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Effect of iron and zinc on growth and yield of buckwheat (*Fagopyrum esculentum* L.)

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Abstract
The field experiment was conducted during *Rabi* season 2024 at Crop Research Farm, Naini Agricultural Institute, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. To determine "Effect of Iron and Zinc on growth and yield of Buckwheat (*Fagopyrum esculentum* L.)'' The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice on the basis of one year experimentation are T., Iron 5 kg/ha + Zinc 15 kg/ha, T_2., Iron 5 kg/ha + Zinc 20 kg/ha, T_3., Iron 5 kg/ha + Zinc 25 kg/ha, T_4., Iron 10 kg/ha + Zinc 15 kg/ha, T_5., Iron 10 kg/ha + Zinc 20 kg/ha, T_6., Iron 10 kg/ha + Zinc 25 kg/ha, T_7., Iron 15 kg/ha + Zinc 15 kg/ha, T_8., Iron 15 kg/ha + Zinc 20 kg/ha, T_9., Iron 15 kg/ha + Zinc 25 kg/ha, T_0.,Control 40-20-20 : N-P-K kg/ha. The result showed that significantly maximum plant height (73.60 cm), plant dry weight (11.03 g/plant), grains per plant (245.56), grain yield (1650 kg/ha), stover yield (4610 kg/ha), were recorded in T_4., [Iron (10 kg/ha) +Zinc (15 kg/ha)] as compared to other treatments. Similarly, maximum gross returns (INR 147770/ ha), net return (INR 92745/ha) and benefit cost ratio (1.69) was obtained in the T_4 [Iron (10kg/ha) +Zinc (15 kg/ha)] as compared to other treatments.

Keywords: Buckwheat, Iron, Zinc, Growth and yield

Introduction
Buckwheat is a gluten-free pseudocereal that has gained attention as a functional food owing to its high biological value (Krumina-Zemture *et al.*, 2016) [10]. Among cultivated crops, it holds a distinct position due to its nutritional, dietary, and therapeutic attributes. Because of its medicinal and nutritive properties, researchers are also exploring its potential as a pharmaceutical crop. Its grains as well as other plant parts are utilized across food, feed, cosmetic, and pharmaceutical industries.

Morphologically, buckwheat is an annual, broad-leaved herbaceous plant. Although its seed resembles cereals with a germ, endosperm, aleurone layer, and hull, taxonomically it belongs to the family *Polygonaceae*, not *Graminae*. This unique position makes it neither a true cereal nor a legume, but a pseudocereal—due to its cereal-like starchy endosperm. Being dicotyledonous, it shares similarities with legumes and nuts. Its achene is generally triangular, though the shape varies among species and cultivars. Once categorized as an underutilized crop, it is now emerging as a future crop with growing demand (Yadav *et al.*, 2017) [20].

Traditionally referred to as a "poor man's crop," buckwheat plays a significant role as a staple food in remote tribal regions of India. It thrives best in high-altitude areas because of its strong adaptability to climatic variability (Baniya, 2001) [3]. Nutritionally, buckwheat proteins are rich in lysine and of superior quality compared to common cereals. Medicinal benefits are attributed to all parts of the plant, further enhancing its value. Agronomically, it is well suited for marginal soils, tolerates acidity better than cereals, and is capable of growing with limited irrigation during the *rabi* season owing to its branched taproot system (Paul & Nandi, 2020) [15].

Iron (Fe) is a vital micronutrient, indispensable for plant metabolic functions. Despite being abundant in soil, Fe is often unavailable to plants, making its deficiency a widespread issue (Nozoye *et al.*, 2011) [14]. Iron is essential in the formation of chlorophyll, nucleic acid metabolism, and acts as a cofactor for numerous enzymes. It forms an integral part of nitrogenase, crucial for nitrogen fixation, and also contributes to redox processes within cells.

Furthermore, it activates enzymes such as aminolevulinic acid synthetase and coproporphyrinogen oxidase, and is a structural element of hemes, hematin, and leghemoglobin (Marschner, 2012) [12].

Zinc (Zn) is another indispensable micronutrient, closely associated with chlorophyll synthesis, growth hormone production, protein and nucleic acid metabolism. It improves the utilization of nitrogen (N) and phosphorus (P), besides influencing water uptake and retention. Its application enhances nodulation, nitrogen fixation, and crop yields, especially in legumes (Katyal *et al.*, 2004) [9].

