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Research Article

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Effect of micron (micronutrients) fertilizer on the growth and yield of Wheat variety Sarsabz

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ABSTRACT

The Department of Chemistry Soil Section Agriculture Research Institute, Tando Jam, conducted an examination in order to find out how micron (micronutrient) fertilizer affected the growth and yield of the wheat variety Sarsabz. Three replicates of a Randomized Complete Block Design were used to investigate the effects of micron (micronutrients) fertilizer utilized at rates of 0, 50, 100, and 150 kg ha^{-1} having a plot size of 46 m x 44 m. The results of the study revealed that applying micronutrient fertilizer to crops significantly altered the crop's parameters. The application of Micron (micronutrients) fertilizer applied at a rate of 150 kg ha^{-1}, with proposed N (168) and P (84) doses, resulting in the maximum wheat plant height (101.73), more tillers $plant^{-1}$ (9.73), spike length (13.7), more grain $spike^{-1}$ (51.66), heavier seeds (39.3), and higher grain yield (3453.3 kg ha^{-1}). Therefore the micro nutrient is essential for achieving maximum yield production and should be applied with recommended doses on the wheat crop, performed better results in soil conditions of Tando Jam.

KEYWORDS: Wheat, Micronutrients, Growth and yield

INTRODUCTION

Wheat usage in Pakistan increases year after year due to increasing numbers of people and stagnating yield per unit area. As reported by Khan *et al.* (2000), wheat production in Pakistan is two and a half times lower than in advanced wheat-producing countries around the world, and bridging this gap is a difficult scenario for scientists and farmers (Nadim *et al.*, 2011). Therefore, enhancing the yield of wheat per unit area can be performed by breeding and cultivating promising wheat cultivars and employing the best culture methods, such as the use of appropriate fertilizer. Hassanein *et al.* (2001), El-Esh (2007) and Zaki *et al.* (2012, 2015) found substantial variations amongst cultivars in all traits studied. Wheat cultivation area in Pakistan is approximately 1980 thousand hectares, with an annual production of approximately 25.48 million tons. Agriculture contributes 18.9% of GDP, with wheat accounting for 9.1% (Tahir *et al.*, 2021).

According to Zeidan *et al.* (2010), a variety of issues, including late sowing, careless fertilizer usage, insufficient irrigation, an abundance of weeds in fields, and prolonged drought, cause production losses. These elements are in charge at different stages of crop development and negatively affect crop output. Micro and macronutrient shortages for different crops have been investigated (Hussain *et al.*, 2006). Each micronutrient is essential for controlling various metabolic processes and yield. For plants to thrive and flourish at their best, they need zinc, boron, iron, copper, manganese, and molybdenum (Rawashdeh & Florin, 2015; Zain *et al.*, 2015).

With a growing population and rapid economic development, especially in developing nations, the world's demand for food is set to rise (Westcott & Trostle, 2012). Fertilizing is a common agronomic strategy for increasing the yield and mineral content nutritional value of food crops. However, understanding the variables affecting micronutrient bioavailability in a soil-plant system is crucial to correctly forecast a crop's response to micronutrient fertilization (Alloway, 2008; Rahman *et al.*, 2020). A few of these crucial soil characteristics include soil pH, organic carbon and carbonate content, clay content, free lime, the quantity and types of minerals that the soil environment supplies, as well as essential micronutrients (Alloway, 2008). These soil characteristics directly affect the adsorption and precipitation of micronutrient elements on mineral and organic surfaces, which causes deficiency issues (He *et al.*, 2005).

The lack of readily available micronutrients in the soil for wheat, as for any cereal crop, and their effects on crop productivity are two of the most urgent issues in current agrochemistry. However, the quality of wheat grain has not improved in recent years despite increased worldwide production, which may be harmful to both human and animal health. Due to its many benefits for human nutrition, wheat is currently the most frequently farmed grain in the world, grown on 217 million hectares annually with a total global production reaching 700 million tons (Rawashdeh & Florin, 2015).

Improving crop production may have a negative influence on agricultural land resources, which is necessary to provide food and nutritional security. Growing of high-yield cultivars lacking micronutrient fertilization has raised concerns because it could gradually reduce soil micronutrient content below the necessary level and cause problems with sufficiency for future crop production (He *et al.*, 2005). Additionally, growing staple crops on soils deficient in micronutrients causes both yield and nutritional quality losses due to the diminishing levels of vital human minerals like Zn and Fe (Alloway, 2008).

