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Effect of zinc and boron on growth and yield of Blackgram (*Vigna mungo* L.)

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Abstract
A field experiment was conducted during *kharif* season of 2023 at Crop Research Farm Department of Agronomy on blackgram. The treatments consisted of 3 levels of zinc (2, 4 and 6 kg/ha) and 3 levels of boron (0.5, 1.5 and 2.5 kg/ha) with N:P:K – 20:60:20 kg/ha (Control). The experiment was laid out in a Randomized Block Design with 10 treatments and replication thrice. Application of zinc at 6 kg/ha with Boron at 2.5 kg/ha (Treatment 9) recorded highest plant dry weight (18.62 g), pods per plant (27.28), test weight (39.50 g), seed yield (1.60 t/ha).

Keywords: Blackgram, zinc, boron, growth, crop

Introduction
Pulses are an essential part of the human diet, providing a significant supply of dietary protein. Blackgram (*Vigna mungo* L.) is one of these edible legumes that thrives in intensive farming systems due to its short growing season. Blackgram is grown on 2.346 million hectares in India, yielding 1.959 million tonnes. In Andhra Pradesh, it covers 0.315 Mha and produces 0.298 MT. In Andhra Pradesh, blackgram productivity averages 946 kg ha^{1}, which is higher than India's average of 604 kg ha^{1}. Leguminous crops are underutilized in terms of nutrient management, which is a major concern.
Blackgram, as a pulse, requires higher levels of Ca, Mg, and S out of the 16 necessary elements. When it comes to dry matter, plant tissue includes little nutrients, with the exception of several key elements such as carbon. It is routine practice to augment these necessary minerals by soil application. India is used as an exclusive example to explicate the role of micronutrient play in optimum utilization of macronutrients (Katyal *et al*., 2004) [26]. However, soil-applied nutrients may or may not be available to plants due to various soil physiochemical processes, and the entire fertilizer is not absorbed by the crop during the season, particularly for short-duration crops. Excess fertilizers not only raise the expense of farming, but also contaminate the dynamic soil ecosystem. As a result, providing these modest amounts directly to the location of food synthesis increases produce quality while also preserving crop yields with minimal environmental impact. Zinc is a necessary component for plant growth and development, and hence classified as a micronutrient. Zinc is particularly important for plant nutrition at low levels since it is engaged in a number of metalo-enzymes that help to stabilize the cytoplasm and ribosomes. It also catalyzes the oxidation process, which involves the creation of auxin-indole acetic acid and the conversion of carbohydrates. Boron also has an important function in reproductive growth, microsporogenesis, pollen germination, pollen tube growth, pollination, and seed set. Flowering and fruit development are severely limited due to a boron deficiency. Zinc and boron deficiencies account for approximately 49% and 33%, respectively, in Indian soils, reducing not just yield but also nutritional quality (Singh *et al*., 2011) [10]. Zinc is involved in auxin production, dehydrogenase enzyme activation, and ribosomal fraction stabilization (Hafeez *et al*., 2013) [4], while boron is essential for cell division, pod and seed formation (Goldberg *et al*., 2007) [3]. Furthermore, because these two minerals have been shown to have a residual impact on subsequent harvests, it is critical to apply Zn and B-containing fertilizers in order to maximize crop production potential and reduce nutrient deficits.

Materials and Methods

During the *Kharif* season of 2023, a field experiment was carried out in alluvial soil at the Crop Research Farm of the Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The soil of the experimental plot was sandy loamy, with a nearly neutral soil reaction (pH 6.8) and electrical conductivity (0.295 ds/m). The experiment was laid out in a Randomized Block Design with ten treatments and replicated thrice. The treatments consisted of three levels of zinc (2, 4, and 6 kg/ha) and 3 levels of boron (0.5, 1.5 and 2.5 kg/ha) with N:P:K – 20:60:20 kg/ha (Control).

Plant growth parameters, such as plant dry weight (g/plant) was measured at 15-day intervals from germination to harvest, and yield and yield attributes, such as no. of pods/plant, no. of seeds/pod, test weight (g), seed yield (t/ha) were measured during harvest. The observed data were statistically analyzed using analysis of variance (ANOVA) as appropriate for Randomized Block Design.

Results and Discussion

Growth parameters

Plant dry weight

At 60 DAS, significant and higher plant dry weight (18.62 g) was recorded in treatment- 9 [6 kg/ha zinc + 2.5 kg/ha boron] as compared to rest of the treatments. However, the treatment- 2 [2 kg/ha zinc + 1.5 kg/ha boron]- (17.44 g) was found to be statistically at par with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron].

Significant and higher plant dry weight was with application of 6 kg zinc might be due to growth and development of plants, which obtained by enhanced metabolic activities and photosynthetic rate, resulting in improvement in the accumulation of dry matter at the successive growth stages. Similar result was also reported by Chhatrapati *et al.*, 2017 [2].

