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Effect of zinc and iron application on growth and yield of blackgram (*Vigna mungo* L.)

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Abstract

A field experiment was conducted during *kharif* 2025 at Karguanji Research Farm, Department of Soil Science and Agricultural Chemistry, Bundelkhand University, Jhansi (Uttar Pradesh). The soil texture of the experimental site was red soil with a pH of 7.4, medium organic carbon (0.58%), low Available Nitrogen (170.2 kg ha⁻¹), Available Phosphorus (9.5 kg ha⁻¹), Available Potassium (216 kg ha⁻¹) and EC (0.21 dS m⁻¹). The experiment was laid out in a randomised block design (RBD) with three replications of nine treatments to evaluate the effect of Zinc and Iron application on growth and yield of blackgram. In view of this experiment, three Zinc levels, *i.e.* 0 kg ha⁻¹, 10 kg ha⁻¹, 20 kg ha⁻¹ and three levels of Iron, *i.e.* 0 kg ha⁻¹, 5 kg ha⁻¹, 10 kg ha⁻¹. Among all the treatments it was found that treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] recorded significantly highest plant height (41.33 cm), number of branches/plant (9.12), number of leaves plant⁻¹ (22.07), number of nodules plant⁻¹ (24.18), number of pods plant⁻¹ (21.19), number of grains pod⁻¹ (6.27), grain yield plant⁻¹ (4.77 g) and grain yield ha⁻¹ (15.92 q).

Keywords: Blackgram, zinc, iron, growth and yield

1. Introduction

Blackgram (*Vigna mungo* L.), also called as urdbean, is the third most important pulse crop after pigeonpea and chickpea in India. One of the most valuable pulse crops is blackgram, which is grown throughout India. It has unavoidably established itself as the most well-liked pulse and is aptly referred to as the “king of pulses”. With 25–26% protein, 60% carbohydrates, 1.5% fat and substantial amounts of minerals, amino acids and vitamins, seeds are extremely nutritious (Sai Bhargavi *et al.*, 2019) [15]. Among the arable soils of India, 48.1% are deficient in zinc and 11.2% deficient in iron. Zinc and iron deficiencies in soils can be caused by several factors, including parent material, climate, cropping system type and management, all of which have a significant impact on the accumulation or depletion of native soil zinc and iron (Karthikeyan *et al.*, 2022) [17]. The synthesis of chlorophyll and thylakoids, as well as the development of chloroplasts, depend on iron, an essential nutrient for plant growth and development. Micronutrients like iron and zinc are crucial for human growth, development and immune system maintenance. Iron and zinc deficiency affects about 2 billion people globally and is frequently cited as the main cause of anaemia (Bhamare *et al.*, 2018) [18]. Due to its positive effects on auxin synthesis, nodulation status and N fixation, which encourage plant growth and development, zinc application increased the grain yield of peas. The need to increase the production of pulses will necessitate a deep understanding of the connection between crop growth and nutrients. Soil organic matter (SOM) improves the structure, ability to hold water, and nutrient cycling of soil (Yadav *et al.*, 2026) [23]. There is little information on how micronutrients affect pulse crops. Given this context, the current study was conducted to investigate the effects of iron and zinc on blackgram growth and yield.

2. Methods and Materials

The present investigation was undertaken during *kharif* 2025 at Karguanji Research Farm, Department of Soil Science and Agricultural Chemistry, Bundelkhand University, Jhansi (Uttar Pradesh). For the intended study, nine treatments (Table 1) were tested under three replications by using a randomised block design (RBD). Observations were recorded on various growth

parameters viz. plant height, number of branches plant⁻¹, number of leaves plant⁻¹, number of nodules plant⁻¹ and yield parameters viz. number of pods plant⁻¹, number of grains pod⁻¹, test weight (1000 seeds weight), pod yield plant⁻¹ (g) and pod yield ha⁻¹ (q). Data on various growth and yield parameters were subjected to statistical analysis in order to draw valid results. Nutrient management was done through ZnSO₄ and FeSO₄. In addition, full quantities of the recommended dosage of fertilizer (RDF) were placed in the field before the time of ploughing. Based on every plot in equal quantity, 20 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹ were applied through farm yard manure (FYM) @ 12 tonnes ha⁻¹.

