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EFFECTS OF ZINC, BORON AND SULPHUR ON THE YIELD AND NUTRIENT UPTAKE OF WHEAT CROP

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Abstract

A field trial was carried out to investigate the effects of Zn, B and S when applied alone or in combination on the yield and nutrient uptake of wheat at New Developmental Farm the University of Agricultural Peshawar during winter season 2010. The experiment was carried out in Randomized Complete Block Design replicated three times having row to row distance of 25 cm and plot size of 3x5 m^2. The NPK fertilizers were applied at rate of 120:90:60 kg ha^{-1}in the farm of urea, DAP and potassium chloride, respectively. Sulphur, zinc and boron were applied at rate of 60:10:2 kg ha^{-1} in form of ammonium sulfate, hepta-hydrated zinc sulfate and borax, respectively. All the treatments revealed significant ($P<0.05$) differences for all the traits. The treatment receiving zinc, boron and sulphur was significantly higher which showed maximum dry matter yield and grain yield. Significantly higher1000-grain weight was found in treatment of Zn with S Uptake of leaves P, B, SO_4-S and Zn was found significantly higher in the treatment of S + B + Zn. The overall result suggested that when sulphur, zinc and boron applied at the rate of 60:10:2 kg ha^{-1}collectively produced maximum yield.

Key words: Zinc Sulphate, Ammonium Sulphate, Potassium Chloride and wheat.

INTRODUCTION

Wheat is the most important cereal crop in Pakistan and cultivated on the largest area in almost all parts of the country. It contributes 2 % to GDP and 14.4% to the value added in agriculture. Wheat is grown under a wide range of environmental conditions in Pakistan. The 'soil fertility' is the term which describes the soil ability to supply plant nutrients. The soils of Peshawar valley are slightly strongly calcareous with neutral to strongly alkaline pH 7.2 to 9.1 (Rerkasem and Jamjod 2004) reported boron (B) deficiency from many of the world's wheat growing countries. It was mostly found in areas i.e. India, Nepaland Bangladesh. Wheat has more chances of boron deficiency than maize and rice. They reported that boron adversely affects many processes of wheat growth and development. Wheat genotypes react differently with their adaptation to low contents of boron in soils. Genotypes growing in excessive boron soil may also provide yield on soils having low contents of boron even in these types of soil inefficient genotypes are so badly affected. This is investigated that few boron efficient advanced breeding lines have already been identified due to

presence of boron efficiency under genetic control.

The main source of micronutrients are parent materiel, fungicide and sewage sludge's (Nafees *et al*. 2009) and in soil farmyard manure are present in small amount (Romheld 2000). Zinc (Zn) plays key role in nitrogen metabolism of plant and protein synthesis (Mengel*et al*. 2001). The function of Boron (B) is inter-related with nitrogen, phosphorus, potassium and calcium in plants (Ahmad et al. 2009). Fleet alteration in ion fluxes i.e. [H], [K] and $[Ca]^2$ in plasma membrane is related with B deficiency. In Peshawar the deficiency of zinc and boron is 17 and 95 % respectively. Boron plays important role in growth behavior and productivity of the yield (El-Sheikh et al. 2007). With increasing pH soil AB-DTPA extractable Zn decreases in the soil (Khattak *et al*.1994). Sulphur supply has decreased in many agricultural areas recently. There are some reasons for that are i.e. sulphur-rich simple fertilizers have been replaced by sulphur-poor compound fertilizers; the atmospheric concentrations of sulphur compounds have decreased; increased yields take up more sulphur from the soil. Generally, crops needs less sulphur like cereals, still start suffering more and more from sulphur deficiency even there are some crops which need more sulphur as well (McGrath et al, 1996). The baking properties of wheat and the biological value of proteins can also be improved by increasing sulphur fertilization which has reported many times (Marschner, 1997; Järvan et al., 2006).

Due to increasing population rates, the demands for food has been increased dramatically all over the world which resulting in famine situations in maximum areas of world. There are some cereal crops i.e. wheat, maize and rice which are used as a staple food all over the world is growing in great concentration. In Pakistan the total wheat production area is 9,260 thousand ha, which adds about 25,482 thousand tons wheat in national production with an average production of 2752 kg ha^{-1} (Pakistan Bureau of Statistics, 2015-16P). For fulfilling the requirements of the people, we have to improve the yielding capabilities of cereal crops especially wheat as it is reported that levels of boron, zinc and sulphur must be kept in consideration for optimum yield of cereal crops.

Keeping the importance of B, S, P and Zn, the present study is planned to investigate the interactive influence of B, S, P and Zn on the yield and nutrient uptake of wheat, with basic doses of NPK.

