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Short Communication

Wheat response to micronutrients in rain-fed areas of Punjab

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Abstract

Wheat response to micronutrients vs. Zn, Fe, & B in rain fed environments was studied in the farmer's fields during 2002-03 to 2004-5. Twelve single replicated experiments were laid out in the districts of Rawalpindi, Jehlum and Chakwal. The micronutrients, i.e., Zn, Fe, B @ 5, 10, 1 kg ha^{-1} respectively were applied either in single or in combination along with basal dose of NPK @150-120-90 kg ha^{-1}. Three wheat varieties- Chakwal-97, Inqlab-91 and Chakwal-2000 were used as test crop. Data revealed that all the micronutrients (Zn, Fe, and B) significantly increased the wheat yield over control when applied in single and in combination. Response of Inqlab-91 to Fe and B was higher than Chakkwal-97 and in case of Zn, Chakwal-97 performed better than Inqlab-91 for increasing the grain yield. Area specific response to micronutrients was quite visible in Rawalpindi district than Jehlum and Chakwal. Micronutrients fertilization improved better crop productivity in Rawalpindi district. The order of wheat response to micronutrients in Rawalpindi district was Zn> Fe>B.

Key words: Wheat, zinc, iron, boron

Triticum aestivum L. (wheat) is amongst the major cereal crops of Pakistan and is extensively grown in irrigated as well as in rain fed environment. In Pakistan, ever increasing demographic pressure demands an enhancement in wheat production per unit cultivation of land. Micronutrients are those essential plant nutrients, which are required in smaller quantities than the major nutrients for normal growth and development of plants. Though micronutrients are required in smaller quantities yet they are as essential as the major plant nutrients.

The soils of Pakistan**,** across much of the 22 mha cultivated area, have been formed from calcareous alluvium and loess, and are low in many essential plant nutrients. Loss of organic matter whether by erosion or high temperature in rain-fed agro-ecosystem adds to impoverishment of soil resources of several elements essential for growth (Hadda and Arora, 2006)**.** The information obtained from 329 soil samples collected from various depths during the period of seven months revealed widespread deficiencies of Zinc (Zn) and boron (B) followed by iron (Fe) (Zia *et al*., 2004). Even on the world scale, it is estimated that Fe and Zn deficiencies are widespread occurring in about 30 and 50% respectively of cultivated soils (Cakmak, 2002). While B deficiency have also been reported in over 80 countries and on 132 crops (Shorrocks, 1997). In Pakistan, Zn and B deficiencies are more widespread micronutrient disorders and have been reported for different field crops in all the four provinces of the country. More than 60% soils in Punjab, 21% soils in NWFP, 6-94% soils in Sindh and above 90% in Buluchistan are reported to be Zn deficient. Iron and boron deficiency exhibited in citrus, deciduous fruits**,** groundnuts and many other crops (Tariq *et al*., 2004). They further stated that make up of mineral nutrients, improves the crop quality and increases resistance in plants against biotic and abiotic stresses.

Deficiencies of various micronutrients are related to soil types, crops and even to various cultivars. The introduction of new high yielding hybrids or cultivars capable of demanding a higher level of soil fertility has further accentuated the incidence of micronutrients deficiencies. Soil and plant analysis showed that > 50% of the cultivated soils of the country are unable to supply sufficient Zn and B to meet the needs of many crops (Khattak, 1995).

Present study was carried out to identify the wheat response to micronutrients in three districts of rain fed areas in Rawalpindi division.

Twelve experiments in single replication were conducted in farmer's fields of three districts i.e. Rawalpindi, Jehlum, and Chakwal, under rain fed environment during 2002-03 to 2004-05. Three wheat varieties i.e. Chakwal-97, Inqlab-91, and Chakwal-2000 were grown as a test crop. The sites were sampled from the depth 0-15 and 15-30 cm, before sowing the wheat crop. Soil samples were air dried, ground, and sieved through 2mm sieve. Electrical Conductivity (EC) and pH of the soil were determined in soil: water (1:10) suspension by conductivity and pH meter (Black, 1965). The soil texture was determined by the hydrometer method (Bouyoucos, 1962). The soil organic matter was oxidized with a mixture of Potassium dichromate and concentrated H_2SO_4. The unused Potassium dichromate was back titrated with ferrous sulphate according to Walklay and Black method improved by Khan and Rafique (1980). Available K was determined flam photo- metrically from neutral normal Ammonium acetate extract of soil (Jackson, 1958) after shaking and filtration by the method of Schollenberger and Simon (1945). The saturation percentage was determined by

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making saturated soil paste according to Richard (1954). Available-P (Olsen P) was determined by bicarbonate extraction (Olsen and Sommers, 1982). The method of Lindsay and Norvell (1978) was used to measure the Zinc and Ferrous (extraction with AB-DTPA, and using Atomic Absorption Spectrophotometer). Soil boron was determined by 0.05M HCl extraction method (Rashid *et al*., 1994) using spectrophotometer. The initial soil analysis of all sites indicated that the soils in texture were loam, free from salinity/sodicity, deficient in organic matter and available-P and satisfactory in available Potash, while deficiency of micronutrients also existed with wide range of occurrence (Table-1).

