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Wheat Yield and Quality Affected by Foliar Micronutrient Mixture Application

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Abstract. Micronutrient deficiency (manganese, copper, zinc, iron and boron) appears to have become more prevalent in crops in recent years. A field experiment was carried out to examine the response of application of foliar commercial micro-nutrients mixture "Uni Micropower" (zinc 4.7%, iron 2%, manganese 2%, boron 1.0% and copper 0.3%) on wheat in 2015-16. Treatments included, control and Uni Micropower spray at tillering, jointing, booting, milking, tillering + jointing, tillering + booting, tillering + milking, jointing + booting, jointing + milking, booting + milking, tillering + jointing + booting, tillering + jointing + milking, tillering + booting + milking and tillering + jointing + booting + milking stage. The results indicated that treatments significantly enhanced plant height, grains/spike, 1000 grain weight, biological yield, grain yield, harvest index, grain protein and carbohydrate contents. The maximum grain yield, quality and economic return were recorded when Uni Micropower sprays were applied at tillering, jointing, booting and milking stage. In conclusion, Uni Micropower foliar spray is helpful to improve the quality and production of wheat.

Keywords: wheat, micronutrients, grain yield, grain quality, economic return

Introduction

In the world, wheat (*Triticum aestivum* L.) is an essential cereal crop and millions of people use as staple food to fulfill daily dietary needs (World Agricultural Production, 2016). Every year food requirement is increasing due to increasing population. In Pakistan, wheat crop average grain yield is two and half times low as related to developed countries and it is a challenge for farmers and agricultural scientists to overcome this gap (Nadim *et al*., 2011). To meet the food demands of a rapidly growing population, it is vital to enhance wheat production capacity in various environmental zones. The most important reason for limiting yield is neither the use of micronutrients nor the proper fertilizers use, water shortage, saline area and increased weed invasions (Khan *et al*., 2010). Micronutrients foliar spray play a crucial role to improve the quality and yield of crop. It plays very significant role in plant metabolic and growth processes such as photosynthesis, enzymatic activities, chlorophyll formation, uptake of nutrients, nitrogen fixation, carbohydrate and protein synthesis, electron transport chain and disease resistance (Biswas *et al*., 2015). The soil texture, pH and calcium carbonate ($CaCO_3$) content significantly affect the micronutrients availability (Zeidan *et al*., 2010). Therefore, the judicious use of micronutrients may help to enhance yield of crop in deficient soils (Sial *et al*., 2003). The micronutrients either soil applied or foliar sprayed has a progressive effect on grain yield as described by Habib (2009). Combined application of micronutrients mixture and NPK fertilizers at different physiological stages noticeably improved the grain quality yield of wheat (Mer and Ama, 2014). Micronutrients spray significantly improved the effective use of plant nutrients by reducing the fixation of nutrients and leaching losses (Shashikumar *et al*., 2013). Previously, numerous researchers have appraised the response of micronutrients foliar and soil application on crop but a little work is present on micronutrients mixture application. It is guessed that micronutrients mixture spray may improve quality, growth and yield of wheat, therefore objective of present trail was to examine the effect of micronutrients mixture foliar spray on grain quality, yield and benefit-cost ratio of wheat.

Materials and Method

The planned research trial was conducted at Agronomic Research Area, University of Agriculture Faisalabad during winter 2015-16. The research trial was carried