MATERIALS AND METHODS

Effect of boron, zinc and sulphur on yield and nutrients uptake of wheat was conducted at The University of Agricultural Peshawar during 2010. The main objective of this experiment was to determine the response of wheat crop to the application of boron, zinc and sulfur in the form of borax, ammonium sulphate and zinc sulphate, respectively.

Experiment was carried out in Randomized complete Block Design replicated three times. Plot size was $3 \times 5m^2$ having 25 cm row to row distance with total area of 527 m^2. All experimental plots were ploughed thoroughly before sowing time followed by the proper leveling for fertilizers application. All fertilizers (potassium, sulphur, phosphorous, boron and zinc) were applied at sowing time except nitrogen which was applied in two splits doses, half dose at sowing while the remaining were applied at knee height stage. Basal doses of NPK were urea, DAP and potassium chloride respectively while for boron,zincand sulphur (borax, zinc sulphate and ammonium sulphate) were used. Efforts have been made to check all applications for observing the betterment of crop yield before applying all the nutrients in soil and it was found that soil contained enough concentration of boron, zinc and sulfur. Due to this reason, boron (B), zinc (Zn) and sulfur (S) were applied alone or collectively along with NPK during an experiment to collaborate their effect on the yield and uptake of nutrient by wheat crop.

Crop related parameters: After harvesting, the total dry matter yield was weighed separately for each plot, respectively. Grain yield was taken after weighing grains from for each plot, respectively. Grains were removed from spikes of each treatments plot and 1000 grains were counted and their respective weights were noted. Ten randomly fully matured ear leaves were taken from all the central two rows of plots and analyzed for B, Zn, P and$SO_4$by standard procedures. Atomic Absorption Spectrophotometer was used to find the zinc concentration in samples of leaf after wet

digestion. Spectrophotometer at a wavelength of 880 nm by using perkin–Elmer Lamda–35 was used to find the phosphorus concentration in samples of leaf after wet digestion. Same procedure was used as in soil analysis. Spectrophotometer was used for determining SO_4-S at 470 nm (Tandon, 1991). Curcumine method was used to measure the boron concentration at 420 nm by spectrophotometer after filtration process (Page *et al*, 1982).

Statistical analysis: MSTATC package (Russell, 1989) was used for analyzing the replicated data and means was compared by using least significant difference (LSD) test after having significant results.

RESULTS AND DISCUSSION

Dry matter yield: There was significant (P<0.05) results found for all the treatments having total dry matter yield in higher quantity in comparison to control. The treatment receiving from S + B + Zn (17094 kg ha^{-1}) was significantly higher which showed maximum dry matter yield by having 67.48 % over boron with sulfur in addition with NPK (15305 kg ha^{-1}) after control (Table 2). These results are in collaboration with the finding of Rego*et al.* (2006) who found that addition of N and P with S + B + Zn collectively provided 74 and 75 % higher grain yield followed by 55 and 53 % higher stover yield with and alone farmer practices, respectively.

Grain yield: There was significantly (P<0.05) increment found in grain yield in comparison with control among different treatments. Application of zinc with boron produced significantly more grain yield (2595 kg ha^{-1}) from zinc in combination with sulphur (2362 kg ha^{-1}) and sole application of sulphur and boron (2051kg ha^{-1} and (2473 kg ha^{-1}) respectively. Grain yield was found maximum in combined application of sulfur, zinc and boron (2662 kg ha^{-1}). The treatment receiving NPK alone, sulphur with boron and only zinc also improved grain yield by 25.09 %, 32.79%, and 31.28 % over control respectively. These finding are similar to Islam *et al.* (1996) who reported highest grain yield of rice was found in sulfur, boron and zinc treatment in comparison with the single application of sulfur, boron and zinc. Rego*et al.* (2006) and Srinivasarao *et al.* (2008) that showed that combine application of boron, sulfur and zinc also resulted highest grain yield.

Table: 1 Dry matter yield (kg ha^{-1}), grain yield (kg ha^{-1}) and thousand grain weight (g $plot^{-1}$).

Treatments (kg ha^{-1})				dry matter yield (kg ha^{-1})	grain yield (kg ha^{-1})	Thousand grain weight (g)
NPK	S	Zn	B			
control	0	0	0	5559g	1699e	35.49c
120-90-60	0	0	0	11009f	2268bcd	39.73ab
120-90-60	60	0	0	13209d	2051cde	39.67ab
120-90-60	0	10	0	12456e	1910de	39.85ab
120-90-60	0	0	2	14770c	2473ab	37.65bc
120-90-60	60	10	0	15088c	2362abc	41.91a
120-90-60	60	0	2	15305c	2528ab	38.96ab
120-90-60	0	10	2	16004b	2595ab	40.75ab
120-90-60	60	10	2	17094a	2662a	41.41a
LSD (P<0.05)				646.47	373.72	3.47
CV (%)				2.79	9.46	5.08

Thousand grain weight: Minimum thousand grain weights was found in control treatment (35.490 g) and maximum thousand grain weight was (41.91g) showed in treatment of Zn + S which also revealed that there was 15.3% increase over control. It also showed that NPK revealed lower grain weight (39.73 g) than Zn + S (Table 1). There were non-significant results found for 1000 grain weight by addition of S according to Bharathi and Poongothai (2008) the maximum grain weight observed in the treatment of Zn + S may be due to increase in protein content. Hussein (2010) also stated that grain weight and grain yield enhanced by the zinc application.

