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Performance of Black gram (*Vigna mungo* L.) as influenced through the application of Zn, B, and Mo

Anupama Verma[1]*, 1M.A. Khan, [1]Anil Kumar Singh, Bal Veer Singh[2], Amit Kumar[1], Shakti Singh[3] and Harshit Gupta[4]

[1]Department of Crop Physiology, Chadra Shekhar Azad University of Agriculture and Technology Kanpur-208002, U.P. State, India
[2]Department of Agronomy, Chadra Shekhar Azad University of Agriculture and Technology Kanpur-208002, U.P. State, India
[3]Department of Agricultural Biochemistry, Chadra Shekhar Azad University of Agriculture and Technology Kanpur-208002, U.P. State, India
[4] Department of Seed Science and Technology, Chadra Shekhar Azad University of Agriculture and Technology Kanpur-208002, U.P. State, India

Abstract

An experiment was conducted in the wire net house of the Department of Crop Physiology, C. S. Azad University of Agriculture and Technology, Kanpur, during the Kharif season of the year 2019. The experiment was conducted to find out the effects of Zn, B, and Mo combinations on growth, yield, and attributes of Black gram laid out in CRD with 7 treatments and 3 replications. The study found that black gram grown with T7-Zn +B + Mo @ 0.5% + 0.2% +0.1% grew significantly better, as evidenced by taller plants (33.65 cm), more leaves/plant (12.55), more branches/plants (7.77), dry weight of the leaves/plant (4.41g), number of nodules/plants (10.72), number of pods/plants (25.99), dry weight of pod/plant (16.86 g), dry weight of stem/plant T7-Zn +B + Mo @ 0.5% + 0.20% + 0.1% also increased leaf area per plant (121.75 & 196.98), chlorophyll intensity (46.15 & 34.10), days to 50% flowering (59.10), days to pod formation (64.20), grain yield per plant (3.45 g), and protein content (21.89%). In the same way, yield characteristics (number of seeds per pod, number of seeds per plant, and weight of 1000 seeds in grams) were also significantly higher with the same treatment.

Keywords: *Black gram, Pulses, proteins, vitamins, and minerals*

Introduction

Pulses are a significant category of food crops that may be used to solve issues of national nutrition and food security as well as environmental concerns. Around 9–10% of the entire food grain basket is made up of pulses, which are an essential and affordable source of plant-based proteins, vitamins, and minerals. The majority of the protein consumed by vegetarians in India comes from pulses, which are high in protein. They are essential to crop rotation, mixed farming, and intercropping because they keep the soil fertile. One of the oldest and most well-known pulse crops is the black gram (*Vigna mungo* L.), which belongs to the family Fabaceae and subfamily Papilionaceae. It is one of the most expensive pulses in India and has its origins in India. The importance of pulses in the food basket (dal-roti, dal-chawal) and their high protein content (at 20–25%), which is twice that of wheat and triple that of rice, are factors in the reduction of obesity, diabetes, malnutrition, and other problems. Pulse crops are special in that they can fix atmospheric nitrogen using nitrogen-fixing bacteria located in their nodules, greatly satisfying their own nitrogen needs in the process. Pulses are reasonably deep roots and the fact that many of them are short-lived crops makes them drought resilient. These are also excellent for numerous cropping systems and intercropping [19].

Pulses have poor productivity since they are often cultivated on marginal and sub-marginal soils with little to no fertilizer input. Since the majority of India's pulse-growing regions have low Zn content, it is required to apply 1.5–5 kg Zn/ha alone or in addition to the NPKS levels suggested for various pulse crops. The quality and production of grains are improved as a consequence of the use of Zn. Different

**CorrespondingAuthor: Anupama Verma*
E-mail Address: - anupamaverma027@gmail.com
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cultivars of pulses have been shown to have different genetic responses to treated Zn. Crops don't need a lot of zinc. Depending on the soil's level of zinc, Zn applications may be made annually, every two years, or every three to five years. To remedy the plants' Zn deficit, a variety of Zn treatment techniques, including soil, seed coating, spraying, etc., have been proven to be successful. The most popular method of applying $ZnSO_4$ is the foliar application, and it occasionally yields better results than applying Zn from other sources. Zn delivery to the leaf is influenced by soil nutrient levels, soil types, rainfall, the addition of organic matter, and cropping patterns. According to Singh *et al.* (2011) [19], the Zn applied in one crop of the system often takes care of the Zn needs of the next crop as well.