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out in randomized complete block design having net plot size 6.0 m×2.25 m with three replications. Micronutrients mixture (Zn 4.7%, Fe 2%, Mn 2%, B 1.0% and Cu 0.3%) foliar spray (@1250 mL/ha) was applied at different physiological stages of wheat *viz*. (tillering, jointing, booting, milking, tillering + jointing, tillering + booting, tillering + milking, jointing + booting, jointing + milking, booting + milking, tillering + jointing + booting, tillering + jointing + milking, tillering + booting + milking and tillering + jointing + booting + milking). Punjab-2011 wheat variety was sown as an experimental crop on 7th December 2015 and used seed rate @150 Kg/ha. Sowing was done with the assist of single row hand drill keeping 22.5 cm row to row distance. The seed was treated with fungicide before sowing. Recommended N: P: K fertilizer dose was applied @120:85:60 Kg/ha, respectively. Total phosphorous, potash and half nitrogen fertilizers were applied at the sowing times and left over 1/2 nitrogen with 1st irrigation. Necessary plant protection measures were created to protect plants from weeds, diseases and infections. All other agronomic exercises were routinely maintained for all treatments. The crop was harvested on 23rd of April, 2016. According to pre-sowing physico-chemical analysis, experimental soil was sandy clay loam with pH (7.9), electric conductivity (ECe) (2.21 dS/m), organic matter (0.71%), nitrogen (0.2 ppm), phosphorous (4.25 ppm), potassium (238 ppm), zinc (0.75 ppm), iron (2.87 ppm), manganese (1.25 ppm), boron (0.39 ppm) and copper (0.12 ppm). Yield contributing and grain quality parameters were noted. The data recorded was statistically analyzed by using Fisher's analysis of variance procedures and by using least significant difference (LSD) test the treatments means were compared at 5% level of probability (Steel *et al*., 1997).

Results and Discussion

Subsequent parameters were observed during the study.

Yield and yield attributing components. Tillering is a genetic factor which depends on ecological circumstance as well as available plant nutrition. The mixture of micronutrients did not significantly affect No. of fertile tillers (Table 1). This might be due to the reason that no spray was applied before tillering stage. Similar results and observations have been reported for the use of micronutrient levels by Khan *et al*. (2010).

Data regarding plant height revealed that foliar spray of micronutrients significantly affected plant height. Significantly maximum plant height (97.6 cm) was noted with four foliar sprays of micronutrients mixture sprayed at four different stages of wheat, while the minimum plant height (88.1 cm) was recorded where foliar spray of mixture containing micronutrients was not applied. Micronutrients have an important role in a variety of physiological processes in plants, including chlorophyll content in leaves, cell wall development, auxin synthesis, enzyme activation, electron transport chain, and stomata control. Hence, increase in plant height may be due to increased Indole-acetic acid (IAA) and chlorophyll formation due to foliar application of micronutrients which finally resulted in improved plant height (Rawashdeh and Sala, 2013).

Number of grains/spike is a very significant yield attributing factor which significantly affects the economic yield of crop. The findings clearly show that when four foliar sprays of micronutrients were administered during wheat growth phases such as tillering, jointing, booting, and milking, an increase in the number of grains/spike (55.23) was attained. In control treatment minimum number of grains/spike (49.00) was achieved. These findings are alike with Aziz *et al*. (2019); Yaseen *et al*. (2011), who represented that micronutrients foliar spray efficiently improved the number of grains/spike. This might be due to micronutrients which play a key role in plant reproductive growth such as boron plays an important role in fruit setting, grain filling and pollen tube formation but Cu plays key role in pollen viability in plants, resulting in more seed set.

Grain weight has much importance for yield determination in wheat. The data related 1000 grain weight of wheat shows that significant differences are present between the treatments means. Foliar spray of micronutrients applied at various four stages of wheat resulted in maximum 1000 grain weight which was 41.2 g and minimum grain weight was 32.1 g noted in control treatment where foliar spray was not applied. Improving this quality with a foliar leaf spray may be due to the incorporation of micronutrients into the physiological processes of the plant, e.g. enzyme activity, membrane integrity, chlorophyll formation, initial starch use and grain accumulation are also increased, resulting in heavier grains of wheat. Similar findings were reported by (Tahir *et al*., 2021; Nadim *et al*., 2011) who described that the use of micronutrients significantly improved the weight of 1000 grains of wheat.