Phosphorus uptake in wheat leaves: Significant ($P<0.05$) results was found for uptake of P of wheat leaves to the treatments applied (Table 2). Minimum P content (8.23 kg ha^{-1}) was recorded in control treatment. Maximum P content was recorded in Zn + B + S (37.7 kg ha^{-1}) followed by Zn + S (31.2 kg ha^{-1}). Gunes and Alpaslan (2000) also found that B application resulted an increase in B contents and its uptake having decrease P contents and its uptake in plant showed opposite relationship between them. Aref (2007) reported that there was maximum leaf P content present in treatment S and Zn due to facts that leaf P has synergistic relationship with soil Zn content.

Zinc uptake in wheat leaves: Significant ($P<0.05$) results were obtained for Zn uptake in wheat leaves with different fertilizer application applied alone or in combination (Table 2). Maximum Zn uptake was obtained (0.77kg ha^{-1}) in treatment of B+ S+ Zn while minimum was found in the treatment of control (0.15 kg ha^{-1}). Likewise, Aref (2011) also found that zinc content was higher in leaves due to lack of boron in soil as they both have anti-parallel relationship with each other. Ozkutlu *et al.* (2006) also showed that zinc application in roots medium can grow zinc content in shoot. Accumulation of sulphur with NPK increased zinc uptake than control in rice observed by Uddin *et al* (2002).

Boron uptake in wheat leaves: Analysis of variance showed significant ($P<0.05$) differences of B content in wheat leaves which could be due to different combination fertilizer sources which applied alone or in combination (Table 2). Maximum B content (1.44 kg ha^{-1}) was recorded in treatment of S + Zn + B while the lowest B content (0.38 kg ha^{-1}) was noted in control plot. These results in line with Aref (2007) who stated that B content decreases due to increase in P content in soil showing antagonistic with each other. Rajashekhara Rao *et al,* (2010) also found that B application have synergetic effects on plant particularly when addition of P was taken in deficient amount also appreciated by Aydin and Mehmet (2000) who found the presence of negative effects of B and P on grain yield or straw yield.

Table. 2 B, P, SO_4-S and Zn uptake by wheat leaves as influenced by S, B and Zn either applied alone or in combination.

Treatments (kg ha^{-1})				Leaf P	Leaf Zn	Leaf B	Leaf SO_4-S
NPK	S	Zn	B	---------- (Kg ha^{-1}) ----------			
Control	0	0	0	8.23f	0.15f	0.38f	42.91e
120-90-60	0	0	0	17.13e	0.35e	0.86e	102.08d
120-90-60	60	0	0	22.40d	0.49c	0.95d	144.05c
120-90-60	0	10	0	23.80cd	0.57b	0.90de	106.57d
120-90-60	0	0	2	21.37d	0.42d	1.12c	115.22d
120-90-60	60	10	0	31.20b	0.64b	1.06c	170.64b
120-90-60	60	0	2	26.57c	0.58b	1.23b	165.89b
120-90-60	0	10	2	30.06b	0.72a	1.21b	157.30bc
120-90-60	60	10	2	37.71a	0.77a	1.44a	186.61a
LSD ($P<0.05$)				3.41	0.08	0.07	15.07
CV (%)				8.27	6.51	5.00	5.98

Sulphur uptake in wheat leaves: Results showed that SO_4-S uptake in wheat leaves significantly enhanced ($P<0.05$) with various fertilizer sources either applied alone or in combination (Table 2). Highest SO_4-S content (186.61kg ha^{-1}) was noted in plot treated with combined sources B + S +Zn, while minimum uptake (42.91kg ha^{-1}) was found in control. Likewise, Rego *et al.* (2006) found that NPK sources along with B + S+ Zn fertilizer and farmer practice increased sulfur contents in plant leaves. Srinivasaroa *et al.* (2008) also recorded that due to application of B + S and practices of farmer in various plants such as soya bean and chick pea increased uptake of S + B over farmer practices.

CONCLUSION

1. The dry matter yield and total grain yield was increased by the combine application of S, Zn and Bat the rate of 60:10:2 kg ha^{-1}along with basal doses, respectively. The higher thousand grain weight was obtained in Zn + S.
2. Uptake of leaves P, B, SO_4-S and Zn was found significantly higher in the treatment of S, Zn and B along with basal doses of NPK.

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