In order to improve food and nutrition security, micronutrient content in regular diets must be increased, particularly in South Asia and Sub-Saharan Africa, where the majority of rural people are already at risk for micronutrient deficiency issues (Welch & Graham, 2004). While the region needs food products with added micronutrients, wealthy nations that export food also need to take into account how their management practices are affecting the nutritional value of their food exports (Zoveda *et al.*, 2014). Therefore, a modern agriculture approach aims to simultaneously enhance staple crops with bioavailable micronutrients while improving efficiency in terms of yield (Rahman & Schoenau, 2020). Keeping the view of the importance of the micronutrients in wheat crops, the present should was conducted to determine the effect of different levels of micron (micronutrients) fertilizer on the growth and yield of wheat variety (Sarsabz) under Tandojam soil condition.

MATERIALS AND METHODS

The piece of land selected for the experiment was laying, and fallow and was well prepared by giving cross-wise deep ploughings in the off-season. After the soaking dose, when the land came in condition, the seedbed was prepared by using crosswise cultivator followed by a rotavator. Thus a good seed bed was prepared and the sowing was done. Variety included in this experiment was 'Sarsabz' developed by the Nuclear Institute of Agriculture, Tandojam. The seed was obtained with the courtesy of Agronomist, Agriculture Research Institute, Tandojam. The done by single coulter hand drill in lines on 13-11-2005 at the sowing rate of 150 kg ha^{-1}. A total of 12 sub-plots were prepared each measuring 2024 m^2 for micron (micronutrients) fertilizer. Application the treatment details are given as under:

Treatments	**Micron (Micronutrients) Fertilizer**
T1	Control
T2	50 kg ha^{-1}
T3	100 kg ha^{-1}
T4	150 kg ha^{-1}

Micron was applied in the form of Zinc (Zn) Sulphate ($ZnSO_4$) 5%, Iron (Fe), Sulphate ($FeSO_4$) 2%, Calcium (Ca) 10%, Manganese (Mn) Sulphate ($MnSO_4$) 2% and Boron (B) 0.25% are present in micron fertilizer Full dose of phosphorus and 1/3rd of nitrogen in the form of Urea and DAP was applied at the time of sowing, whereas the remaining dose of N fertilizer was given in two splits i.e. at the time of booting and at milky stage. In all, four irrigations were applied to the crop.

All the agronomic practices were carried out uniformly in all the plots. For recording the data 05 plants from each replication of each treatment were labeled and data was recorded on the following parameters:

Observations Recorded

1. Plant height (cm)
2. Number of tillers $plant^{-1}$
3. Spike length (cm)
4. Number of grains $spike^{-1}$
5. Seed index (1000-grains weight, g)
6. Average grain yield kg ha^{-1}

RESULTS

The data on crop parameters of wheat variety Sarsabz as affected by micron (micronutrients) fertilizer is presented in Table 1 and their analysis of variance as Supplementary Tables 1 to 4. The results on individual parameters are presented as under:

Plant Height (cm)

The results of plant height are displayed in Table 1 and their ANOVA is shown in Supplementary Table 1. It can be observed from the results that the differences in plant height with the micron (micronutrients) fertilizer application exhibited significant differences.

The results showed that wheat crop fertilized with micron (micronutrients) fertilizer recorded maximum plant height (101.7 cm), at a role of 100 kg micron ha^{-1} followed by highest doses of micron (micronutrients) fertilizer (99.6 cm), while no application of micronutrients recorded shorter plant height (93.6 cm).

Number of Tillers $Plant^{-1}$

The data regarding the numbers of tillers $plant^{-1}$ of wheat variety Sarsabz as affected by micron (micronutrients) fertilizer present in Table 1 and the analysis of variance is given in Supplementary Table 2. The experimental results revealed that the application of micron (micronutrients) fertilizer had a non-significant influence on the number of tillers $plant^{-1}$.

The data depicts that wheat fertilized with micron (micronutrients) fertilizer displayed the maximum number of

Table 1: Mean plant height (cm), number of tiller plant^{-1}, spike length (cm), grains spike^{-1}, seed index (1000) grains weight (g) and grain yield kg ha^{-1} of wheat as affected by the application of Micron (micronutrients) fertilizer

Treatment	Plant height (cm)	Number of tillers plant^{-1}	Spike length (cm)	Grains spike^{-1}	Seed index (1000) grains weight (g)	Grain yield kg ha^{-1}
T1=0.00 (control)	93.6	9.0	12.3b	48.0b	31.7c	3106.7c
T2=50 kg Micron ha^{-1}	99.3	9.3	12.4b	48.3b	35.0b	3266.7bc
T3=100 kg Micron ha^{-1}	101.7	9.2	13.7a	50.3ab	36.7ab	3320.0b
T4=150 kg Micron ha^{-1}	99.6	9.7	13.5a	51.6a	39.3a	3453.3a
S.E. ±	0.97	0.314	0.447	0.182	0.264	29.793
LSD 0.05	-	-	0.403	0.673	1.413	85.17
LSD 0.01	-	-	0.829	1.383	2.904	120.51
CV %	2.938	10.144	3.273	1.104	2.225	2.719

tillers (9.7), followed by 50 kg micron (micronutrients) fertilizer which produced non-significant tiller numbers in the range of 9.2 to 9.3. The minimum tiller numbers (9.0) however were exhibited by the control plots where micronutrients were not applied.