Table 1: Treatment details and their symbols

Symbols	Treatments
T ₁	RDF (control)
T ₂	RDF + Zn (10 kg ha ⁻¹)
T ₃	RDF + Zn (20 kg ha ⁻¹)
T ₄	RDF + Fe (5 kg ha ⁻¹)
T ₅	RDF + Fe (5 kg ha ⁻¹) + Zn (10 kg ha ⁻¹)
T ₆	RDF + Fe (5 kg ha ⁻¹) + Zn (20 kg ha ⁻¹)
T ₇	RDF + Fe (10 kg ha ⁻¹)
T ₈	RDF + Fe (10 kg ha ⁻¹) + Zn (10 kg ha ⁻¹)
T ₉	RDF + Fe (10 kg ha ⁻¹) + Zn (20 kg ha ⁻¹)

3. Results and Discussion

Growth parameters

The results revealed (Table 2 and 3) that there was a significant difference due to the application of different doses of zinc and iron on growth parameters of blackgram. It has also been confirmed that combined application of zinc and iron is better than the individual application of zinc and iron to blackgram.

3.1 Plant height (cm)

It is revealed from Table 2 that plant height (cm) was significantly influenced by varying treatment levels of ZnSO₄ and FeSO₄ at different stages of crop growth, i.e. 25, 50 and 75 DAS. The maximum plant height (20.18, 38.15 and 41.33 cm) at successive stages of crop growth (25, 50 and 75 DAS, respectively) was recorded in treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)], which was statistically at par with treatment T₆ at 25 and 75 DAS (10.04 and 40.74cm) and treatment T₈ at 50 DAS (37.64 cm) significantly higher over other treatments. The results are consistent with an increase in plant height being due to iron and zinc application along with RDF in black gram crop, which helps in various enzymes that are responsible for driving many metabolic activities in the crop and are involved in the synthesis

of chlorophyll, which is essential for the maintenance of chloroplast structure and function, which helps in increasing plant growth. A significant effect was due to zinc, which activates certain enzymes responsible for cell division and elongation, which is a major source of increase in plant height (Nadergoli *et al.*, 2011) [16]. Zinc also actively takes part in auxin production, which increases cell size and number and thus increases plant height (Dashadi *et al.*, 2013) [5]. Similar results were reported by Gidaganti *et al.* (2019) [7], who found the highest plant height (54.10 cm) with the application of RDF + Zn @ 25 kg ha⁻¹ + Fe @ 20 kg ha⁻¹ in green gram. Ajannavar *et al.* (2021) [1] observed an increase in plant height (32.10 cm) with the treatment RDF + Rhizobium + PSB + FeSO₄ @ 10 kg ha⁻¹ + ZnSO₄ @ 10 kg ha⁻¹ + Borax @ 10 kg ha⁻¹ + sodium molybdate @ 1.0 g kg⁻¹ seeds in chickpea. Almad *et al.* (2020) [2] observed that in pigeon pea, the highest plant height (252.5 cm) was recorded with RDF + soil application of ZnSO₄ @ 15 kg ha⁻¹ and foliar application of 0.5% Zn EDTA compared with other treatments.

