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Evaluating the Varied Effects of Micronutrients on Wheat Variety TJ-83 Cultivation in Tando Jam

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ABSTRACT: *In Pakistan, wheat is a staple food crop and this field experiments were department of agronomy at SAU Tando Jam. The present study revealed significant variations in the growth and yield of the wheat variety TJ-83. The extreme values were observed under treatment T9 (1750g ha-1), including a plant height of 95.50 cm, tillers at 325.00 m-2, spike length of 11.75 cm, grains per spike totaling 47.00, the weight of grain per spike at 2.50 g, seed index (1000 grain weight) of 48.00 g, a biological yield of 11960 kg ha-1, a grain yield of 5780 kg ha-1, and a harvest index of 48.90%. Following closely, treatment T7 (1500 g ha-1) exhibited a plant height of 94.80 cm, tillers at 320.00 m-2, spike length of 11.60 cm, grains per spike amounting to 47.80, weight of grain per spike at 2.45 g, seed index (1000-grain weight) of 47.80 g, biological yield of 11900 Kg ha-1, grain yield of 5680 Kg ha-1, and a harvest index of 47.90%. Conversely, the lowest values were recorded in the control group (T1 = No fertilizer), with a plant height of 70.10 cm, tillers at 240.10 m-2, spike length of 8.06 cm, grains per spike totalling 30.80, the weight of grain per spike at 1.40 g, seed index (1000-grain weight) of 32.10 g, biological yield of 7125 kg ha1, grain yield of 2920 kg ha1, and a harvest index of 40.80%.. The results suggest that enriching the soil with micronutrients significantly enhances wheat production.*

Keywords: Wheat, Micro NutrientsVarity TJ-83

INTRODUCTION

Wheat is positioned as the world's second-largest grain produced (Samar et al., 2019). It is the main crop grown by many people in Pakistan and makes up most of the country's cultivated area, which is about 9.1 million hectares (Abdullah, 2023). Wheat is paramount as Pakistan's mainstay crop, playing a vital role in safeguarding the nation's food security. The cultivation of wheat makes a substantial contribution, constituting 9.2 percent of agricultural value added and 1.8 percent of Pakistan's total GDP. Irshad et al., 2022. Wheat is a primary global food source, supplying carbohydrates and essential micronutrients such as iron, zinc, and vitamin B (Peter and Sandra, 2015). Micronutrient deficiency affects half of the world's population. The enrichment of food crops, particularly grains, which are widely consumed around the world, could assist in solving the problem. Plant nutrition management is one approach for enriching cereals with micronutrients (Cho et al., 2008; Bouis and Welch, 2010). Micronutrients have been shown to be important in agriculture all around the world. Micronutrient insufficiency is an expected trend among cereal crops, limiting grain output and nutritional value. Boron, iron, manganese, and zinc are micronutrients that perform significant physiological roles in humans and animals (Aref et al., 2012). Zinc is one of the most significant fundamentals in a carbohydrate's metabolism; most of the enzymes that play an important role in carbohydrate metabolism are stimulated by zinc. Zinc is the foremost building block of many enzymes, and it is essentially necessary for the development of some significant plant enzymes. In accumulation, it initiates many enzymatic responses. It is essential in many enzymes for their appropriate functioning and plays a vital role in the transcription of DNA (Kumar et al., 2016). Zinc is an essential micronutrient for plants, engaging actively in key cellular functions that are vital for important metabolic and physiological activities. It is critical for enzyme activation and the regulation of ion balance within the plant's system (Alsafran et al., 2022). Boron is essential for preserving the structural integrity of wheat plant cell walls, which is crucial for their overall stability. A boron deficiency can negatively impact root growth, ultimately leading to a reduced grain yield (Reid et al., 2014). Micronutrient deficiencies are prevalent globally; more than half of the soil utilized for cereal crop cultivation suffers from micronutrient deficiencies. In Pakistan, a considerable number of soils are deficient in crucial micronutrients such as boron (B), attributed to their alkaline and calcareous nature, limited organic matter, regular cropping patterns, and poor nutrient management strategies. Research conducted by Cakmak in 2006, Rashid in 2006, and Shah et al. in 2017 has underscored this problem. Plants require boron for essential functions, and recent research on the biological role of this element in various metabolic, nutritive, hormonal, and physiological contexts has supplied evidence suggesting that boron is similarly indispensable for humans and animals (Kabu et al., 2013). In the wheat crop, insufficient boron can cause irregular growth patterns, impede the development of shoots and roots, and ultimately lead to a reduction in crop yield (Hu et al., 2013). This study's primary goal was to identify the optimal growth stage for wheat at which zinc (Z) and boron (B) application would result in the highest yield. Furthermore, it sought to determine the appropriate amounts of Z and B to apply and to evaluate the impact of these nutrients on different yield characteristics of wheat.