Approximately 49% of Indian soils are Zn-deficient, and responses to Zn fertilization have been reported in several crops. Buckwheat is particularly sensitive to zinc deficiency, although varietal differences exist. Deficiency of Zn can lead to reduced yield, delayed maturity, lower water use efficiency, and impaired nodulation and N-fixation (Khan *et al.*, 2003; Ahlawat *et al.*, 2007) [8, 1]. The problem is especially pronounced in calcareous soils, while excessive Zn may induce toxicity (Nan *et al.*, 2002) [13]. Being a part of several enzymatic systems, Zn is directly or indirectly linked with auxin regulation, seed development, protein synthesis, and overall plant maturation.

Materials and Methods

The field experiment was conducted during the *Rabi* season of 2024 at the Crop Research Farm, Allahabad School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh. The experimental site is geographically located at 25°24′42″ N latitude, 81°50′56″ E longitude, and 98 m above mean sea level. It is situated on the right bank of the river Yamuna, alongside the Prayagraj-Rewa road, about 5 km away from Prayagraj city.

The experiment was laid out in a Randomized Block Design (RBD) comprising 10 treatments, each replicated three times. The gross plot size for each treatment was 3 m × 3 m. The treatments consisted of different combinations of iron (5, 10, and 15 kg/ha) and zinc (15, 20, and 25 kg/ha), along with a control. The treatment details are as follows: T: Iron 5 kg/ha + Zinc 15 kg/ha,T_2: Iron 5 kg/ha + Zinc 20 kg/ha, T_3: Iron 5 kg/ha + Zinc 25 kg/ha, T_4: Iron 10 kg/ha + Zinc 15 kg/ha, T_5: Iron 10 kg/ha + Zinc 20 kg/ha, T_6: Iron 10 kg/ha + Zinc 25 kg/ha, T_7: Iron 15 kg/ha + Zinc 15 kg/ha, T_8: Iron 15 kg/ha + Zinc 20 kg/ha, T_9: Iron 15 kg/ha + Zinc 25 kg/ha, T_0 (Control): 40:20:20 N:P:K kg/ha.

The buckwheat variety 'Sangla B-1' was selected for the study. Seeds were manually sown in lines on 10 October 2024 and immediately covered with soil. At harvest, crop samples were collected from a net plot area of 1 m² per treatment, from which five plants were randomly selected for recording observations.

The data were recorded on the following growth and yield attributes: plant height, dry weight, crop growth rate (CGR), relative growth rate (RGR), number of grains per plant, test weight, grain yield, stover yield, and harvest index.

The experimental data were subjected to statistical analysis using the Analysis of Variance (ANOVA) technique. The economics of treatments was also worked out, including cost of cultivation, gross return, net return, and benefit-cost ratio (B:C ratio).

Results and Discussion

Plant Height (cm): Significant variation in plant height of buckwheat was observed due to different levels of iron and zinc application. The maximum plant height (73.60 cm) was recorded in T_4 (Iron 10 kg/ha + Zinc 15 kg/ha), which was statistically at par with T_2 (Iron 5 kg/ha + Zinc 20 kg/ha) and T_9 (Iron 15 kg/ha + Zinc 25 kg/ha). The minimum plant height (63.06 cm) was recorded under T_0 (Control).

The elevation in plant height can be ascribed to the crucial role of iron in facilitating the transfer of energy within the plant, aiding in the formation of enzymes and proteins, and contributing to the fixation of nitrogen. Moreover, the augmented plant height due to Fe could be a result of its synergistic association with nitrogen. In addition to Sudha and Stalin (2015) [19]; Badiyal *et al*. (2011) [5]; Bameri *et al.* (2013) [4]; and; Choudhary *et al.* (2021); have all reported similar observations, indicating that the application of iron leads to an increase in growth in rice.

Plant dry weight (g/plant): The data pertaining to plant dry weight are presented in Table 1. At harvest, a significant variation in dry matter accumulation was observed among the different treatments. The highest plant dry weight (11.03 g/plant) was recorded in T_4 (Iron 10 kg/ha + Zinc 15 kg/ha), which was closely followed by T_2 (Iron 5 kg/ha + Zinc 20 kg/ha). The lowest dry weight (7.90 g/plant) was recorded under T_0 (Control).