Biological yield tells the total biomass produced by plant throughout its life cycle in normal conditions by

Table 1. Yield and quality attribute of wheat response to micronutrients foliar application at different growth stages

Treatment	Productive tillers/ (m^2)	Plant height (cm)	Grains/ spike	1000 grain weight (g)	Biological yield (Kg/ha)	Grain yield (Kg/ha)	Harvest index (%)	Protein contents (%)	Carbohydrates contents (%)
Control	311	88.1 k	49.00 j	32.10 n	10474 m	4285.1 n	40.90 fg	09.03 l	58.30 o
Tillering	308	90.4 h	50.27 i	33.10 l	11059 j	4498.9 k	40.70 gh	09.50 j	60.20 l
Jointing	309	91.0 g	49.94 i	32.80 m	10890 k	4351.8 m	39.93 j	09.10 l	59.03 n
Booting	306	89.7 i	50.92 h	34.40 k	10923 k	4541.1 j	41.60 bc	09.73 i	61.63 k
Milking	305	89.0 j	50.04 i	33.20 l	10715 l	4417.7 l	41.23 de	09.20 k	59.43 m
Tillering + Jointing	310	92.9 e	51.16 gh	34.90 j	11158 i	4579.2 i	41.03 ef	09.76 hi	62.40 i
Tillering + Booting	311	91.6 f	52.92 e	37.00 f	11924 e	4828.8 f	40.50 hi	11.63 e	64.30 f
Tillering + Milking	306	90.5 h	52.14 f	36.70 g	11607 g	4733.2 g	40.80 g	11.43 f	63.13 g
Jointing + Booting	304	92.8 e	51.78 f	35.90 h	11583 g	4673.0 h	40.33 i	11.13 g	62.73 h
Jointing + Milking	306	91.2 g	51.39 g	35.20 i	11385 h	4610.7 i	40.50 hi	09.83 h	62.00 j
Booting + Milking	306	90.9 g	53.43 d	37.30 e	11822 f	4905.3 e	41.46 bc	11.70 e	64.53 e
Tillering + Jointing + Booting	307	95.7 b	54.26 b	39.50 c	12299 c	5096.2 c	41.43 cd	12.13 c	65.10 c
Tillering + Jointing + Milking	309	94.7 c	53.85 c	38.50 d	12090 d	4987.4 d	41.23 de	11.90 d	64.83 d
Tillering + Booting + Milking	306	93.4 d	54.53 b	40.10 b	12437 b	5179.2 b	41.66 b	12.33 b	65.30 b
Tillering + Jointing + Booting + Milking	304	97.6 a	55.23 a	41.20 a	12818 a	5374.9 a	41.93 a	12.53 a	65.83 a
LSD	ns	0.3158	0.391	0.164	35.139	34.993	0.2152	0.0956	0.0822

Means followed by same letter do not differ significantly at P = 0.05 level; LSD = least significant difference; ns = non significant.

using available resources. It depends on genetic makeup of crop, soil fertility together with nutrients applied. Data regarding biological yield presented in Table 1 revealed that micronutrients mixture foliar spray significantly affected biological yield. The treatment, where four sprays of micronutrients mixture were applied at tillering, jointing, booting and milking stages of wheat resulted in highest biological yield (12818 Kg/ha) as compared with control having minimum biological yield (10474 Kg/ha). These outcomes might be due the micronutrients role in several physiological processes (Tahir *et al*., 2021; Yaseen *et al*., 2010).

Grain yield is most significant attribute of wheat and it is the final outcome of all associated and contributing components like productive tillers, number of grains/ spike and 1000 grains weight. Any change in these attributes can extremely affect the final grain yield. Foliar spray of micronutrients considerably affected the grain yield. Noticeably the highest grain yield (5374.9 Kg/ha) was noted, where four micronutrients foliar sprays were applied at tillering, jointing, booting and milking stages. However, lowest grain yield (4285.1 Kg/ha) was obtained where no micronutrients spray was applied (control). Grain yield has positive correlation with number of grain/spike and grain size so, improvement in grain yield might be direct effect of development in yield traits. Several reports indicated positive correlation of micronutrients foliar spray with grain yield of wheat. Foliar application of iron, boron, zinc, manganese and copper at different growth stages significantly enhances grain and straw yield of wheat (Tahir *et al*., 2021; Mer and Ama, 2014; Khan *et al*., 2010).

