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Dinesh Kumar Yadav
Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Devendra Singh
Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Anup Kumar Choubey
Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

RK Raj
Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Corresponding Author:
Dinesh Kumar Yadav
Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Effect of micro and secondary nutrients on yield of blackgram (*Vigna mungo* (L.) hepper)

Dinesh Kumar Yadav, Devendra Singh, Anup Kumar Choubey and RK Raj

Abstract
A field experiment was conducted during *kharif* 2015 at the experimental farm, Tirhut College of Agriculture, RPCAU, Pusa, Bihar to study the effect of micro and secondary nutrients on growth, yield and quality of blackgram (*Vigna mungo* (L.) Hepper) The experiment was laid-out in a randomized block design (RBD) with eight treatments, each having four replications. The treatments were T_0: RDF (control), T_1: RDF + B, T_2: RDF + Zn, T_3: RDF + S, T_4: RDF + B + Zn, T_5: RDF + B + S, T_6: RDF + Zn + S and T_7: RDF + Zn + B + S. Uniform basal application was made with 20 kg N ha^{-1}, 40 kg P_2O_5 ha^{-1}, 20 kg K_2O ha^{-1} through urea, DAP and MOP, respectively. Sulphur, Zn and B were applied @ 20, 5 and 1.5 kg ha^{-1} from Bentonite-S, Zinc sulphate and Di-sodium tetra-borate pentahydrate, respectively. Yield attributes characters, grain yield kg ha^{-1}, straw yield kg ha^{-1}, protein content and protein production of blackgram was significantly affected due to various treatments.

Keywords: Blackgram, Sulphur, Zinc, Boron, Protein.

Introduction
Pulses are the second important Indian diet after cereals. Pulses are rich in proteins and found to be main source of protein to vegetarian people of India. They play an important role in crop rotation, mixed and intercropping, as they help in maintaining the soil fertility. In the world, pulses are grown by 171 countries. The highest area was contributed by India (32.24%). Pulses occupy a strategic position in agricultural economy of India. Pulse crops are grown on an area of 23.84 lakh ha in India accounting for nearly 33 percent of world acreage and consumed by 2.2 percent of world's population. Pulses normally produce a large number of flowers but only a few are retained and developed into pods. Among these pulses, black gram (*Vigna mungo* L.) is one of the oldest and popular pulse crops belongs to family Fabaceae and constitute a vital constituent of Indian recipe. Black gram is originated in India, where it has been in cultivation from ancient times and is one of the most highly priced pulses of India and Pakistan Proper management of the seed crop is highly essential in a seed production program to harvest good amount of high quality seeds. Nutritional management is an important factor of seed crop production.

Micronutrients needs in lower amount but its presence at proper ratio contributes efficient use of primary and secondary nutrients, plant itself and in biological nitrogen fixation process in soil, maximizing the yield through their effects on crop growth parameters and yield contributing characters. Among the micronutrient deficiency, Sulphur, Zinc (Zn) and Boron (B) deficiency is wide spread in the country and much common in wet rice cultivation soil, light texture and calcareous soils. The optimum level of Zn and B are essential from the very beginning of the plant life as these two elements help to maintain cell wall plasticity and elongation, plasma membrane integrity and related to other physiological and metabolic activities otherwise hampered and that leads to lower leaf area index, dry matter accumulation and finally yield. Among micronutrients, zinc influences the synthesis of auxin in plant by inhibiting the synthesis of tryptophan, a precursor of auxin. It is the essential component of various enzyme systems for energy production, photosynthesis, zinc deficient plants also exhibit delayed maturity. Zinc uptake by plant decreases with increase of soil pH. Uptake of zinc is also adversely affected by high levels of available P and Fe in soils.

