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Research Paper

Effect of zinc and boron on grain quality of wheat (*Triticum aestivum*) in north-western plain zone of India

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ABSTRACT

An experiment was conducted to study the "Effect of zinc and boron on grain quality of wheat (*Triticum aestivum* L.) during the winter (*rabi*) season of 2018–2019 and 2019–20 at the agronomy research farm of IFTM University, Lodhipur Rajput, Moradabad, Uttar Pradesh. Ten treatments, viz. T_1, Control (no fertilizer); T_2, zinc @ 5 kg/ha (SA); T_3, zinc @ 1 kg/ha (FA); T_4 - zinc @ 1 + 1 kg/ha (2 FA); T_5, zinc @ 5 kg/ha (SA) + zinc @ 1 kg/ha (FA); T_6, boron @ 0.5 kg/ha (SA); T_7, boron @ 0.1 kg/ha (FA); T_8, boron @ 0.2 kg/ha (2 FA); T_9, boron @ 0.5 kg/ha (SA) and boron @ 0.1 kg/ha (FA) and T_{10}-, zinc @ 5 kg/ha + boron @ 0.5 kg/ha (SA) were comprised in randomized block design (RBD) with the three replications. The results revealed that different levels and application methods of zinc and boron significantly improved the grain quality of wheat. Maximum Zn content (35.4 and 35.9 mg/ha) and Zn uptake (185.1 and 197.1 g/ha) in 2018–19 and 2019–20, respectively were recorded with Zn @ 5 kg/ha (SA) + zinc @ 1 kg/ha (FA). Moreover, maximum B content (58.5 and 59.5 mg/ha) and B uptake (361.9 and 376.4 g/ha) in 2018–19 2019–20, respectively were observed with B @ 0.5 kg/ha (SA) and B @ 0.1 kg/ha (FA). Maximum protein content in grain (12.6 and 12.7%) and protein yield (712.8 and 744.9 kg/ha) was recorded under Zn - 5 kg/ha (SA) + B 0.5 kg/ha (SA) in 2018–19 and 2019–20, respectively.

Key words: Foliar application, Protein content, Soil application, Wheat, Zinc

Production of wheat and other grain crops have been tripled since 1960 and is expected to grow further through the middle of the 21st century (Godfray *et al.,* 2010). Global demand for wheat is increasing due to the unique viscoelastic and adhesive properties of gluten proteins, which facilitate the production of processed foods, whose consumption is increasing as a result of the worldwide industrialization process and the westernization of the diet (Day *et al.,* 2006; Shewry and Hey 2015). Wheat is an important source of carbohydrates, multiple nutrients, and dietary fiber (Shewry and Hey 2015). Wheat grains also contain high levels of protein, starch, sufficient amounts of essential minerals, vitamins and trace elements etc. Globally, it is the leading source of vegetable proteins in the human diet, having a protein content of about 13%, relatively high as compared to other major cereals but relatively low in protein quality for supplying essential amino acids (FAO, 2013). Widespread micro-nutrient deficiencies in crops, now being recorded all over the country, have resulted in severe losses in yield and nutritional quality. It is estimated that 50% of Indian soils on are deficient in zinc (Zn). Next to Zn, boron (B) (33%) and iron (Fe) (15%) deficiencies are also limiting the crop production to a large extent. The crucial role played by micro-nutrients in enhancing food/crop production in India is now a well-recognized fact.

Although the crop response to micro-nutrients application varies with soil type, crops, genotype, agro-climatic conditions, and severity of deficiency. An enormous response to micro-nutrient fertilization has been reported in a wide variety of crops including horticultural crops across the country. It has been estimated that proper Zn management contributes about 18.4 million tonnes (with economic value of ₹2,11,619/- million) for major food grain crops. The contribution of B is estimated about 4.02 million tonnes assuming 10% of cultivated area is receiving B fertilization (PIB, 2023). Micro-nutrient deficiencies/malnutrition in animal and human being are becoming increasingly important globally. The crops grown in micro-nutrient deficient soils contain low level of micro-nutrients to meet the demand of animal and human being. Application of micro-nutrients play an instrumental role in sustaining food security and wellbeing of animals and human being without harming the environment (Shukla *et al.,* 2012).