3.2 Number of branches plant⁻¹

The number of branches plant⁻¹ grew significantly as influenced by different doses of zinc and iron application at 25, 50 and 75 DAS. The maximum number of branches plant⁻¹ (5.89, 9.12 and 5.99) was found in application of treatment T₆ [RDF + Fe (5 kg ha⁻¹) + Zn (20 kg ha⁻¹)] at 25 DAS and T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] at 50 DAS and 75 DAS, respectively, which was statistically at par with treatment T₉ and T₃ at 25 DAS (5.09), treatment T₃ at 50 DAS (8.79) and treatment T₆ at 75 DAS (4.99) significantly higher over rest of the other treatments. Almad *et al.* (2020) [2] reported findings that were similar and found that RDF + soil application of ZnSO₄ @ 15 kg ha⁻¹ foliar application of 0.5% Zn EDTA significantly increased the number of primary branches plant⁻¹ (23.42) and secondary branches plant⁻¹ (25.42) in pigeon pea compared to other treatments. Kareti and George (2017) [9] found that the maximum number of branches plant⁻¹ (19.5) was recorded from those plots that had received 70 kg P₂O₅ + 20 kg ZnSO₄ ha⁻¹ in chickpea. Ajannavar *et al.* (2021) [1] found that treating chickpeas with RDF + Rhizobium + PSB + FeSO₄ @10 kg ha⁻¹ + ZnSO₄ @10 kg ha⁻¹ + Borax @10 kg ha⁻¹ + sodium molybdate @1.0 g kg⁻¹ seeds increased the maximum number of branches plant⁻¹ (12.74). Sudhanshu *et al.* (2022) [21] found that the maximum number of branches plant⁻¹ (5.93) was obtained from 20 kg ha⁻¹ sulphur as gypsum + 20 kg ha⁻¹ sulphur as single super phosphate + 25 kg ha⁻¹ ha FeSO₄ as basal dose application in green gram.

Table 2: Effect of zinc and iron application on plant height (cm) and number of branches plant⁻¹ of blackgram

Growth parameters						
Treatments	Plant height (cm)			No. of branches plant ⁻¹		
	At 25 DAS	At 50 DAS	At 75 DAS	At 25 DAS	At 50 DAS	At 75 DAS
T ₁	13.95	30.57	32.85	2.09	5.44	3.98
T ₂	14.07	34.35	33.10	4.13	7.18	4.22
T ₃	14.50	34.73	36.11	5.09	8.79	4.94
T ₄	13.35	30.99	36.71	3.53	6.19	3.72
T ₅	15.17	35.68	38.42	4.36	7.51	3.70
T ₆	18.04	35.72	40.74	5.89	7.13	4.99
T ₇	14.58	33.26	37.13	3.94	6.80	3.76
T ₈	16.14	37.64	40.13	4.44	7.88	4.50
T ₉	20.18	38.15	41.33	5.09	9.12	5.99
S.Em±	0.39	0.31	4.60	0.26	0.33	0.27
CD (5%)	1.17	0.94	13.8	0.78	0.99	0.81

3.3 Number of leaves plant⁻¹

Data on the number of leaves plant⁻¹ are presented in Table 3. The result revealed that treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] recorded significantly higher number of leaves plant⁻¹ (18.92, 22.07 and 21.21) at 25, 50 and 75 DAS, which was closely followed by Treatment T₆ (17.49, 18.01 and 19.69) at 25, 50 and 75 DAS, respectively. The outcomes supported the findings of Gidaganti *et al.* (2019) [7], who found that the number of leaves plant⁻¹ in green gram at 30 DAS (15.9), 45 DAS (18.0) and 60 DAS (16.6) was significantly increased by soil application of RDF + Zn @ 25 kg ha⁻¹ ha + Fe @ 20 kg ha⁻¹. Plants treated with different doses of zinc and iron produced more leaves. More zinc and iron applied through different treatments showed a better response than any other treatment. Salina *et al.* (1985) reported that quantity of dosages is therefore better than any other kind of treatment. Similar results were noted by Verma *et al.* (2004) [24] and Sangolli *et al.* (2018) [19].