Spike Length (cm)

The data pre-training to spike length (cm) of wheat are given in Table 1 and their analysis of variance in Supplementary Table 3. It can be observed from the table that spike length varied significantly among the treatments.

The data further showed that application of micron (100 kg ha^{-1}) (micronutrients) higher doses recorded longer spikes (13.7 cm) followed by micron (micronutrients) fertilizer (13.5 cm). The shorter spikes (12.3) were observed in the control plots where no micronutrients were added.

Number of Grains Spike^{-1}

The mean for the number of grains spike^{-1} of wheat is presented in Table 1 and their analysis of variance in Supplementary Table 4. The result depicts that the differences in the number of grain spike^{-1} due to micron (micronutrients) fertilizer were significantly different from other treatments.

The result further showed that wheat plots treated with micron (micronutrients) 150 kg ha^{-1} produced the maximum number of grain spike^{-1} (51.6 spike^{-1}) followed by 100 kg micron ha^{-1} (micronutrients) fertilizer (50.3 spike^{-1}) whereas, control treatment exhibited very minimum (48.0 spike^{-1}) number of grain spike^{-1}.

Seed Index 1000 Grain Weight (g)

The results on seed index values wheat obtained are shown in Table 1 and their analysis of variance is given in Supplementary Table 5. It may be seen from the statistical results that micron (micronutrient) fertilizer had a highly significant influence on seed index.

The results further showed that wheat crop treated with 150 kg micron ha^{-1} (micronutrients) fertilizer recorded higher seed index values (39.3 g), followed by 100 kg micron ha^{-1} (36.7 g) while wheat treated with no micronutrients showed poor seed index value (31.7 g).

Grain Yield (kg ha^{-1})

The grain yield (kg ha^{-1}) mean values are shown in Table 1 and their analysis of variance in Supplementary Table 6. It is evident from the data that grain yield varied significantly due to application of micron (micronutrient) fertilizer.

The result further revealed that application of 150 kg micron ha^{-1} (micronutrients) fertilizer recorded maximum grain yield (3453.3 kg ha^{-1}), followed by 100 kg micron ha^{-1} (micronutrients) fertilizer (3320.2 kg ha^{-1}) and (3266.7 kg ha^{-1}). The plot without application of micronutrients recorded minimum grain yield (3106.7 kg ha^{-1}).

DISCUSSION

Fertilizers play a significant role among the agronomic elements that are favorably correlated with wheat grain yield. The use of fertilizers is one of the quickest and possibly most cost-effective ways to increase wheat production. Without a doubt, our farmers are gradually learning how to apply macronutrients and balance fertilizers. Micronutrients are necessary for plant growth even though they are only needed in minute amounts. As a result, they are crucial for the absorption and translocation of macronutrients like NPK. A lack of any one of the elements may be the main cause of the wheat crop's low production. Under the specified doses, the experiment's results revealed significant effects of the combination of macronutrients.

The micron (micronutrients) fertilizer at the rates of 100 and 150 kg each was discovered to be the best among the tested combinations for recording taller plants, more tillers, longer spikes, a greater number of grains spike$^{-1,}$ a better seed index, and higher grain yields. These findings are in close agreement and with the results of Nadim *et al.* (2011) also demonstrated that adding boron to wheat increased yield and grain quality, and that copper and manganese use also had a favorable impact on wheat productivity. The use of different micronutrients and how they were applied affected plant growth and production significantly. Boron is crucial for producing cell walls, maintaining plasma membrane integrity, dividing cell walls, accelerating photosynthetic rate and transport, forming pods, expanding nodule populations, and improving grain quality (Jalata *et al.*, 2022). The application of boron improved yield rates, relative growth rates, and net assimilation rates in plants (Nadim *et al.*, 2012). According to Firdous *et al.* (2018), adding boron significantly enhanced wheat production.