Statistical analysis revealed that treatments T, T_3, T_5, and T_9 were found to be statistically at par with T_4, indicating that these treatment combinations were equally effective in enhancing dry matter accumulation.

Similar result were Saji *et al.* (2023) [16] that Applying iron and zinc to plants generally leads to an increase in their dry weight per plant, meaning that the overall plant biomass is greater when these micronutrients are present in adequate amounts; this is because both iron and zinc play crucial roles in vital plant functions like photosynthesis and enzyme activity, contributing to better growth and development.

Yield attributes and Yield

Grains per plant: A significant difference was observed in the number of grains per plant due to different treatment combinations of iron and zinc. The maximum number of grains per plant (245.56) was recorded in T_4 (Iron 10 kg/ha + Zinc 15 kg/ha), while the minimum (100.62) was observed in T_0 (Control).

These results are consistent with the findings of Krishnaveni *et al.* (2004) [11] who reported that fertilization with NPK combined with Fe (500 ppm), Zn (300 ppm), and Mn (300 ppm) significantly increased grain per plant compared to control. These studies underscore the beneficial effects of micronutrient zinc and iron on in leguminous crops.

Test Weight (g): The data pertaining to the mean Test weight (g)as influenced by different treatment combination between Iron and Zinc was recorded periodically during the crop at harvest. The maximum and significantly higher Test weight (g) was recorded in T_5 (Iron 10kg/ha + Zinc 20 kg/ha) with (41.40), and minimum with (32.20) in T_0 (Control N-P-K:40-20-20kg/ha), However, only T_9 were found statically at par with T_5 (Iron 10kg/ha + Zinc 20 kg/ha).

The increased pod breadth with higher concentrations of Zn and Fe can be attributed to the role of zinc in biomass production and iron in chlorophyll synthesis, which are essential for overall plant growth and development (Abdollahi *et al.* 2010) [2]. These results are in agreement with Bhamare, who reported that the application of GRDF combined with iron (0.2%) and zinc (0.2%) significantly enhanced test weight.

Grain yield (kg/ha): The data revealed a significant influence of iron and zinc application on grain yield of buckwheat. The maximum and significantly higher grain yield (1650 kg/ha) was recorded in T_4 (Iron 10 kg/ha + Zinc 15 kg/ha), which was followed closely by T_2 (Iron 5 kg/ha + Zinc 20 kg/ha) with (1647 kg/ha). The minimum grain yield (720 kg/ha) was obtained under T_0 (Control: 40-20-20 NPK kg/ha).Statistical analysis further indicated that treatments T_2 and T_5 were found to be at par with T_4, suggesting comparable effectiveness in improving grain yield.

The increase in seed yield due to Zn and Fe application could be attributed to the enhanced synthesis of carbohydrates and proteins and their subsequent transport to the seed formation sites, as suggested by Mali). These results are consistent with findings of Fouda and Abd-Elhamied (2017) [7] and Sahu *et al.* (2008) [17], who also reported a positive impact of Zn and Fe on yield, highlighting the importance of these micronutrients in improving crop productivity.

Stover Yield (kg/ha): The application of iron and zinc significantly influenced the stover yield of buckwheat. The maximum and significantly higher stover yield (4610 kg/ha) was obtained from T_4 (Iron 10 kg/ha + Zinc 15 kg/ha), which was followed by T_2 (Iron 5 kg/ha + Zinc 20 kg/ha) with (4480 kg/ha). The lowest stover yield (3080 kg/ha) was recorded under T_0 (Control: 40-20-20 NPK kg/ha). Statistical analysis showed that treatments T_2, T_5, T_6, and T_7 were found to be at par with T_4, indicating similar effectiveness in improving stover yield.