Table 1. Physico-chemical characteristics of experimental sites (Depth 0 – 15 cm).

Sr. No.	Characteristics	Units	Mean	Range	S.D.
1	pH		7.57	7.40 – 8.00	0.26
2	Electrical Conductivity	dS m^{-1}	0.30	0.14 – 1.08	0.22
3	Organic matter	%	0.60	0.40 – 0.88	0.14
4	Available P	mg kg^{-1}	4.42	3.20 – 5.60	0.85
5	Extractable K	mg kg^{-1}	136	105 – 170	19.32
6	Zinc	mg kg^{-1}	1.28	0.20 – 1.97	3.70
7	Iron	mg kg^{-1}	1.83	0.25 – 7.80	0.58
8	Boron	mg kg^{-1}	0.38	0.10 – 1.20	2.30
9	Textural class	Loam			

All NPK @ 150-120-90 kg ha^{-1} as urea, DAP and SOP respectively were incorporated into the soil as a blanket dose before sowing the crop. Boron, Iron, and zinc treatments were applied @ 1, 10, and 5 $Kgha^{-1}$ from boric acid (HBO_3), iron sulphate ($FeSO_4.7H_2O$) and zinc sulphate ($ZnSO_4.7H_2O$) respectively, either alone or in combination with one or the both, at the time of sowing. Net plot size was 252.9 m^2 for all the treatments. Three samplings, size $1m^2$ from each plot were harvested for the wheat grain yield data.

The results were subjected to the analysis of variance employing the randomized complete block design (RCBD) and the means were compared suing Duncan's Multiple Range Test (Steal and Torrie, 1980).

Either the effect of Boron (B), Iron (Fe), or Zinc (Zn) applied individually or in combination on wheat yield under rain fed conditions is given year-wise in Table-2. Pooled data revealed that the differences among various treatments for wheat grain yield were significant at 5% level of significance. All doses of B, Fe, and Zn fertilizer application increased the wheat grain yield significantly over control when applied singly or in combination, suggesting that application of those nutrients may have significant position to increase the wheat grain yield in rain fed environment. The results are in conformity with Rashid (2006). Data also revealed that the application of Zn+B produced lesser wheat grain yield than Zn+Fe. Few studies however, indicate that under certain conditions Zn application may ameliorate the ill effects of high B (Alam and Shah, 2003). The highest wheat grain yield of 3883 kg ha^{-1} was achieved with B, Fe and Zn applied in combination followed by the yield of 3655

Table 2. Chronological wheat response to micronutrients (2002-2005) in rain-fed areas (grain yield in kg ha^{-1}).

Sr. No.	Nutrient kg ha^{-1}			2002-03	2003-04	2004-05	Overall
	Zn	Fe	B				
1	0	0	0	2081 c	3404 d	2856 d	2846 e
2	0	0	1	2575 ab	3712 cd	3064 d	3158 d
3	0	10	0	2489 b	3756 c	3243 cd	3225 d
4	0	10	1	2521 b	3991 bc	3530 bc	3432 c
5	5	0	0	2623 ab	3867 c	3498 bc	3403 c
6	5	0	1	2669 ab	4033 bc	3577 bc	3502 bc
7	5	10	0	2553 b	4226 ab	3859 ab	3655 b
8	5	10	1	2866 a	4375 a	4099 a	3883 a
	Cd1			280	308	380	173
	Cd2			389	420	512	229

kg ha^{-1} obtained with the application of Zn+Fe. Difference between both the grain yields was statistically at par.

Manipulation of grain yield of data for three years (2002-03 to 2004-05) indicates higher response to Zn followed by Fe and B when applied alone. Wheat grain yield achieved during 2003-04 was observed high followed by 2004-05 with the application of micronutrients either alone or in combination. It might be due to great variation in rainfall (Rashid, 2004). He also explained that in pothohar region; generally, 70% rainfall is received in summer monsoon and only 30% in winter. During the year 2002-03 the maximum yield of 2866 kg ha^{-1} was achieved from the treatment containing all three nutrients followed by 2669, 2623 and 2575 kg ha^{-1} from the treatments having Zn+ B, Zn and B alone, respectively. The differences in wheat yields obtained from these treatments were statistically at par. During the year 2003-04 and 2004-05 wheat response to B was statistically non-significant. The maximum yields of 4375and 4099 kg ha^{-1} were obtained from the treatments containing Zn+Fe+B followed the yield of 4226 and 3859 kg ha^{-1} with the application of Zn+Fe during 2003-04 and 2004-05 respectively. The difference in wheat yield between both the treatments was statistically non significant during both the years 2003-04 and 2004-05.