MATERIAL AND METHODS

The investigation was carried out at the Student Experimental Farm, situated in the Department of Agronomy at SAU Tando Jam in Sindh, Pakistan, during the Rabi season of 2022–23. The experiment's specifics followed the guidelines of the randomized complete block design.

Replication = 03

Net plot size: 3 m x 4 m, 12 m2.

Variety =TJ-83

Treatments=08

T1 = untreated (control)

T2 = 250g ha^{-1}

T3 = 500g ha^{-1}

T4 = 750g ha^{-1}

T5 = 1000g ha^{-1}

T6 = 1250g ha^{-1}

T7 = 1500g ha^{-1}

T8 = 1750g ha^{-1}

Culture practices

The soil underwent careful preparation involving two comprehensive plowings, followed by leveling of the land to establish an optimal seedbed. The recommended quantity of DAP fertilizer was evenly distributed across all plots during the sowing process. Throughout the research, zinc, boron, and iron were provided at different stages of wheat growth. To evaluate the plant characteristics, five plants were selected from each plot every five days during the initial ten days following the planting of crops.

The observation was recorded. Key parameters for evaluating crop performance include plant height, tillers per square meter, spike length, grains per spike, grain weight per spike, seed index (weight of 1000 grains), biological yield per hectare, grain yield per hectare, and harvest index.

Statistical analysis: The data underwent statistical analysis using Statistix 8.1 software. The LSD test was employed to compare the means of different treatments at a significant level of 5%.

Table 1: Evaluation of the soil at the field trial location involved both physical and chemical analyses.

Characteristics	**Units**	**Value (2017–18)**
Soil depth	(cm)	0–15
		15–30
Texture	(Class)	Sandy clay loam
pH		7.5
		7.7
EC	(dS m−1)	2.31
		2.36
Organic matter	(%)	0.72
		0.67
Total nitrogen	(%)	0.041
		0.038
Available B	(mg kg−1)	0.7
		1.4
DTPA Zn	(mg kg−1)	0.51
		0.47

Table 2: Zinc, Boron and Iron fertilization assessing their differential impact on wheat crops

Micronutrients Levels	Plant height (cm)	Tillers m^{-2}	Spike Length (cm)	Grain per $spike^{-1}$	Grain weight per $spike^{-1}$	Seed index (1000) grain weight, g)	Biological yield (kg ha^{-1})	Grain Yield (kg ha^{-1})	Harvest Index (kg ha^{-1})
T1=Untreated (Control)	70.10 f	240.10 g	8.06 g	30.80 h	1.40 d	32.10 e	7125 h	2920 g	40.80 d
T2=250g ha^{-1}	75.55 e	260.10 f	9.55 e	34.40 f	1.60 d	37.65 d	7895 f	3740 e	46.90 bc
T3=500g ha^{-1}	80.65 d	272.00 e	9.90 d	36.11 e	1.69 cd	27.65 cd	8380 e	3870 e	45.90 c
T4=750g ha^{-1}	83.50 c	280.00 d	10.00 c	38.77 d	1.70 cd	41.19 c	9120 d	4360 d	47.60 ab
T5=1000g ha^{-1}	84.30 c	290.30 c	10.25 c	40.55 c	1.95 bc	43.20 c	9870 c	4670 c	46.80 bc
T6=1250g ha^{-1}	91.10 b	310.00 b	11.50 b	45.80 b	2.00 b	46.50 b	11718 b	5490 b	47.90 bc
T7=1500g ha^{-1}	94.80 a	320.00 a	11.60 ab	47.80 ab	2.45 a	47.80 a	11900 ab	5680 a	47.90 ab
T8=1750g ha^{-1}	95.50 a	325.00 a	11.75 a	47.00 a	2.50 a	48.00 a	11960a	5780 a	48.90 a
S.E± =	1.11	1.89	0.059	0.52	0.15	5. 19	40.26	93.48	0.57
$LSD_{0.05}$ =	2.51	4.14	0.14	1.09	0.33	11. 07	87.59	190.28	1.42

RESULTS

Plant height (cm)

The utilization of micronutrients zinc and boron on wheat crops substantially and positively influenced numerous physiological yields and yield constituent characteristics. (Table 1). The plant height (cm) of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha^{-1} produced a maximum plant height of 95.50 cm, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} resulted in mean plant heights of 94.80 cm and 91.10 cm, respectively. Similarly, the following mean plant heights (84.30 cm, 83.50 cm, 80.65 cm, and 75.55 cm) were observed when crop treatments with T5, T_4, T_3, and T_2 were applied. Further, the lowest mean plant height (70.10 cm) was noted with T_1 = Control, no fertilizer, 00 kg ha^{-1}.