These results are consistent with the findings of Fouda and Abd-Elhamied (2017) [7] and Sahu *et al*. (2008) [17], who also reported a positive impact of Zn and Fe on yield, highlighting the importance of these micronutrients in improving crop productivity

Harvest index (%): The data reveals that there is no significant difference among the treatments on Harvest index**.** The maximum Harvest index (%) was recorded in T (Iron 5kg/ha + Zinc 15 kg/ha) was (27.46), was (27.14) and minimum with (18.94) in T_0 (Control N- P- K: 40- 20- 20 kg/ha)

Economic analysis: The Highest benefit cost ratio (2.46) was recorded in T_4 (Iron 10kg/ha+ Zinc 15 kg/ha) as compared to other treatments. Successive increase in zinc rates increased benefit cost ratio. This result is in conformity with the work of (Shivay *et al.* 2014) [18].

Conclusion: It was concluded that for obtaining higher yield components with better quality of buckwheat, application of Iron 10 kg/ha + Zinc 15 kg/ha was recorded significantly higher plant height (73.60 cm), grains per plant (245.56), grain yield (1650 kg/ha), stover yield (4610 kg/ha) and benefit cost ratio (1.69) as compared to other treatments. Since, the findings based on the research done in one season.

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Table 1: Effect of Iron and Zinc on growth attributes, yield attributes and yield of Buckwheat (*Fagopyrum esculentum* L.)

S No	Treatment combination	Plant Height (cm)	Dry Weight (g/plant)	Grains per plant(g)	Test weight (g/m)	Grain yield (kg/ha)	Stover yield (kg./ha)	Harvest Index (%)
1.	Iron 5 kg/ha + Zinc 15 kg/ha	69.11	10.27	196.25	34.97	1527	4030	27.46
2.	Iron 5 kg/ha + Zinc 20 kg/ha	71.42	8.80	245.56	30.55	1647	4480	26.87
3.	Iron 5 kg/ha + Zinc 25 kg/ha	64.27	10.48	155.37	39.10	1350	4060	24.95
4.	Iron 10 kg/ha + Zinc 15 kg/ha	73.60	11.03	217.48	34.14	1650	4610	26.35
5.	Iron 10 kg/ha + Zinc 20 kg/ha	70.39	9.90	169.56	41.40	1560	4440	26.87
6.	Iron 10 kg/ha + Zinc 25 kg/ha	68.04	8.58	177.81	36.02	1410	4160	25.31
7.	Iron 15 kg/ha + Zinc 15 kg/ha	66.73	8.50	191.62	35.46	1510	4340	25.81
8.	Iron 15 kg/ha + Zinc 20 kg/ha	68.45	8.43	188.84	36.22	1520	4080	27.14
9.	Iron 15 kg/ha + Zinc 25 kg/ha	69.75	8.53	172.75	34.21	1310	3720	26.04
10	Control N:P:K- (40:20:20 Kg/ha)	63.06	7.90	100.62	32.20	720	3080	18.94
	F - test	S	S	S	S	S	S	NS
	S. Em (±)	1.03	0.68	2.41	0.30	32.85	163.39	2.00
	CD (p = 0.05)	2.92	1.92	7.15	0.84	97.60	485.37	-

Table 2: Effect of Iron and Zinc on economic of production of Buckwheat (*Fagopyrum esculentum* L.)

S No.	Treatment combination	Cost of Cultivation (INR/ha)	Gross return (INR/ha)	Net Return (INR/ha)	B:C ratio
1	Iron 5 kg/ha + Zinc 15 kg/ha	54,675	135100	80425	1.47
2	Iron 5 kg/ha + Zinc 20 kg/ha	54,850	146650	91800	1.67
3	Iron 5 kg/ha + Zinc 25 kg/ha	55,025	122920	67895	1.23
4	Iron 10 kg/ha + Zinc 15 kg/ha	55,025	147770	92745	1.69
5	Iron 10 kg/ha + Zinc 20 kg/ha	55,200	140280	85080	1.54
6	Iron 10 kg/ha + Zinc 25 kg/ha	55,375	127820	72445	1.31
7	Iron 15 kg/ha + Zinc 15 kg/ha	55,375	136080	80705	1.46
8	Iron 15 kg/ha + Zinc 20 kg/ha	55,550	134960	79410	1.43
9	Iron 15 kg/ha + Zinc 25 kg/ha	55,725	117740	62,015	1.11
10	Control N:P:K- (40:20:20 Kg/ha)	53,800	68880	15,080	0.28

