight

In the 45 DAS, data was significant and maximum plant dry weight (9.72 g) was recorded on treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha. However, treatment 8 Phosphorus 60 kg/ha. + Zinc at 4 kg/ha (8.96 g) was found to be statistically at par with treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha (9.72 g).

The significant and higher plant dry weight was with the application of phosphorus (60 kg/ha) being an energy bond compound and its major role is transformation of energy essential for almost all metabolic processes photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimately increase all the growth attributes and dry weight of plants Kumar *et al*. (2016) [8]. Further Significant and higher plant dry weight was observed with application of Zinc (5.5kg/ha) may be due to micronutrient helps to activate the synthesis of tryptophan and precursor of IAA which is responsible to stimulation of plant growth and accumulation of biomass and micronutrient being a component of ferrodoxin and electron transport are also associated with chloroplast which acceleration in photosynthesis is evident for the better vegetative growth, resulted in higher plant dry weight. Similarly, findings were also reported by Singh *et al.* (2018) [11].

Pods/plant

The data pertaining to number of pods/plants affected by different, phosphorus and Zinc are provided in Treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha was data recorded in significant and maximum number of pods/plant (9.64) which was superior over all other treatments. However, the treatment 8 Phosphorus at 60 kg/ha. + Zinc at 4 kg/ha (9.22) and treatment 7 Phosphorus at 60 kg/ha. + Zinc at 2.5 kg/ha (9.07) and treatment 6 Phosphorus at 50 kg/ha. + Zinc at 5.5 kg/ha (8.83) was found to be statistically at par with the treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha (9.64).

The Significant increase in the number of pods/plants observed with the application of phosphorus application may be attributes to the moderate availability of plant nutrients, prompting enhanced pod production compare to other treatments. Additionally, phosphorus is known to stimulate plant reproduction, including flowering and fruiting was similar with that of Abid *et al.* (2017) [15]. Furthermore Significant and higher number of pods/plants has in the application of might to the because zinc (10kg/ha) might in the increase levels of Zinc application to crops on nutrient metabolism, biological activity and growth parameters and resulting in applied zinc results in taller and higher enzyme activity in pods/ plant. Similar results were reported by Yashona *et al.* (2018) [13].

Seeds/pod

At harvest, Treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha was recorded significant and maximum number of seeds/pod (10.49) which was superior over all other treatments. However, the treatment 8 Phosphorus at 60 kg/ha. + Zinc at 4 kg/ha (9.63) treatment 7 Phosphorus at 60 kg/ha. + Zinc at 2.5 kg/ha (9.42) and treatment 6 Phosphorus at 50 kg/ha. + Zinc at 5.5 kg/ha (9.19) was found to be statistically at par with the treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha (10.49).

The notable increase in seed/plants count was observed with application phosphorus (60 kg/ha) likely due to enhanced availability of essential nutrients, prompting produces more number of seed/pod. This trait genetically controlled character and the difference among genotypes reflecting their distinct capacities in this parameter as discussed by Kadam *et al.* (2014) [6].

Test weight

At harvest, highest test weight (39.95 g) was recorded in treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha, However, the treatment 8 Phosphorus at 60 kg/ha. + Zinc at 4 kg/ha (38.43 g) and treatment 7 Phosphorus at 60 kg/ha. + Zinc at 2.5 kg/ha (37.53 g) and treatment 6 Phosphorus at 50 kg/ha. + Zinc at 5.5 kg/ha (37.31) in this found the statistically at par with the treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha.

Seed yield

Treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha (1456.86kg/ha) was recorded significantly and higher Seed yield which was superior over all other treatments. However, the treatment 8 Phosphorus at 60 kg/ha. + Zinc at 4 kg/ha (1366.14kg/ha) was found to be statistically at par with the treatment 9 Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha.

The higher seed yield observed with zinc application (45 kg/ha) may be attributed to sulphur enhances the plant metabolism and photosynthetic activity. Similar results have been to Jat *et al.* (2013) [4]. Further additionally the increase in seed yield observed with zinc application (10kg/ha) could be due to its role in biosynthesis of indole acetic acid initiation of primodial for reproductive parts and optimizing photosynthesis toward them resulting improved grain yield as noted results were reported by Sunil *et al*. (2017) [12].

Table 1: Influence of Phosphorus and Zinc levels on yield attributes and yield of Greengram

No.	Treatment combination	Dry weight (g) (45 DAS)	Pod/plant (No.)	Seeds/pod (No.)	Test weight (g)	Seed Yield (kg/ha)
1.	Phosphorus at 40 kg/ha. + Zinc at 2.5 kg/ha.	6.62	7.87	8.27	34.49	898.71
2.	Phosphorus at 40 kg/ha. + Zinc at 4.0 kg/ha.	6.33	7.93	8.33	35.65	942.63
3.	Phosphorus at 40 kg/ha. + Zinc at 5.5 kg/ha.	6.33	8.18	8.67	35.88	1018.56
4.	Phosphorus at 50 kg/ha. + Zinc at 2.5 kg/ha.	7.40	8.36	8.85	36.48	1080.38
5.	Phosphorus at 50 kg/ha. + Zinc at 4.0 kg/ha.	7.71	8.66	8.94	36.77	1139.56
6.	Phosphorus at 50 kg/ha. + Zinc at 5.5 kg/ha.	7.95	8.83	9.19	37.31	1212.27
7.	Phosphorus at 60 kg/ha. + Zinc at 2.5 kg/ha.	8.11	9.07	9.42	37.53	1282.69
8.	Phosphorus at 60 kg/ha. + Zinc at 4.0 kg/ha.	8.96	9.22	9.63	38.43	1366.14
9.	Phosphorus at 60 kg/ha. + Zinc at 5.5 kg/ha.	9.72	9.64	10.49	39.95	1456.86
10.	NPK - 20:40:20 kg/ha (Control)	6.59	8.21	7.42	32.35	788.07
	SEm (±)	0.46	0.30	0.47	1.03	41.87
	CD (p=0.05)	1.39	0.89	1.40	3.06	124.42

Conclusion

Application of phosphorus 60 kg/ha along with zinc at 5.5 kg/ha (treatment 9) recorded highest yield attributes and yield in Greengram.

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