Yield and yield attributes number of pods/plant

Significant and maximum number of Pods/plant (27.28) was recorded with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron] which was superior over all other treatments. However, the treatment-2 [2 kg/ha zinc + 1.5 kg/ha boron]- (24.69), treatment-8 [6 kg/ha zinc + 1.5 kg/ha boron]- (25.72), treatment-7 [6 kg/ha zinc + 0.5 kg/ha boron]- (24.27) and treatment-1 [2 kg/ha zinc + 0.5 kg/ha boron]- (23.59) was found to be statistically at par with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron].

Significant and maximum number of pods/plant yield was with 2.5kg/ha boron, which help in easy pod development. Similar result was also reported Khan *et al.*, 2020. Further, significant and maximum number of pods/plant was with application of boron might be due to supply of the nutrients in adequate amount also help in the development of floral and reproductive parts, which results in the maximum development of pods and seeds in plant. Similar result was also reported by Banerjee *et al*, 2021 [1].

Number of seeds/pod

Significant and maximum number of seeds/pod (6.74) was recorded with treatment-8 [6 kg/ha zinc + 1.5 kg/ha boron] which was superior over all other treatments. However, the treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron]- (6.67), treatment-2 [2 kg/ha zinc + 1.5 kg/ha boron]- (6.59) and treatment-1 [2 kg/ha zinc + 0.5 kg/ha boron]-(6.40) was found to be statistically at par with treatment-8 [6 kg/ha zinc + 1.5 kg/ha boron].

Significant and maximum number of seeds/pod was with application of boron; might be due to synthesis of zinc containing amino acids, proteins, which leads to stimulating photosynthesis and seed formation and also boron plays vital role in energy storage and transformation, carbohydrate metabolism and activation of enzymes, which results in the development of seeds in plants. Similar findings is also reported by Ravi *et al.*, 2022 [9].

Test weight (g)

Significant and higher test weight (39.50 g) was recorded with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron] which was superior over all other treatments. However, the treatment-5 [4 kg/ha zinc + 1.5 kg/ha boron]- (39.28 g) and treatment-7 [6 kg/ha zinc + 0.5 kg/ha boron]- (38.24 g) was found to be statistically at par with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron]. Significant and higher test weight was with application of zinc; could be due to two nutrients, which are essential for nitrogen fixing nodules in legumes and in formation of chlorophyll, promotes proteins formation, amino acids and seed development. Similar result was also reported by Chhatrapati *et al.*, 2017 [2].

Seed yield (t/ha)

Significant and higher seed yield (1.60 t/ha) was recorded with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron] which was superior over all other treatments. However, the treatment-8 [6 kg/ha zinc + 1.5 kg/ha boron]- (1.33 t/ha) was found to be statistically at par with treatment-9 [6 kg/ha zinc + 2.5 kg/ha boron].

Significant and higher seed yield was with application of boron might be due to two nutrients which result in easy peg penetration, pod development and seed formation which increases seed yield of the crop, Similar result was also reported Kumar *et al.*, 2020. Further, significant and higher seed yield was with application of zinc; might be due to overall improvement in growth and development by fertilization with increased photosynthesis and greater mobilization of photosynthates towards reproductive structures leads to increase in yield of blackgram. Similar result was also reported Jat *et al.*, 2021 [5].

Table 1: Response of zinc and boron on growth and yield of Blackgram

S. No.	Treatment Combinations	Dry weight (g/plant) 60 DAS	Pods/Plant (No.)	Seeds/Pod (No.)	Test weight (g)	Seed yield (t/ha)
1.	2 kg/ha zinc + 0.5 kg/ha boron	16.69	23.59	6.40	33.28	1.12
2.	2 kg/ha zinc + 1.5 kg/ha boron	17.44	24.69	6.59	35.44	1.28
3.	2 kg/ha zinc + 2.5 kg/ha boron	14.50	20.73	6.18	37.74	1.08
4.	4 kg/ha zinc + 0.5 kg/ha boron	13.11	21.87	5.82	37.21	1.06
5.	4 kg/ha zinc + 1.5 kg/ha boron	14.71	22.61	5.58	39.28	1.10
6.	4 kg/ha zinc + 2.5 kg/ha boron	13.97	21.66	6.13	35.74	1.05
7.	6 kg/ha zinc + 0.5 kg/ha boron	16.05	24.27	6.14	38.24	1.26
8.	6 kg/ha zinc + 1.5 kg/ha boron	15.28	25.72	6.74	34.43	1.33
9.	6 kg/ha zinc + 2.5 kg/ha boron	18.62	27.28	6.67	39.50	1.60

Conclusion
It is concluded that, using 6 kg/ha Zinc and 2.5 kg/ha Boron (Treatment 9) perform better in growth parameters and yield of blackgram.

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