Zinc is an essential micro-nutrient that has a significant

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role in plant metabolic processes and enhances the growth, yield and quality of crops by stimulating chlorophyll production, photosynthetic activity, nutrient uptake, and protein biosynthesis. The zinc application to wheat crop either by seed treatment, soil application or by foliar spray have shown significant impact on growth, yield, nutrient uptake, quality and economics (Alsafran *et al.,* 2022) Moreover, boron (B) is a indispensable element for plant growth and reproduction. It is important for the metabolism of carbohydrates and translocation (Soomro *et al.,* 2011). It also plays a vital role in the materialization of cells in plants, integrity of plasma membrane, and the encouragement of fertilization for seed development (Pereira *et al.,* 2021). It is essential micro nutrient responsible for enhancing the production of nectar in flowers, thus increasing the attractions of insects for pollination. Therefore, there is need to spread awareness regarding health and nutrition sectors at both national and international level. Emphasis should be given on social, economic, and health consequences of micro-nutrient deficiencies, and provide significant funding opportunities for the development of sustainable, agriculture-based approaches to prevent micro-nutrient deficiencies (Cakmak *et al.,* 2011). Therefore, current study is undertaken to investigate the effect of zinc and boron application on grain quality of wheat.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research Farm, IFTM University, Moradabad, (U.P.), during the winter (*rabi*) season of 2018–19 and 2019–20. The experiment site lies between 28º 16´ to 28º 21´ N l, 78º 4´ to 79º E and 193 meters above mean sea level. This location is characterized by a subtropical and semi-arid climate with hot and dry summer and cold winter. The experimental soil was alluvial, sandy clay loam with moderate water-holding capacity. The soil has 7.9 pH and low in organic carbon (0.46%), EC 0.7 mS/cm and low in available nitrogen (123.50 kg/ha), medium in available phosphorus (23.5 kg/ha) and potassium (235 kg/ha), and available sulfur (9.30 ppm), Zn (0.58 ppm), B (0.55 ppm), Fe (5.22 ppm), Mn (5.69 ppm), and Cu (0.76 ppm). The soil samples were collected randomly to analyze the physico-chemical properties from the experimental site at a depth of 0–15 cm before conducting the experiment. The experiment was laid in randomized complete block design comprising ten treatments viz. T_1, Control (no fertilizer); T_2, Zn @ 5 kg/ha (SA); T_3, Zn @ 1 kg/ha (FA); T_4, Zn @ 1 + 1 kg/ha (2 FA); T_5, Zn @ 5 kg/ha (SA) + Zn @ 1 kg/ha (FA); T_6, B @ 0.5 kg/ha (SA); T_7, B @ 0.1 kg/ha (FA); T_8, B @ 0.2 kg/ha (2 FA); T_9, B @ 0.5 kg/ha (SA) and B @ 0.1 kg/ha (FA) and T_{10}, Zn @ 5 kg/ha + B @ 0.5 kg/ha (SA) replicated thrice. The variety 'HD 2967' was used as a test variety. The seed was applied at the rate of 100 kg/ha. The RDF (NPK) was applied @ 150 : 60 : 40 kg/ha. Zn and B were applied as per the treatments. All other agronomic practices were kept uniform for all the plots of the experiment. Observations on growth and yield attributes were recorded from five selected plants from the net plots. All the data obtained from the experiment were analyzed statistically using the F-test as per the standard statistical procedure (Gomez and Gomez, 1984), and the least significant difference (LSD) values (P=0.05) were used to determine the significance of the difference between treatment means.

RESULTS AND DISCUSSION

Zinc content (mg/ha) and Zinc uptake (g/ha)

Results showed that all the Zn and B treatments significantly affected the Zn content of wheat grain over the control during both the years of the experiment (Table 1). Application of Zinc @ 5 kg/ha (SA) + Zinc @ 1 kg/ha (FA) recorded higher Zn content (35.4 and 35.9 mg/ha) compared to rest of the treatments during both the years of experimentation. Higher Zn content in wheat grain might be due to enhanced availability of Zn to the plant through Zn

Table 1. Zn content (mg/ha) and Zn uptake (g/ha) by wheat as influenced by Zinc and Boron fertilization

Treatment	Zn Content (mg/ha)		Zn Uptake (g/ha)	
	2018–19	2019–20	2018–19	2019–20
T_1, Control	18.2	18.6	64.4	69.7
T_2, Zinc @ 5 kg/ha (SA)	24.5	25.5	112.8	122.6
T_3, Zinc @ 1 kg/ha (FA)	26.4	26.6	115.5	119.5
T_4, Zinc @ 1 + 1 kg/ha (Two FA)	30.1	31.1	146.7	156.1
T_5, Zinc @ 5 kg/ha (SA) + Zinc @ 1 kg/ha (FA)	35.4	35.9	185.1	197.1
T_6, Boron @ 0.5 kg/ha (SA)	18.4	18.5	88.6	93.2
T_7, Boron @ 0.1 kg/ha (FA)	18.4	18.5	88.6	93.2
T_8, Boron @ 0.2 kg/ha (Two FA)	19.2	19.2	95.7	101.8
T_9, Boron @ 0.5 kg/ha (SA) and Boron @ 0.1 kg/ha (FA)	19.4	19.5	107.4	112.5
T_{10}, Zinc @ 5 kg/ha + Boron @ 0.5 kg/ha (SA)	25.6	26.1	149.1	158.3
SEm±	0.31	0.33	1.83	1.85
CD (P=0.05)	0.92	0.99	5.48	5.53

application. Results are in conformity with those already reported by Prasad *et al.* (2014), Maqsood *et al*. (2009) and Shivay and Prasad (2014).

The significantly higher Zn uptake (185.1 and 197.1 g/ha) during both the years was recorded with application of Zn @ 5 kg/ha (SA) + Zinc @ 1 kg/ha (FA). It might be attributed due to higher Zn content and grain yield through soil and foliar application of Zn. Same findings also reported by Kanwal *et al.* (2010) and Panhwar *et al.* (2011).