Materials and Methods
A field experiment was carried out at the Research Farm, Tirhut College Agriculture, RPCAU, Pusa, Bihar during kharif 2015. The soil of experimental field was calcareous sandy-loam alkaline in reaction with pH 8.15. It was moderately fertile being low in organic carbon

(0.56%), available nitrogen (251.9 kg N ha^{-1}), phosphorous (15.06 kg P_2O_5 ha^{-1}), potassium (116.58 kg K_2O ha^{-1}), Sulphur (8.33 mg kg^{-1}), Zinc (0.67 mg kg^{-1}) and Boron (0.51 mg kg^{-1}). The experiment was conducted randomized block design (RBD) with eight treatments, each having four replications. The treatments were T_0: RDF (control), T_1: RDF + B, T_2: RDF + Zn, T_3: RDF + S, T_4: RDF + B + Zn, T_5: RDF + B + S, T_6: RDF + Zn + S and T_7: RDF + Zn + B + S. Uniform basal application was made with 20 kg N ha^{-1}, 40 kg P_2O_5 ha^{-1}, 20 kg K_2O ha^{-1} through urea, DAP and MOP, respectively. Sulphur, Zn and B were applied @ 20, 5 and 1.5 kg ha^{-1} from Bentonite-S, Zinc sulphate and Di-sodium tetra-borate pentahydrate, respectively. In all the treatments seeds were first treated with *Rhizobium* + PSB and also treated with captan @ 2.5 g kg^{-1} of seed before sowing against fungal diseases. Sowing was done relatively at higher seed rate to ensure desired plant population within a row. Plant spacing was maintained row to row 30 cm and plant to plant 10 cm by thinning out extra plants at 10 days after sowing when all the plants emerged out and cultivar 'PU-31' was taken as a test crop. The recommended dose of fertilizers N: P_2O_5: K_2O, 20: 40: 20 kg ha^{-1} per hectare was used. Whereas full dose of N, P_2O_5, K_2O, Sulphur, Zinc and boron was applied as basal at the time of blackgram sowing. Total crude protein content of urdbean was calculated by nitrogen percentage of grain multiplied with 6.25, a constant factor.

Results and Discussion

Number of pods plant^{-1}

Result presented in Table 1, indicates that pods plant^{-1} count was statistically significant due to various treatments. The total number of pods plant^{-1} varied from 17.68 to 21.80. The highest number of pods plant^{-1} was observed in the treatment T_7, which was significantly superior to control, while at par with treatments T_5, T_4, T_6, T_2, T_1 and T_3, the difference among them were also non-significant. While application of nutrient in combination like B + Zn (T_4), B + S (T_5), Zn + S (T_6) and Zn + B + S (T_7) showed their superiority over check in respect pods plant^{-1}. However, it is the apparent that the application of Zn, B and S in all combination increased the number of pods plant^{-1}. Kumar *et al.* (2009) [3] and Kaisher *et al.* (2010) [2] reported similar findings.

Number of grains pod^{-1}

The Table 10 and Fig.5 clearly indicated that numbers of grains pod^{-1} were found significant due to various treatments. The maximum grains per pod was recorded under treatment T_7, which was significantly superior to T_0 (5.4), T_1 (5.5), T_2 (5.7), T_3 (5.9) and T_4, however at par with treatments T_5 and T_6. Most of the treatments showed their superiority over check except T_1 (B 1.5 kg ha-1) in respect to grains pod^{-1}. These results are in line with the findings of Rathi *et al.* (2009) [8], Ahmad *et al*. (2013) [1] and Tahir *et al.* (2013) [11].

Test weight

Table 1 clearly showed that variations in test weight as affected by different treatments were found significant. The maximum test weight (38.85 g) recorded under treatments T_7 (Zn + B + S) which was significantly superior to treatments T_0 (check) and T_2 (Zn 5 kg ha-1) and at par with treatments T_1 (B 1.5 kg ha^{-1}), T3 (S 20 kg ha-1), T_4 (B + Zn), T_5 (B + S) and T_6 (Zn + S).The lowest test weight (34.56 g) obtained from control (T_0). Significant increment in test weight was recorded with treatments T_7, T_5, T_6, T_4 and T_3 over check (T_0). Alone application of B and Zn were found non-significant in respect of test weight over check. The application of different micro and secondary nutrient combination significantly improved the test weight. Balanced fertilization provides congenial atmosphere to growth and development. This increase in 1000-grain weight might be due to better nutrition of pods and grains. Pandey *et al.* (2009) [6] and Niraj and Prakash (2015) [5] also found similar results.