Number of tillers: m²

The number of tillers per m2 of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum number of tillers m^{-2} of 325.00, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} had a mean number of tillers per hectare of 320.00 and 310.00, respectively. Similarly, the following mean number of Tillers m^{-2} (290.30, 280.00, 272.00, and 260.10) were observed when crop treatments with T_5, T_4, T_3, and T_2 = were applied. Further, the lowest mean number of tillers (m^{-2}) (240.10) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Spike Length (cm)

The spike length (cm) of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum spike length of 11.75 cm, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} had spike lengths of 11.60 cm and 11.50 cm, respectively. Similarly, the following mean spike length cm (10.25, 10.00, 9.90, and 9.55) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean spike length (cm (8.06)) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Grain per spike

The grain per spike of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum grain per spike of 47.00, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} resulted in grain per spike of 47.80 and 45.80, respectively. Similarly, the following mean grain per spike (40.55, 38.77, 36.11, and 34.40) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean grain per spike (30.80) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Grain weight per spike

The grain weight per spike of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum grain weight per spike of 2.50, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} had a grain weight per spike of 2.45 and 2.00, respectively. Similarly, the following mean grain weight per spike (1.95, 1.70, 1.69, and 1.60) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean grain weight per spike (1.40) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Seed index: 1000; grain weight: g

The seed index (1000) and grain weight (g) of wheat are affected by different levels of micronutrients. The treatments T8

= 1750 g ha^{-1} had a maximum seed index (1000) grain weight (g) of 48.00, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} resulted in seed index (1000) grain weight (g) of 47.80 and 46.50, respectively. Similarly, the following mean grain weight per spike (43.20, 41.19, 27.65, and 37.65) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the minimum seed index (1000) grain weight (g) (32.10) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Biological yield (kg ha^{-1})

The biological yield (kg ha^{-1}) of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum biological yield (kg ha^{-1}) of 11960, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} resulted in a maximum biological yield (kg ha^{-1}) of 11900 and 11718, respectively. Similarly, the following mean biological yields (kg ha^{-1}) (9870, 9120, 8380, and 7895) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean biological yield (kg ha^{-1}) (7125) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Grain yield kg ha^{1}

The grain yield (kg ha^{-1}) of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum grain yield (kg ha^{-1}) of 5780, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} had a grain yield (kg ha^{-1}) of 5680 and 5490, respectively. Similarly, the following mean grain yields (kg ha^{-1}) (4670, 4360, 3870, and 3740) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean grain yield (kg ha^{-1}) (2920) was noted with T_1 = control, no fertilizer, 00 kg ha^{-1}.

Harvest Index (kg ha^{-1})

The harvest index (kg ha^{-1}) of wheat is affected by different levels of micronutrients. The treatments T8 = 1750 g ha-1 had a maximum harvest index (kg ha^{-1}) of 48.90, while the crops receiving T_7 =1500g ha^{-1} and T_6 = 1250g ha^{-1} had a harvest index (kg ha^{-1}) of 47.90 and 47.90, respectively. Similarly, the following mean Harvest Index (kg ha^{-1}) (46.80, 47.60, 45.90, and 46.90) were observed when crop treatments with T_5, T_4, T_3, and T_2 were applied. Further, the lowest mean harvest index (kg ha1) of 40.80 was noted with T_1 = control, no fertilizer, and 00 kg ha1.