Nutritional deficiency and health issues in humans and animals are caused by a lack of zinc in the soil. Zn insufficiency now affects 50% of the world's population [6], placing it second only to iron in terms of prevalence. In India, over half of the children under the age of five are undersized owing to a Zn deficit, and roughly 25% of the population has difficulties connected to Zn. Zn deficiency has also been linked to several illnesses, including hypogonadism, anorexia, dwarfism, skin lesions, geophagia, taste loss, and others. In women of childbearing age and younger generations, such as children and cattle, the Zn-related issues are more severe. People and animals can have health problems if they eat food made from these crops or eat the crops themselves. This is because these crops often have less zinc, which makes it harder for the body to absorb zinc [26].

"The vitamin boron is vital for boosting pulse bean output. When cells divide and when pods and seeds are formed, it is crucial. When it comes to overall quantity and seed and stem concentration, boron is the second most abundant micronutrient after zinc [28]. Boron has had a big impact on seed production. Boron treatment at 1.5–2.5 kg/ha enhanced black gram seed output. One of the most well-known nutrients, molybdenum, is regarded as crucial to plant development. Due to heat and drought stress brought on by climate change, especially in tropical and subtropical countries, food poverty will worsen in the twenty-first century. For poor nations like India, legumes are a valuable and comparatively less expensive source of proteins, carbohydrates, and minerals [18].

Materials and Methods

A field experiment was carried out in 2019's Kharif season. The experiment, which included seven treatment combinations and three replications, was designed to determine the effects of Zn, B, and Mo combinations on the growth, yield, and quality of black gram. The prescribed dosage of NPK kg ha^{-1} is used for the treatments, which are Control, Zn @ 0.5 %, B @ 0.2 %, Mo @ 0.1 %, and Zn + B @ 0.5 % + 0.2 %. The C.S. Azad University of Agriculture and Technology, Kanpur, Crop Physiology Department, conducted the whole research. Geographically, the experiment's location is located in genetic alluvium soil in latitudes 800, and 24 ^{0} East at an elevation of 127 m above mean sea level in summer and a very frigid winter. The subtropical, semi-arid climate of the area is distinguished by scorching summers (maximum temperature of 45 ^{o}C) and very cold winters (min. temp. of 30 ^{o}C). About 80 cm of precipitation falls on average each year.

The experimental field's soil had a sandy loam texture, a pH of 7.60, and was accessible with low levels of organic carbon (0.034 %), medium levels of P (13.5 kg ha^{-1}), and greater levels of K. (336 kg ha^{-1}). (Zinc was determined using the DTPA extractant Dithizonate technique, whereas Mo was determined using water and ammonium oxalate extractants [9]. The protein content in the seed of mungbean was calculated by using the constant food factor of 6.25, which means (%N × 6.25) [8].

Select five plants at random from the net plot area at the beginning of the process for subsequent observational recording by taller plants, leaves per plant, branches per plant, the dry weight of the leaves per plant, the number of nodules per plant, the number of pods per plant, the dry weight of the pods per plant, and the total dry matter output reported at harvest from the net plot. Days till flowering began and 50% flowering were noted in the standing crop. Separate experimental pot harvests were made, and spring balance weights were taken. The produce from each pot was then manually threshed, and the separated grains were weighed on a bar ranger balance and converted into grams per plant. The seed and Stover yield was taken for the net plot and further calculated to 1 hectare. The harvest index is calculated using the formula (economic yield/biological yield) × 100.

The data was statistically analyzed using a block

Table:1(a) Growth performance of Black gram (*Vigna mungo* L.) as influenced through application of Zn, B and Mo