Boron content (mg/ha) and Boron uptake (g/ha)

Results showed that all the Zn and B treatments significantly increased the B content in wheat over rest of the treatments (Table 2). The higher B content (58.5 and 59.5 g/kg) was recorded with the application of B @ 0.5 kg/ha (SA) and B @ 0.1 kg/ha (FA) compared to other treatments during both the years of experimentation. Higher B content in wheat grain might be due to enhanced availability of B to the plant through soil and foliar application of B. Results are in conformity with those already reported by Anand *et al.* (2021) and Khan *et al.* (2006).

The significantly higher B uptake (361.9 and 376.4 g/ha) during both the years was recorded with application of B @ 0.5 kg/ha (SA) and B @ 0.1 kg/ha (FA). It might be attributed due to higher B content and grain yield through soil and foliar application of B. Same findings also reported by Anand *et al.* (2021) and Ariraman *et al.* (2020).

Protein content (%) and Protein yield (kg/ha)

Results showed that all the Zn and B treatments significantly improved the protein content and protein uptake of wheat over control during the experiments (Table 3). The significantly higher protein content 12.6 and 12.7 % during both the years of experimentation was recorded with the application of Zn@ 5 kg/ha + B @ 0.5 kg/ha (SA). It might be attributed due to application of Zn enhanced the Zn availability in soil which in turn increased the nitrogen uptake and ultimately improved the protein content. Same findings also reported by Singh *et al.* (2015).

Results showed that all the Zn and B treatments significantly increased the protein yield over control during the experiments (Table 3). The significantly higher protein

Table 2. B content (mg/ha) and B uptake (g/ha) by wheat as influenced by Zinc and Boron fertilization

Treatment	B Content (mg/ha)		B Uptake (g/ha)	
	2018–19	2019–20	2018–19	2019–20
T_1, Control	22.5	22.6	103.0	107.5
T_2, Zinc @ 5 kg/ha (SA)	22.5	23.5	128.4	136.6
T_3, Zinc @ 1 kg/ha (FA)	23.5	23.6	112.0	115.8
T_4, Zinc @ 1 + 1 kg/ha (Two FA)	23.4	23.5	131.4	135.9
T_5, Zinc @ 5 kg/ha (SA) + Zinc @ 1 kg/ha (FA)	23.5	23.7	142.2	147.4
T_6, Boron @ 0.5 kg/ha (SA)	45.2	46.1	247.1	260.6
T_7, Boron @ 0.1 kg/ha (FA)	50.2	51.5	259.1	277.4
T_8, Boron @ 0.2 kg/ha (Two FA)	55.2	55.6	325.8	341.1
T_9, Boron @ 0.5 kg/ha (SA) and Boron @ 0.1 kg/ha (FA)	58.5	59.5	361.9	376.4
T_{10}, Zinc @ 5 kg/ha + Boron @ 0.5 kg/ha (SA)	48.5	48.1	318.81	326.3
SEm±	0.47	0.80	3.29	3.35
CD (P=0.05)	1.40	2.39	9.85	10.0

Table 3. Protein content (%) and Protein yield (kg/ha) by wheat as influenced by Zinc and Boron fertilization

Treatments	Protein Content (%)		Protein Yield (kg/ha)	
	2018-19	2019-20	2018-19	2019-20
T_1, Control	10.4	10.5	368.5	391.3
T_2, Zinc @ 5 kg/ha (SA)	11.5	11.6	529.5	555.9
T_3, Zinc @ 1 kg/ha (FA)	11.5	11.6	503.2	521.2
T_4, Zinc @ 1 + 1 kg/ha (Two FA)	11.3	11.4	548.4	569.6
T_5, Zinc @ 5 kg/ha (SA) + Zinc @ 1 kg/ha (FA)	12.6	12.7	659.3	694.3
T_6, Boron @ 0.5 kg/ha (SA)	11.3	11.4	541.2	573.7
T_7, Boron @ 0.1 kg/ha (FA)	12.1	12.6	549.2	607.5
T_8, Boron @ 0.2 kg/ha (Two FA)	11.6	11.7	580.4	620.4
T_9, Boron @ 0.5 kg/ha (SA) and Boron @ 0.1 kg/ha (FA)	11.6	11.7	643.2	674.1
T_{10}, Zinc @ 5 kg/ha + Boron @ 0.5 kg/ha (SA)	12.2	12.3	712.8	744.9
SEm±	0.14	0.22	8.89	7.55
CD (P=0.05)	0.43	0.65	26.6	22.6

yield, 712.8 and 744.9 kg/ha in 2018-19 and 2019-20, respectively was recorded with the application of Zinc @ 5 kg/ha + Boron @ 0.5 kg/ha (SA). It might be attributed due to higher crop yield and high protein content of wheat under this treatment which ultimately enhanced the protein yield was increased. Same findings also reported by Saleem *et al.* (2020).

CONCLUSION

Based on the results of two years field study, it can be inferred that soil and foliar application of Zn and B could improve the content and uptake of Zn, B, and protein in wheat and may be recommended to the farmers for improving nutritional quality of wheat.

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