3.4 Number of nodules plant⁻¹

There were steady increases in root nodules from 25 to 50 DAS and from 50 to 75 DAS; root nodules plant⁻¹ decreased. At 25, 50 and 75 DAS, the maximum number of nodules plant⁻¹ (18.29, 24.18 and 13.77, respectively) was observed in application of treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)], which was

significantly superior over all rest of treatments and statistically at par with treatment T₈ (17.39, 22.90 and 13.09) at 25, 50 and 75 DAS, respectively. Similar results were also reported by Meena *et al.* (2013) [13], who found the maximum number of nodules per plant (19.00) with the application of 25 kg ha⁻¹ FeSO₄ as a basal dose application in green gram crop. Ajjannavar *et al.* (2021) [11] observed an increase in the maximum number of nodules plant⁻¹ (17.55) with treatment RDF + Rhizobium + PSB + FeSO₄ @ 10 kg ha⁻¹ + ZnSO₄ @ 10 kg ha⁻¹ + Borax @ 10 kg ha⁻¹ + sodium molybdate @ 1.0 g kg⁻¹ seeds in chickpea. Lokhande *et al.* (2018) [12] found that a higher number of nodules plant⁻¹ (28.4) was observed under application of 100% N + 50 kg ha⁻¹ P₂O₅ + 25 kg ha⁻¹ ZnSO₄ in green gram. Shaik *et al.* (2021) [20] noticed a greater number of nodules plant⁻¹ (24.32), which were obtained from Boron 3 kg ha⁻¹ + Zinc 30 kg ha⁻¹ in the cowpea crop. Sudhanshu *et al.* (2022) [21] observed a higher number of nodules plant⁻¹ (30.16) at 45 DAS with the application of 20 kg ha⁻¹ sulphur as gypsum + 20 kg ha⁻¹ sulphur as single super phosphate + 25 kg ha⁻¹ FeSO₄ as basal dose application in green gram. Kumar *et al.* (2020) [11] revealed that a higher number of root nodules plant⁻¹ (73.82) was obtained with the application of 12.5 kg S ha⁻¹ as SSP + 1% FeSO₄ as foliar spray at 25 DAS in blackgram.

Table 3: Effect of zinc and iron application on number of leaves plant⁻¹ and number of nodules plant⁻¹ of blackgram.

Growth parameters						
Treatments	No. of leaves plant ⁻¹			No. of nodules plant ⁻¹		
	At 25 DAS	At 50 DAS	At 75 DAS	At 25 DAS	At 50 DAS	At 75 DAS
T ₁	10.11	12.97	15.05	11.24	13.21	10.22
T ₂	14.04	15.45	18.41	14.09	17.29	12.36
T ₃	15.82	16.02	19.53	15.85	18.31	11.69
T ₄	13.01	13.79	16.40	15.62	18.27	11.74
T ₅	15.00	16.20	19.13	15.63	18.99	12.57
T ₆	17.49	18.01	19.69	17.20	20.90	12.65
T ₇	12.30	14.72	17.85	17.20	19.67	12.01
T ₈	15.13	17.13	19.45	17.39	22.90	13.09
T ₉	18.92	22.07	21.21	18.29	24.18	13.77
SEm±	0.37	0.38	0.34	0.38	0.40	0.63
CD (5%)	1.11	1.15	1.03	1.15	1.19	1.88

Yield attributes and Yields

The results revealed (Table 4) that there was a significant difference due to the application of different doses of zinc and iron on yield attributes of blackgram. It has also been confirmed that combined application of zinc and iron is better than the individual application of zinc and iron to blackgram.

3.5 Number of pods plant⁻¹

The results revealed that application of zinc and iron application were significantly influenced the number of pods plant⁻¹ in blackgram. The maximum number of pods plant⁻¹ (21.19) was observed in treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] and it was at par with the application of treatment T₈ (20.94), significantly superior over the rest of the other treatments. These results conform with Banoth *et al.* (2022) [3], who reported that the maximum number of pods plant⁻¹ (39.70) was obtained from ZnSO₄ @ 15 kg ha⁻¹ + B 0.3% foliar application in green gram. Gidaganti *et al.* (2019) [7] observed that soil application of RDF + Zn @ 25 kg ha⁻¹ ha + Fe @ 20 kg ha⁻¹ in green gram significantly increased the number of pods per plant at 45 DAS (13.7), 60 DAS (21.3) over control. Meena *et al.* (2013) [13] reported that the maximum number of pods plant⁻¹ (13.57) was obtained with the application of 25 kg ha⁻¹ FeSO₄ as a basal dose in green gram

crop. Shaik *et al.* (2021) [20] noticed that a greater number of pods plant⁻¹ (24.32) was obtained from Boron 3 kg ha⁻¹ + Zinc 30 kg ha⁻¹ in cowpea crop.