TREATMENT	AT MATURITY					
	Plant height (cm)	Number of leaves/ plants	Number of branches/ plants	Dry weight of leaves/plant	Dry weight of stem per plant	Total dry weight of plant
T_1- Control	22.65	10.15	5.45	3.25	4.33	20.03
T_2 - Zn @ 0.5%	30.85	11.17	7.10	3.67	4.88	22.57
T_3 - B @ 0.2%	27.05	10.25	6.35	3.48	4.63	21.34
T_4 - Mo @ 0.1%	30.69	11.25	7.25	3.71	4.93	22.80
T_5 - Zn + B @ 0.5% + 0.2 %	33.05	12.33	7.37	4.20	5.58	25.79
T_6 - Zn + Mo @ 0.5% + 0.1 %	31.77	11.85	7.05	3.97	5.27	24.39
T_7- Zn +B + Mo @ 0.5% + 0.2 % +0.1%	33.65	12.55	7.77	4.41	5.87	27.14
SE (d)	**0.873**	**0.502**	**0.360**	**0.273**	**0.290**	**0.389**
C.D. (%)	**1.812**	**1.044**	**0.749**	**0.567**	**0.604**	**0.808**

Table:1(b). Growth performance of Black gram (*Vigna mungo* L.) as influenced through application of Zn, B and Mo

TREATMENT	Leaf area/plant (cm^2)		Chlorophyll intensity		No of pods/ plant	No of pods/ plant	Number of Nodules / plants at maturity
	At pre-flowering	At Post-Flowering	At pre-flowering	At Post-Flowering			
T_1- Control	111.35	180.15	39.71	29.60	18.75	12.45	6.95
T_2 - Zn @ 0.5%	119.40	193.18	43.58	32.20	23.75	14.02	8.95
T_3 - B @ 0.2%	115.35	186.68	41.13	30.39	21.24	13.23	8.10
T_4 - Mo @ 0.1%	117.18	189.58	44.03	32.53	24.10	14.16	8.66
T_5 - Zn + B @ 0.5% + 0.2 %	118.65	191.96	45.94	33.94	24.65	16.01	9.56
T_6 - Zn + Mo @ 0.5% + 0.1 %	116.10	187.85	44.78	33.10	23.60	15.15	9.46
T_7- Zn +B + Mo @ 0.5% + 0.2 % +0.1%	121.75	196.98	46.15	34.10	25.99	16.86	10.72
SE (d)	**1.310**	**2.181**	**1.246**	**1.004**	**0.873**	**0.655**	**0.425**
C.D. (%)	**2.725**	**4.538**	**2.592**	**2.088**	**1.816**	**1.370**	**0.658**

pattern. The experimental data were combined, and statistical analysis was performed on the mean data for one year (1984) using Gomez and Gomez's methodology. At the probability threshold <p 0.05, the ANOVA was utilised to test for significant differences between the means using Fisher's Least Significant Difference. NS was used to indicate non-significant treatment differences.

Results and Discussion

Effect of growth parameters on black gram

The data showed that the treatment (T_7): RDF+ Zn + B + Mo @ 0.5 percent + 0.2 percent +0.1 percent had the highest dry matter production at harvest, along with taller plants (33.65 cm), more leaves per plant (12.55), leaf area per plant at pre flowering & post flowering (121.75 & 196.98), number of branches/ plants (7.77), dry weight of the leaves stem/plant (4.41g and 5.87g), and total dry matter It's possible that zinc and boron's impact on developing plant's metabolism is what causes the rise in plant growth under treatment; this might account for the observed response to zinc and boron application. Raj *et al.* (2018) also observed that zinc and boron spraying had a favorable effect on plant height and growth. The fact that molybdenum is a structural component of nitrogenase, an enzyme actively engaged in nitrogen fixation by root nodule bacteria of leguminous

Table:2. Yield attributes, yield and protein content performance of Black gram (*Vigna mungo* L.) as influenced through application of Zn, B and Mo

Treatments	No of seed/ pod	No of seed/ plant	1000 seed weight (g)	Protein content	Grain yield / plant (g)	Harvest index (%)
T1- Control	4.35	81.56	32.480	21.15	2.65	13.23
T2 - Zn @ 0.5%	5.51	103.30	33.35	21.65	3.36	14.88
T3 - B @ 0.2%	4.93	82.39	33.05	21.50	3.00	14.05
T4 - Mo @ 0.1%	5.59	104.83	33.45	21.75	3.40	14.91
T5 - Zn + B @ 0.5% + 0.2 %	5.72	107.23	33.65	21.87	3.50	13.57
T6 - Zn + Mo @ 0.5% + 0.1 %	5.48	102.66	33.30	21.82	3.35	13.73
T7- Zn +B + Mo @ 0.5% + 0.2 % +0.1%	5.85	112.25	34.15	21.89	3.65	13.44
SE (d)	**0.077**	**2.182**	**0.436**	**0.141**	**0.150**	**0.273**
C.D. (%)	**0.159**	**4.540**	**0.908**	**0.295**	**0.312**	**0.567**