Grain and straw yield

The data of grain yield were analyzed and summarized in Table 2. Different treatments exhibited significant variation in grain yield of urdbean. The highest grain yield (838 kg ha-1) was obtained from treatments T_7, which was significantly superior over treatments yield T_0, T_2, T_1, T_3 and T_4 while at par with T_5 and T_6. The maximum straw yield was recorded under treatment T_7, which was significantly superior over T_0 and treatments T_2, T_1, T_3 and T_4, however at par with treatments T_6 and T_5. Significantly increase in grain and straw yield could be attributes to the fact that nutrients uptake by the crop plant and ultimately photosynthesis activities, resulting laid doun the foundation of higher yield. The results in respect of grain and straw yields are in agreement with the results advocated by Mishra and Tiwari (2002) [4], Sahu and singh (2009) [9] and Ram and Katiyar (2013) [7].

Protein content and production kg ha^{-1} in grains

The data obtained have been significantly analyzed and presented in table 2. The maximum protein was recorded under treatment T_7 (Zn + B + S) which was significantly higher over T_0, T_1 (B) and T_2 (Zn), however at par with treatments T_3 (S), T_4 (B + Zn), T_5 (B + S) and T_6 (Zn + S). The lowest protein value recorded with control. Protein production kg ha^{-1} was calculated by using protein percentage (%) in grains, and grain yield obtained in the particular treatment. The maximum protein production was recorded with treatment T_7 with using Zn + B + S which was significantly superior to control, T_1, T_2, T_3, T_4, T_6 and at par with T_5 while the lowest protein production kg ha^{-1} was recorded in control (T_0). Alone application of any nutrient unable to increase protein content in significant level. Shrinivasan *et al.* (2000) [10], Kumar and Singh (2009) [3] reported similar findings.

Conclusion

It was conducted that yield attributes, grain yield, straw yield, protein content and protein production was also recorded under combined application of T_7 (Zn + B + S) which was significantly superior over T_0 (control), T_1 (B), T_3 (S), T_4 (B + Zn), and T_2 (Zn) and at par with T_5 (B + S) and T_6 (Zn + S). Though all treatments showed positive effect in increasing growth parameter and yield.

Table 1: Effect of different treatments on yield attributes of blackgram.

Treatment	No. of pods plant^{-1}	No. of grains pod^{-1}	Test weight (g) (1000-grains wt.)
T_0 Control	17.68	5.4	34.56
T_1 B(1.5kg ha^{-1})	19.80	5.5	36.78
T_2 Zn(5 kg ha^{-1})	19.97	5.7	36.29
T_3 S (20kg ha^{-1})	19.47	5.9	36.84
T_4 B + Zn	21.09	6.0	37.51
T_5 B + S	21.30	6.2	37.28
T_6 Zn + S	21.00	6.1	37.73
T_7 Zn + B + S	21.80	6.4	38.85
SEm±	0.823	0.11	0.77
CD $_{(0.05)}$	2.420	0.33	2.26

Table 2: Effect of different treatment on yield and quality of blackgram

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Protein in grains (%)	Protein production kg ha^{-1}
T_0 Control	646.50	1854	20.62	133.54
T_1 B(1.5kg ha^{-1})	710.00	2067	22.03	156.33
T_2 Zn(5 kg ha^{-1})	700.00	1970	21.55	151.05
T_3 S (20kg ha^{-1})	719.50	2068	22.37	160.95
T_4 B + Zn	781.00	2113	22.67	177.31
T_5 B + S	793.75	2310	23.35	185.33
T_6 Zn + S	787.50	2290	22.96	180.80
T_7 Zn + B + S	838.00	2472	24.07	201.67
SEm±	17.514	87.955	0.674	7.073
LSD $_{(0.05)}$	51.508	258.675	1.983	20.803

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