3.6 Number of grains pod⁻¹

The data regarding the number of grains pod⁻¹ of black gram as influenced by soil application of micronutrient fertilizers was recorded during growth stages. The maximum number of grains pod⁻¹ (6.27) was recorded in the application of treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] at par with treatment T₈ (5.76), which was significantly superior over the rest of the treatments. These results are in line with Gidaganti *et al.* (2019) [7] showed that soil application of RDF + Zn @ 25 kg ha⁻¹ + Fe @ 10 kg ha⁻¹ in green gram significantly increased the number of seed pod⁻¹ at 60 DAS (9.13) over the control. Banoth *et al.* (2022) [3] reported the maximum number of seeds pod⁻¹ (8.84), which was obtained from ZnSO₄ @ 15 kg ha⁻¹ + B 0.3% foliar application in green gram. Kareti and George (2017) [9] noticed that the maximum number of seeds pod⁻¹ (1.45) was recorded from those plots that had received 70 kg P₂O₅ + 20 kg ZnSO₄ ha⁻¹ in chickpea. Sudhanshu *et al.* (2022) [21] observed a higher number of seeds pod⁻¹ (12.07) with application of 20 kg ha⁻¹ sulphur as gypsum + 20 kg ha⁻¹ sulphur as single super phosphate + 25 kg ha⁻¹ FeSO₄

as basal dose application in green gram.

3.7 Test weight (1000 seeds weight in g)

The test weight of blackgram enhanced significantly with application of RDF with zinc and iron micronutrients. Significantly highest test weight (36.07 g) was found with application of treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] over the rest of the treatments, which was at par with treatment T₈ (34.48 g). Similar findings were recorded by Gidaganti *et al.* (2019) [7], who observed that soil application of RDF + Zn @ 25 kg ha⁻¹ + Fe @ 10 kg ha⁻¹ in green gram significantly increased the test weight (36.6 g) over the control. Almad *et al.* (2020) [2] noticed that in pigeon pea, a higher test weight (12.05 g) was

recorded with RDF + soil application of ZnSO₄ @ 15 kg ha⁻¹ foliar application of 0.5% Zn EDTA over other treatments. Banoth *et al.* (2022) [3] reported that maximum test weight (37.93 g) was obtained from ZnSO₄ @ 15 kg ha⁻¹ + B 0.3% foliar application in green gram. Sudhanshu *et al.* (2022) [21] revealed that maximum test weight (37.03 g) was recorded with application of 20 kg ha⁻¹ sulphur as gypsum + 20 kg ha⁻¹ sulphur as single super phosphate + 25 kg ha⁻¹ FeSO₄ as basal dose application in green gram crop. Misal (2018) [14] observed that maximum test weight (42.61 g) was produced by the RDF + soil application of ZnSO₄ (25 kg ha⁻¹) + FeSO₄ (25 kg ha⁻¹) + Borax (10 kg ha⁻¹) found significantly superior over the rest of the treatments in green gram.