crops, may account for the improvement in growth characteristics brought on by molybdenum. [17], [12] and [16] all reported findings of a similar nature. The results regarding the effect of zinc, molybdenum, and boron on the chlorophyll intensity of black gram are respectively presented in Table 1. When compared to the recommended fertilizer dosage, the effects of zinc, molybdenum, and boron on chlorophyll intensity at pre-flowering and post-flowering (46.15 & 34.10) were shown to be substantially different. The leaf is the primary photosynthetic organ in plants, and variations in the macro and micronutrient composition of the leaf contribute significantly to the variation in photosynthetic area rate. According to Kusum *et al.* (2015) [15], the effects of zinc on chlorophyll content, nitrogen percentage, and protein content are all enhanced. [22] reported similar outcomes.

According to the findings in Table 2, fertilizer application, regardless of nutrients, substantially enhanced the number of nodules/plants and the number of pods/plants compared to no fertilizer treatment. Application of Zn + B + Mo @ 0.5 percent + 0.2 percent + 0.1 percent with RDF (NPK) increased the number of nodules/plants (10.7) and pods/plants (25.99) more than no NPK fertilizer application. These might result from the administration of micronutrients (Zn, Mo, and B), which increased photosynthetic activity and stimulate growth. Additionally, effective partitioning of accumulated photosynthates led to improved yield characteristics with sufficient major and micronutrient supplies. These results conform with the findings of [4], [7],[9] and [27].

Yields attributes and yield of black gram

The yield attributes of seeds/pod, seeds/plant, and 1000 seeds weight (g) of black gram increased clearly with each micronutrient treatment over control (T1). T7 (Zn + B + Mo @ 0.5 percent + 0.2 percent + 0.1 percent) treatment yielded the highest numbers of seeds/pod (5.85), seeds/plant (112.25), and 1000 seed weight (34.15 g). Nearly every micronutrient treatment outperformed the control in terms of these yield metrics. Zn, Mo, and B, three micronutrients, increased the generation of photosynthates and stimulated rapid development. Additionally, effective partitioning of accumulated photosynthates led to improved yield characteristics with sufficient major and micronutrient supplies. These findings are consistent with those made by [2], [3] and [17].

The highest grain weight per plant was recorded in treatment T_7-Zn + B + Mo @ 0.5 % +0.2% + 0.1% (3.65 g), which was closely followed by T5 (3.50 g) and T1 (2.65 g) controls. The maximum yield under this treatment can be attributed to macro- and micronutrients that have a direct or cumulative impact on black gram metabolic functions. Higher grain and straw production is a direct consequence of increased root development, rapid cell division, and plant vigor, all of which are directly impacted by the availability of nutrients, particularly the micronutrients, at the optimal level. Similar findings were reported by [11], [13], and [15]. Black gram grain production was significantly impacted by the application of Zn, Mo, and B. Boron provided somewhat smaller yields of black gram than the other micronutrients. However, the variation in yield caused by these micronutrients was not statistically significant.

Quality

Different treatments significantly increased the protein content of black gram grains compared to the control alone (Table 2). The percentage of protein in grains varied from 21.15 to 21.89, respectively. The treatment comprising Zn + B + Mo @ 0.5 percent + 0.2 percent + 0.1 percent (T7) and the lowest control both recorded the highest values of protein content in grain (23.1 percent) and (21.15 percent). Increased grain yield and nitrogen content in grain with a sufficient supply of nutrients may be responsible for this rise in protein content (in percent) in black gram grain. Greater grain production may be the reason why the majority of treatments outperformed the control in terms of protein yield. The earlier research on the application of micronutrients supported some comparable findings about the protein content in various crops [22], [4], and [1].

Conclusion

The findings indicate and support the conclusion that foliar treatment of Mo, B, and Zn on the Urd bean variety Azad-3 considerably altered plant morphology, improved vegetative and reproductive development, and had effects that persisted throughout the plant's life cycle. When used wisely, these ingredients may be effective in increasing urd bean output.

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