DISCUSSION

The agricultural challenge extends beyond merely feeding the masses; it also involves delivering nutrient-rich food to impoverished individuals. To address this, there is a need to design agriculture systems that prioritize the overall health and well-being of the population. (Maberly et al., 2010). Typically, integrating micronutrient fertilizers such as zinc and boron into the soil can significantly improve the growth, yield, and overall health of wheat crops. Farmers and agricultural specialists advocate for the inclusion of these fertilizers in their crop management plans to boost productivity and enhance profitability. The findings of the research underscore the vital significance of trace elements in fostering the development and productivity of the wheat variety TJ-83. The maximum plant height is 95.50 cm, the number of tillers is 325.00, the spike length is 11.75 cm, the grain per spike is 47.00, the grain weight per spike is 2.50, the seed index (1000) of grain weight is 48.00, the biological yield (kg ha^{-1}) is 11960, the grain yield (kg ha^{-1}) is 5780, and the harvest index (kg ha^{-1}) is 48.90. The test results showed that trace elements are significant in the growth and yield characteristics of the wheat variety TG-83 when applied at levels of treatment T8 = 1750 g ha^{1} Respectively. The total number of tillers remained largely unaffected by the application of zinc (Z), boron (B), and iron (Fe) at various growth stages. This lack of significant change might be since B was not applied during the tillering phase. This observation aligns with findings previously reported by Khan et al. (2010) and Hussain et al. (2005). The results of the experiment indicated that trace elements are vital in affecting the growth and yield of the wheat variety TJ-83. Micro-nutrient fertilizers were administered at a rate of 1750 g/ha. Subsequently, various plant parameters were assessed, including plant height, tillers per square meter, spike length, grains per spike, grain weight per spike, seed index, biological yield, grain yield, and harvest index. In comparison, the untreated control treatment exhibited minimal growth and yield characteristics. The findings of this study are consistent with the research conducted by Rahman et al. (2014). Likewise, the results from this investigation closely represent those reported by Zeidan et al. (2010). Adding zinc to the soil was found to enhance several aspects of wheat production, including grain weight, grain count per spike, total grain yield, biological yield, zinc concentration in flag leaves and grains, and the protein content of the wheat grains. As reported by Debnath et al. (2014), soil application of zinc contributed to improvements in the weight of a thousand grains, the number of grains per spike, overall grain yield, total biological yield, zinc levels in flag leaves and grains, and the protein content in the grains. The research findings indicated that applying zinc and boron significantly enhanced numerous plant growth metrics, including plant height, number of tillers m2, spike length cm, grain per spike, grain weight per spike, seed index 1000 grain weight g, biological yield kg ha^{-1}, grain yield kg ha-1, and harvest index kg ha^{-1} (Anjum et al., 2017). In a 2019 study by Hassan et al., it was discovered that applying zinc to the soil during the tillering and ear stages of wheat growth significantly enhanced both the yield and quality of the grain compared to untreated plants. Moreover, research conducted by Pahlavan and Pessarakli in 2009 underscored the synergistic impact of zinc and iron on wheat grain weight, demonstrating a substantial increase in yield when both nutrients were supplied. The highest weight of 1000 grains were achieved through the application of 20 kg of zinc and iron. Muhammad et al. (2006) investigated the influence of soil zinc levels on the physiology, phenology, yield indices, and zinc and iron content of wheat grains. Results indicated that leaf area, tiller m2, productive tiller, and yield components. Mekkei and Eman (2010) achieved comparable findings, noting that the soil application of zinc significantly elevated plant height (in centimeters), spike length (in centimeters), grains per spike, 1000-grain weight (in grams), and wheat grain yield (in tons per hectare). Metwally and co-authors (2012) discovered that employing zinc fertilizer in soil has been effective in enhancing grain quality. Similarly, Bameri et al. (2012) corroborated this finding, asserting that zinc soil fertilizer effectively improves grain quality. Furthermore, Esfandiari et al. (2016) documented that applying zinc to the soil had a notably positive influence on wheat grain production and its assorted components. Many studies have indicated that the augmentation of agronomic traits can be attributed to the foliar application of zinc. According to Jiang and Huang

(2002), the increase in wheat yield and its components is associated with zinc influencing the volume of chlorophyll and the concentration of abscisic acid. The elevation of chlorophyll levels contributes to enhanced yield by promoting photosynthesis. The use of boron positively influenced the grain yield of wheat crops, an effect attributable to boron's distinctive distribution within the plant's dry matter, as noted by Hussain and Yasin (2004). Conversely, a deficiency in boron can cause grain sterility, leading to a marked reduction in grain yield, as documented by Subedi et al. (2000). Generally, adding micronutrient fertilizers, including zinc and boron, can significantly boost the growth, yield, and quality of wheat. It is strongly advised for farmers and agronomists to include these fertilizers in their crop management plans to improve productivity and increase profits.

CONCLUSIONS

The study concludes that the yield-affecting characteristics of the wheat variety TJ-83 are notably influenced by various soil-applied micronutrients. The results suggest that the application of micronutrients to the soil significantly enhances wheat yield and that various factors contribute to yield. After conducting research, it was established that the most efficient approach to boosting wheat growth and augmenting grain yield involves applying micronutrients at a rate of 1750 grams per hectare alongside the recommended dose of fertilizer.

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