The latest trends in response of three wheat genotypes to micronutrients fertilization were studied through twelve field experiments spread over the rain fed area (Table 3). The effect of three micronutrients (B, Fe, Zn) applied either singly or in combination on three wheat genotype i.e. Chakwal-97, Inqlab-91, and Chakwal 2000, in terms of grain yield, was significant at 5% level of significance. Inqlab-91 responded better to B and Fe when applied alone whereas Zn performed better in augmenting the grain yield of Chakwal-97 under rain fed condition. It might be due to difference in yield potential or micronutrients accumulative behavior of two wheat cultivars. Alam (2004) postulated that two wheat genotypes differed significantly in producing grain yield. Similarly Kausar and Hamid (1998) also reported similar differences in yield potential of wheat genotype. Chakwal-2000 response to micronutrients application was non-significant. This variety was tested at only one site and it needs further field research. Inqlab-91 increased the yield by 13% and 15% over control with the application of B and Fe alone respectively where as Chakwal-97 increased the wheat grain yield by 21% with the application of Zn alone. The combined effect of three micronutrients on the grain yield of Chakwal-97 was greater than inqlab-91. Combined application of all the three nutrients increased the grain yield of Chakwal-97 by 42% whereas Inqlab-91 by 32% over control. The maximum wheat grain yield of 3970 kg ha^{-1} was observed in Chakwal-97 with the application of B+Fe+Zn followed by 3646 kg ha^{-1} with Zn+Fe. The difference in grain yield of Chakwal-97 between these two treatments was statistically non-significant at 5% level of significance. Maximum wheat grain yield of 4006 kg ha^{-1} of Inqlab-91 was obtained from the treatment containing all the three nutrients (B+Zn+Fe). However the magnitude of maximum grain yield of Inqlab-91 was statistically at par with yield of 3695, 3698 and 3650 kg ha^{-1} obtained from the treatments receiving Zn+Fe, Zn+B and Fe alone, respectively.

Table 3. Varietals response of wheat to micronutrients in rain-fed areas (Grain yield in kg ha^{-1}).

Sr. No.	Nutrient kg ha^{-1}			Chahwal-97	Inqlab-91	Chakwal-2000	Overall
	Zn	Fe	B				
1	0	0	0	2801 d	3017 abc	2774 NS	2846 e
2	0	0	1	3090 cd	3415 b	3013	3158 d
3	0	10	0	3181 cd	3467 b	2886	3225 d
4	0	10	1	3388 bc	3650 ab	2998	3432 c
5	5	0	0	3379 bc	3583 b	2961	3403 c
6	5	0	1	3477 bc	3698 ab	3051	3502 bc
7	5	10	0	3646 ab	3695 ab	3163	3655 b
8	5	10	1	3970 a	4006 a	3036	3883 a
	Cd1			400	366		173
	Cd2			536	500		229

The results from 12 experiments conducted on wheat in Rawalpindi, Jehlum and Chakwal districts during 2002-03 to 2004-05 revealed area specific response to Zn, Fe and B applied either alone or in combination (Table 4). The crop significantly responded to all the nutrients in all districts when applied singly and in combination at 5% level of

Table 4. Wheat responses to micronutrients in three districts of rain-fed areas (Grain yield in kg ha^{-1}).

Sr. No.	Nutrient kg ha^{-1}			Rawalpindi	Jehlum	Chakwal	Overall
	Zn	Fe	B				
1	0	0	0	2925 e	3173 d	2361 b	2846 e
2	0	0	1	3220 d	3379 cd	2813 ab	3158 d
3	0	10	0	3380 cd	3540 bcd	2701 ab	3225 d
4	0	10	1	3643 bc	3678 bcd	3095 a	3432 c
5	5	0	0	3541 c	3671 bcd	2870 ab	3403 c
6	5	0	1	3672 bc	3806 abc	2858 ab	3502 bc
7	5	10	0	3693 ab	4128 ab	2873 ab	3655 b
8	5	10	1	4108 a	4288 a	3028 a	3883 a
	Cd1			288	549	464	173
	Cd2			388	762	644	229

significance. Wheat response to individual micronutrient in Rawalpindi district was statistically significant but non-significant in Jehlum and Chakwal district. The order of response to micronutrient in Rawalpindi district was Zn>Fe>B. The combined effect of Zn+Fe+B and Zn+Bon the wheat grain yield was statistically at par in Rawalpindi. In Jehlum district response to individual micronutrient was statistically non-significant and combined application was significant. Effect of micronutrients in Chakwal district was statistically non- significant when applied alone as well as in combination. The results are in conformity with Rashid (2006), Zia *et al*., (2004), and Tariq *et al*., (2004).

From this study it might be concluded that all the nutrients (Zn, Fe and B) significantly increased the wheat grain yield over control when applied singly and in combination. It is inferred from these field experimentation that micronutrient fertilization may enhance the crop productivity in rain fed areas. Inqlab-91 response to Fe and B was higher than the Chakwal-97 and the trend was reverse in case of Zn. Area specific response to micronutrients was significant in Rawalpindi district and non-significant in Jehlum and Chakwal, which is also confirmed by soil analysis of different districts. The order of response in terms of crop productivity to micronutrients fertilization in Rawalpindi district was Zn>Fe>B.

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