References

1. Ahlawat GB, Zadid MA. Nutrient management in chickpea. In: Yadav SS, Redden R, Chen W, Sharma B, editors. Chickpea breeding and management. Wallingford (UK): CAB International; 2007. p. 213-232.
2. Abdollahi M, Eshghi S, Tafazoli E. Interaction of paclobutrazol, boron, and zinc on vegetative growth, yield, and fruit quality of strawberry (*Fragaria* × *ananassa* Duch. cv. Selva). J Biol Environ Sci. 2010;4:67-75.
3. Baniya BK. Buckwheat research in Nepal: an overview. In: Bimb PH, Joshi BK, editors. Research and development on buckwheat: an important yet a neglected crop in Nepal. Proc Natl Workshop. Khumaltar, Nepal: Biotechnology Unit-NARC; 2001.
4. Bameri M, Abdolshahi R, Mohammadi-Nejad G, Yousefi K, Tabatabaie SM. Effect of different microelement treatment on wheat (*Triticum aestivum*) growth and yield. Int Res J Appl Basic Sci. 2013;3(1):219-223.
5. Badiyala D, Pankaj C. Effect of zinc and FYM on productivity and availability in maize (*Zea mays*) - linseed (*Linum usitatissimum*) cropping sequence. Indian J Agron. 2011;56(2):88-91.
6. Choudhary B, Sharma PK, Mandeewal RL, Verma BL, Dudwal M. Response of iron and zinc on yield attributes, yield and economics of wheat (*Triticum aestivum* L.). Int J Plant Soil Sci. 2021;33(22):29-35.
7. Fouda KF, Abd-Elhamied AS. Integrated effect of foliar fertilization of Fe, Zn, and rates of P fertilization on growth and yield of cowpea. J Soil Sci Agric Eng Mansoura Univ. 2017;8(12):733-740.
8. Khan MA, Ali A, Tanveer A. Effect of seed inoculation and different levels of phosphorus on the yield and yield components of chickpea. Pak J Life Soc Sci. 2003;1:106-108.
9. Katyal JC, Rattan RK, Dutta SP. Management of Zn and B for sustainable crop production. Fertilizer News. 2004;49(12):83-89.
10. Krumina-Zemture G, Beitane I, Gramatina I. Amino acid and dietary fibre content of pea and buckwheat flours. Res Rural Dev. 2016;1:103-108.
11. Krishnaveni AS, Palchary A, Mahendram S. Effect of foliar spray of nutrient on growth and yield of green gram (*Phaseolus radiatus*). Legume Res. 2004;27(2):149-150.
12. Marschner P. Mineral nutrition of higher plants. 3rd ed. UK: Academic Press; 2012. p. 191-243.
13. Nan Z, Li J, Zhang J, Cheng G. Cadmium-zinc interactions and their transfer in soil-crop system under actual field conditions. Sci Total Environ. 2002;285:187-195.
14. Nozoye T, Nagasaka S, Kobayashi T. Phytosiderophore efflux transporters are crucial for iron acquisition in graminaceous plants. J Biol Chem. 2011;286:5446-5454.
15. Paul T, Nandi K. Response of buckwheat varieties in northern parts of West Bengal. Int J Curr Microbiol Appl Sci. 2020;9(1):2434-2437.
16. Saji J, Dawson J. Effect of application of iron and zinc on growth and yield of cluster bean (*Cyamopsis tetragonoloba* L.). Int J Environ Clim Change. 2023;13(9):2961-2964.
17. Sahu S, Lidder RS, Singh PK. Effect of micronutrients and biofertilizers on growth, yield, and nutrient uptake by chickpea (*Cicer arietinum* L.) in Vertisols of Madhya Pradesh. Adv Plant Sci. 2008;21:501-503.
18. Shivay YS, Prasad R, Rahal A. Genotypic variation for productivity, zinc utilization efficiencies and kernel quality in rice under low available zinc conditions. J Plant Nutr. 2014;33:1835-1848.
19. Sudha R, Stalin P. Influence of micronutrients on yield and quality of rice (*Oryza sativa* L.). Int J Curr Microbiol Appl Sci. 2015;4(2):819-827.
20. Yadav BK. Effect of different levels of iron and zinc on the growth and yield of rice. Int J Plant Anim Environ Sci. 2017;2(1):17-21.