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

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Abstract

To evaluate the effect of Zinc (Zn), boran (B) and sulphur (S) alone and in combination on wheat yield and nutrient uptake, an experiment was conducted at New Developmental Farm of the University of Agricultural Peshawar during winter 2010. The experiment was carried out in randomized complete block design having three replications. 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. Wheat variety "Siran" was sown on 13th November 2010 with row to row distance of 25 cm and plot size of 3x5 m^2. All the treatments caused significant ($P<0.05$) differences in all the studied parameters. Plots receiving zinc, boron and sulphur resulted in significantly higher dry matter yield and grain yield. Moreover, combined application of S + B + Zn resulted in higher Zn and S Uptake of leaves and leaf P, B, SO_4-S contents. Thus application of sulphur, zinc and boron at the rate of 60:10:2 kg ha^{-1} produced higher yield of wheat.

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 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 India, Nepaland Bangladesh. Wheat is more sensitive to boron deficiency than maize and rice. 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 studied at The University of Agricultural Peshawar during 2010. The main objective of this experiment was to determine the response of wheat 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. Plot size was $3 \times 5m^2$ having 25 cm row to row distance with total area of 527 m^2. All treatments were replicated three times. All experimental plots were ploughed thoroughly before sowing followed by planking. All fertilizers (potassium, sulphur, phosphorous, boron and zinc) were applied at sowing time except nitrogen which was applied in two splits doses, half at sowing while the remaining half was applied at tillering stage. Urea was used as source of N, DAP was applied as source of P and potassium chloride was applied as source of K. Moreover, for boron, zinc and Sulphur,borax, zinc sulphate and ammonium sulphate were used respectively. Boron (B), zinc (Zn) and sulfur (S) were applied alone and in combination.

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 treatment and 1000 grains were counted and their respective weights were noted. Ten randomly fully matured leaves were taken from all the central two rows of each plot and were 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: Data on total dry matter of wheat are shown in Table -1. It was found that all treatment significantly affected total dry matte of wheat as compared to control ($P<0.05$). Plots treated with S + B + Zn in combination resulted in higher total dry matter yield (17094 kg ha^{-1}) in addition with NPK as compared to control. These results are in line with the finding of Rego *et al.* (2006) who found that application of N and P in combination with S + B + Zn resulted in higher total dry matter yield as compared to sole application of these nutrients and control plots.

Grain yield: Different treatments significantly affected wheat grain yield as compared to control plots ($P<0.05$). Combined application of Zn and B produced significantly higher grain yield (2595 kg ha^{-1}) followed by application of zinc in combination with sulphur (2362 kg ha^{-1}) which was at par with application of sulphur and boron (2051kg ha^{-1} and (2473 kg ha^{-1}) respectively. Combined application of Zn, S and B performed better than control and sole application of these nutrients. The plots treated with NPK alone 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 that highest grain yield of rice was found in plots treated with combined application of sulfur, boron and zinc in comparison with the single application of sulfur, boron and zinc. Rego *et al.* (2006) and Srinivasarao *et al.* (2008) are of the view that combined application of of boron, sulfur and zinc improved wheat yield and yield components.

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: Thousand grain weight was significantly affected by different treatments ($P < 0.05$). Lower thousand grain weights was recorded in control plots (35.490 g) while combined application of Zn+S resulted in hieh thousand grain weight of wheat. Sole application of NPK resulted in lower thousand grain weight as compared to combined application of NPK and Zn + S. Our results are confirmed by the findings of Bharathi and Poongothai (2008) who reported that the maximum grain weight was recorded in plots treated with Zn + S. Hussain (2010) also stated that grain weight and grain yield of wheat was increased by Zn application along with N and P.

Phosphorus uptake in wheat leaves: Differently treatments significantly affected phosphorus uptake in wheat leaves (P<0.05). Higher P P content (8.23 kg ha^{-1}) was recorded in control plots where no treatment was applied. Maximum P content was recorded in Zn + B + S (37.7 kg ha^{-1}) treated plots followed by application of Zn + S in combination (31.2 kg ha^{-1}). Our results are confirmed by the finding of Gunes and Alpaslan (2000) who stated that B application resulted in higher B content of leaf and its uptake by wheat. Aref (2007) reported that combined application S and Zn resulted in higher P content of wheat leaf and attributed it to the fact P has synergistic relationship with soil Zn content.

Zinc uptake in wheat leaves: Significant (P<0.05) effect of different fertilizer application alone or in combination was found on wheat leaf Zn uptake (Table 2). Zinc uptake was higher in leaves treated with combined application of Zn + S + B as compared to control plots. 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 in B content of wheat leaves (Table 2). Higher B content in wheat leaves (1.44 kg ha^{-1}) was recorded in leaves collected from the plots treated with combined application of S + Zn + B while control plots resulted in lower leaf B content (0.38 kg ha^{-1}).These results in line with Arif (2007) who stated that B content in wheat leaves was decreased due to increased soil P content. It might be due to the antagonistic effect of P on B. 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 Aydsin 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 was significantly enhanced (P<0.05) as a result of fertilizer sources (B, S, Zn and NPK) 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 of B + S +Zn, while minimum uptake (42.91kg ha^{-1}) was found in control plots. Our results are confirmed by the findings of, Rego *et al.* (2006) who found that NPK sources along with B + S+ Zn fertilizer increased sulfur contents in plant leaves. Srinivasarao *et al.* (2008) also recorded that due to application of B + S increased uptake of S + B in soybean and Chick Pea plants.

CONCLUSION

The dry matter yield and total grain yield was increased by the combine application of S, Zn and B at the rate of 60:10:2 kg ha^{-1} along with basal dose of NPK, respectively.Similarly, application of Zn, S and B improved wheat leaf P, B, SO_4-S and Zn uptake as compared to control.

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