Table 4: Effect of zinc and iron application on yield attributes of blackgram

Yield attributes			
Treatments	Number of pods plant ⁻¹	Number of grains pod ⁻¹	Test weight (1000 seeds weight in g)
T ₁	15.66	3.71	30.37
T ₂	17.29	4.03	32.88
T ₃	17.94	4.18	34.09
T ₄	18.18	4.28	31.67
T ₅	19.31	5.21	32.66
T ₆	20.22	5.68	33.58
T ₇	20.56	5.50	33.74
T ₈	20.94	5.76	34.48
T ₉	21.19	6.27	36.07
S.Em±	0.46	0.53	0.50
CD (5%)	1.39	1.60	1.51

3.8 Grain yield plant⁻¹ (g) and Grain yield ha⁻¹ (q)

The grain yield plant⁻¹ (g) and grain yield ha⁻¹ (q) were significantly influenced by the application of different doses of zinc and iron micronutrients in blackgram crop. Among all the treatments, T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] significantly produced the highest grain yield of 4.77 g per plant, with a per cent increase in grain yield plant⁻¹ by 171.02%, which was on par with treatment T₈ (4.15 g), significantly superior over the rest of the treatments. The highest grain yield ha⁻¹ (15.92q) was observed in the application of treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)], which was on par with treatment T₈ (13.83q), significantly increasing grain yield ha⁻¹ over the rest of the other treatments. The higher yield might be attributed to the crop meeting demand through increased assimilation and translocation of photosynthates from source to sink, coupled with a beneficial role of iron and zinc during the reproductive growth phase. Ultimately, the combined effect of iron and zinc provided adequate nutrition, leading to enhanced yield attributes and overall yield. Similar findings were observed by Gidaganti *et al.* (2019) [7], who recorded that soil application of RDF + Zn @ 25 kg ha⁻¹ + Fe @ 10 kg ha⁻¹ in green gram significantly increased the seed yield (32.37 q ha⁻¹) over the control. Sudhanshu *et al.* (2022) [21] revealed that maximum seed yield (1421.00 t ha⁻¹) was obtained with the application of 20 kg/ha sulphur as gypsum + 20 kg ha⁻¹ sulphur as single super phosphate + 25 kg ha⁻¹ FeSO₄ as basal dose application in green gram. Meena *et al.* (2013) [13] reported that higher seed yield (1081.35 kg ha⁻¹) was obtained with the application of 25 kg ha⁻¹ FeSO₄ as basal dose application in green gram crop. Gahlot *et al.* (2020) [6] reported that the soil application of ZnSO₄ and FeSO₄ each @ 25 kg ha⁻¹ along with foliar application of 0.5% FeSO₄ recorded significantly maximum grain yield (1357 kg ha⁻¹) in mungbean crop. Ajjannavar *et al.* (2021) [1] observed an increase in maximum grain yield (1591 kg ha⁻¹) with treatment RDF + Rhizobium + PSB + FeSO₄ @ 10 kg ha⁻¹ + ZnSO₄ @ 10 kg ha⁻¹ + Borax @ 10 kg ha⁻¹ + sodium

molybdate @ 1.0 g kg⁻¹ seeds in chickpea. Comparable results were also reported by Choudhary *et al.* (2014) in greengram, Jha *et al.* (2015) [8] in blackgram and Todawat *et al.* (2017) [22] in greengram when micronutrients (Fe and Zn) were applied.

Table 5: Effect of zinc and iron application on yields of blackgram

Yields		
Treatments	Grain yield plant ⁻¹ (g)	Grain yield ha ⁻¹ (q)
T ₁	1.76	5.88
T ₂	2.31	7.71
T ₃	2.57	8.58
T ₄	2.48	8.29
T ₅	3.28	10.95
T ₆	3.87	12.91
T ₇	3.81	12.71
T ₈	4.15	13.83
T ₉	4.77	15.92
S.Em±	0.36	1.21
CD (5%)	1.09	3.64

4. Conclusion

The results revealed that there was a significant difference due to the application of different doses of zinc and iron on growth parameters, yield attributes and yields of blackgram. It has also confirmed that combined application of zinc and iron is better than the individual application of zinc and iron to blackgram. From the results, it was concluded that the application of treatment T₉ [RDF + Fe (10 kg ha⁻¹) + Zn (20 kg ha⁻¹)] at 25, 40 and 55 days after sowing significantly increased the growth parameters, yield attributes and yields of blackgram.

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