Harvest index (H.I) is the ratio of economic and biological yield. Higher the H.I more will be the plant physiological potential for transforming total dry matter into economic yield. The micronutrients spray considerably affected the harvest index of wheat. Considerably the maximum H.I (41.93%) was noted where foliar sprays were applied at tillering, jointing, booting and milking stages, while lowest (40.90%) was observed where micronutrients spray was applied at jointing. This might be due to better starch utilization, improve seed set and assimilates translocation to improve grains which resulted in enhanced no. of grains/spike and grain size. These results are same with the results reported by Zain *et al*. (2015) that micronutrients significantly improve the harvest index.

Grain quality components. Protein and carbohydrate contents are most important characters that describe grain quality. Grain quality as well as its protein and carbohydrate contents was also increased. It is obvious from the data that micronutrients foliar spray greatly affects the grain protein and carbohydrate contents. Considerably maximum grain protein contents (12.53%) were noted in treatment containing foliar sprays of four micronutrients at several growth stages, including tillering, jointing, booting, and milking, as opposed to the standard treatment, which did not include sprays. Control treatment was statistically at par with various treatments where micronutrients spray was applied at jointing stage of wheat. These results are similar with the results of (Yasir *et al*., 2020; Mer and Ama, 2014) who described that the micronutrients foliar application effectively enhanced protein contents of grain. This might be due to micronutrients that played effective role in many physiological processes of plant such as starch utilization, amino acid biosynthesis and enzyme activation, while enhanced to integrate accumulation in grain, which resulted in high contents of grain protein of wheat (Rasul *et al*., 2015).

Foliar feeding of micronutrients mixture was practiced at four different growth phases i.e. tillering, jointing, booting and milking of wheat which will give maximum contents of grain carbohydrate (65.83%) as compared to the controlled treatment which have a minimum contents of grain carbohydrate (58.30%). This outcome may be due to the effective role of micronutrients in many physiological processes such as metabolic reactions, enzymatic activity, carbohydrate production, starch utilization, membrane integrity and protein synthesis (Tahir *et al*., 2021; Monreal *et al*., 2015).

Economic analysis. Economic analysis showed that highest net income (102975) and benefit cost ratio (1.83) were noticed, where four various micronutrients fusion foliar sprays were applied at different stages of wheat (Table 2).

Table 2. Net income and benefit-cost ratio of wheat response to micronutrients foliar application at different growth stages

Treatment	Gross income (Rs/ha)	Total expenses (Rs/ha)	Net benefit (Rs/ha)	Benefit-cost ratio (BCR)
Control	182588	117513	65076	1.55
Tillering	192133	119087	73045	1.61
Jointing	187203	119087	68116	1.57
Booting	192259	119087	73172	1.61
Milking	187657	119087	68570	1.58
Tillering + Jointing	194880	120662	74218	1.62
Tillering + Booting	206604	120662	85942	1.71
Tillering + Milking	201945	120662	81283	1.67
Jointing + Booting	200243	120662	79581	1.66
Jointing + Milking	197270	120662	76608	1.63
Booting + Milking	207841	120662	87179	1.72
Tillering + Jointing+ Booting	216046	122237	93809	1.77
Tillering + Jointing+ Milking	211809	122237	89572	1.73
Tillering + Booting + Milking	219130	122237	96893	1.79
Tillering + Jointing+ Booting + Milking	226786	123811	102975	1.83

Conclusion

Micronutrients play significant role in crop production. Uni Micro Power when applied at tillering, jointing, booting and milking stage performed best in comparison to individual stage and control with no spray.

Conflict of Interest. The authors declare they have no conflict of interest.

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