The two most common ways to provide zinc to crops are through the soil and the leaves. Grain yield and Zn status in wheat grains have both improved as a result of Zn seed treatments. Microorganisms can increase the amount of soil-available Zn for the wheat crop in cropping systems when legumes are grown in a rotation with wheat. Wheat cultivars with high grain Zn density have been created using breeding and molecular techniques (Rehman *et al.*, 2018). Rengel and Graham (1995) concluded that crops grown from seed with a higher Zn content have a distinct advantage which culminates in greater yield when grown in soils of low Zn status. Zain *et al.*, (2015) also observed that when micronutrients ($ZnSO_4$ and $FeSO_4$) were provided as a foliar treatment, spike length increased significantly. Furthermore, the foliar Zn application significantly boosted spike length compared to control, according to Afshar *et al.* (2020). However, the cause may be the result of prolonged plant exposure to any kind of stress that negatively impacts the growth and development of plants. It is one of the primary reasons for how soil behaves, increasing soil acidity, affecting cation exchanges and soil structure, and regulating the helpful qualities of microorganisms and the useful oxidation-reduction reaction.

One of the greatest and most practical methods for improving cereal crop production with appropriate nourishment is the foliar application of micronutrients (Aziz *et al.*, 2019). The application of a foliar spray of micronutrients has a significant effect on growth, yield and quality parameters. Such as plant height, grains/spike, grain yield, biological yield, carbohydrates and protein (Tahir *et al.*, 2021). Micronutrients combined with macronutrients greatly improve plant development, physiological features, yield components, grain yield, and quality traits (Saquee *et al.*, 2023). Micronutrient application increased the harvest index (Tahir *et al.*, 2021). Similar results have been published by Zain *et al.* (2015), who said that foliar micronutrient spray improves harvest index. This method improved a variety of growth parameters, including spike length, grain mass, biomass, harvest index, and photosynthetic pigment (Ali *et al.*, 2022). Another method for increasing the supply of minerals to plants is to use plant growth-promoting microbes (PGPM), which optimize wheat crop yield attributes such as plant height, dry and fresh weight, net photosynthesis, grain yield, spike length, and other physiochemical characteristics of wheat plants (El-Katatny & Idres, 2014). After careful review and assessing present results, it was observed that micronutrients exhibit a significant effect on the crop growth yield parameter and grain yield.

CONCLUSION

This study made an effort to carefully analyze previous research findings and limitations, with a focus on components of the wheat response to micronutrient fertilizers. Numerous researchers have determined that combining micronutrients and macronutrients improves plant development, physiological attributes, yield components, yield, and overall grain quality traits. Therefore micron micronutrient fertilizer application is essential for achieving maximum grain yield of wheat crop and Tandojam soil conditions.

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SUPPLEMENTARY TABLES

Table S1: Analysis of variance for plant height (cm)

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	3	107.08	35.69	4.25	4.76	9.78	NS
Replication	2	71.33	35.66	4.25	5.14	10.92	NS
Error	6	50.35	8.39	-	-	-	-
Total	11	228.76	-	-	-	-	-

NS=Non significant

Table S2: Analysis of variance for number of tillers plant^{-1}

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	3	0.86	0.28	0.31	4.76	9.78	NS
Replication	2	5.18	2.59	2.91	5.14	10.92	NS
Error	6	5.36	0.89	-	-	-	-
Total	11	11.4	-	-	-	-	-

NS=Non significant

Table S3: Analysis of variance for spike length (cm)

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	3	4.87	1.62	9.0	4.76	9.78	S
Replication	2	1.31	0.65	3.6	5.14	10.92	NS
Error	6	1.1	0.18	-	-	-	-
Total	11	7.27	-	-	-	-	-

NS=Non significant
S=Significant at 5% probability level

Table S4: Analysis of variance for number of grain spike^{-1}

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	3	26.92	8.97	29.9	4.76	9.78	HS
Replication	2	2.17	1.08	3.6	5.14	10.92	NS
Error	6	1.83	0.30	-	-	-	-
Total	11	30.92	-	-	-	-	-

NS=Non significant
HS=Highly Significant at 1% probability level

Table S5: Analysis of variance for seed index 1000 grains weight (g)

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	3	92.67	30.89	49.03	4.76	9.78	HS
Replication	2	2.17	1.08	1.71	5.14	10.92	NS
Error	6	3.83	0.63	-	-	-	-
Total	11	98.67	-	-	-	-	-

NS=Non significant
HS=Highly Significant at 1% probability level

Table S6: Analysis of variance for grain yield kg ha^{-1}

Source of variation	D.F.	S.S.	M.S.	F. C	F. Tabulate		Remarks
					5%	1%	
Treatments	4	185066.7	61688.9	7.72	4.76	9.78	S
Replication	3	80066.7	40033.35	5.01	5.14	10.92	NS
Error	12	47933.3	7988.9	-	-	-	-
Total	19	313066.7	-	-	-	-	-

NS=Non significant
S=Significant at 5% probability level