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# Effect of Zinc, Copper, Iron, Manganese and Boron on the Yield and Yield Components of Wheat Crop in Tehsil Peshawar

A. Asad[1,2] and R. Rafique[3]
[1]Department of Soil science, N. W. F. P. University of Agriculture Peshawar, Pakistan
[2]Current address: The School of Land and Food Sciences, University of Queensland, 4072. Australia
[3]Department of Soil Science and Plant Nutrition, University of Western Australia, 6907, Western Australia

**Abstract:** A field experiment was conducted in a commercial wheat grower's field, to study the combined effect of micronutrients, zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), boron (B) and a source of commercial micronutrients called Zarzameen on the yield and the yield components of wheat crop at Wahid Garhi, Peshawar, Pakistan. Different combinations of Zn, Cu, Fe, Mn, B and Zarzameen were applied at the rate of 4.0, 2.0, 5.0, 2.0, 1.0 kg $ha^{-1}$ and 1.0 kg $ha^{-1}$, respectively, along with a basal dose of 100 kg $ha^{-1}$ nitrogen (N), 75 kg $ha^{-1}$ phosphorus (P), 50 kg $ha^{-1}$ potassium (K). The fertilizer treatments (macro and micro nutrients) increased wheat dry matter, grain yield, and straw yield significantly over control. Soil contents of B and Zn were increased both at boot and harvesting stage and Fe only at boot stage with the addition of micronutrients. Plants of -B treatments had showed classical B deficiency symptoms at grain formation stage but not at vegetative stage. Boron concentration in the dry matter of wheat plants increased with the addition of the B fertilizer in the soil. Results of the experiment demonstrated that soil under experiment was deficient in B with the deficiency of N, P or K.

**Key words:** Boron, micronutrients, plant nutrition, wheat, yield

## Introduction

Wheat is one of the most important crops among all cereals consumed directly by the people in different forms. Wheat straw used for feeding the animals and also for some industrial use i.e. packing and hard board making. Wheat ranks first in acreage as well as in production among all cereals in Pakistan. In 1998-99 wheat crop was sown on 8,299,900 hectares of land in Pakistan and production was 17,853,700 tons with an average grain yield of 2,168 kg $ha^{-1}$ (Anonymous, 1999).

Micronutrients (Zn, Cu, B, Fe and Mn) are as essential as macronutrients (N, P and K) for crop plants. Each micronutrient has its own function in plant growth. For example, Fe is required for biological redox system, enzyme activation, oxygen carrier in nitrogen fixation (Romheld and Marschner, 1991). Manganese is required for enzyme activation, in electron transport, and in disease resistance (Burnell, 1988). Zinc is important for membrane integrity and most importantly phytochrome activities (Shkolnik, 1984). Copper is important for physiological redox processes, pollen viability and lignification (Marschner, 1995). Boron is required for reproductive plant parts, cell will formation and stabilization, membrane integrity, carbohydrate utilization and stomatal regulation (Marschner, 1995). Reproductive of some plant species, Including wheat, is impaired by low soil B even when the vegetative growth of the same plant is apparently unaffected by B deficiency (Mozafar, 1993). Thus in the field It is commonly observed that plants remained free of B deficiency symptoms until reproductive growth commences when a variety of B deficiency symptoms may appear including abortion of flower buds or flowers, male sterile flowers, aborted fruit and pots with reduced number of seeds and reduced seed size (Bell, 1997).

Boron deficiency in wheat has been reported in many countries of Asia, i.e. India (Tandon and Naqvi, 1992) Thailand (Jamjod and Rerkasem, 1999), China (Li *et al.,* 1978; Liu *et al.,* 1981) and Nepal (Sthapit, 1988). Compared with other micrnutrients, B requirements are reported to differ among monocotyledons *and* dictyoledons and also among plant species within these groups (Gupta, 1993; Bell, 1997; Asad *et al.,* 2000). For example, in wheat, a B concentration of 3 mg $kg^{-1}$ dry matter was reported to be adequate during vegetative stage (Martens and Westermann, 1991; Reuter and Robinson, 1997). By contrast, during reproductive growth, pollen appears to require 8-10 mg B $kg^{-1}$ in order to avoid grain yield losses from sterility (Rerkasem *et al.,* 1997). Even among the reproductive parts of wheat, the B requirement of the male reproductive organs for pollen germination was greater than that for female gamete development (Rerkasem *et al.,* 1997). Generally, the symptoms of B deficiency have been described as male sterility, resulting in grain set failure (Jamjod and Rerkasem, 1999). However, no apparent effect on any vegetative parts of the wheat plants has been observed (Rerkasem *et al.,* 1997; Jamjod and Rerkasem, 1999).

There is little scientific evidence available in the use of micronutrients for wheat crop in Peshawar, Pakistan. The objective of the experiment was to study the growth of wheat crop with and without the application of micronutrients to identify the micronutrients deficiencies for wheat crop. The experiment was conducted on a commercial framer's land, who previously applied only N, P and K to his crops.

## Materials and Methods

The seedbed was thoroughly prepared before sowing the crop. Composite soil sample was taken before sowing from the depth of 0-20 cm. The soil was analyzed for various physico-chemical characteristics, which will be discussed in detail under analytical procedure. Size of plot was $3 \times 5$ $m^2$ with 10 rows 30 cm apart from each other. Wheat variety Pak-81 was sown at the recommended rate of 100 kg $ha^{-1}$ on December 14 and harvested on 25 May. All the treatments were arranged in a randomized complete block design with four replicates for each harvest time. The results were analysed by standard analysis of variance techniques (Gagnon *et al.,* 1984). Significant treatment effects were separated with Fisher's Protected LSD Test at p s 0.05.

The wheat-growing season was typical of the Peshawar valley. The minimum temperature for December and January ranged from -3 to 1°C and of May it ranged from 15 to 12°C: the respective maximum temperatures ranged from 7 to 23°C and from 29 to 40°C.

A basal dose of NPK (100:75:50) kg $ha^{-1}$ was applied as N, $P_2O_5$ and $K_2O$ in the form of urea, single superphosphate and potassium sulphate, respectively. Micro nutrients i.e. (Zn, Cu, Fe, Mn, and B) were applied at the rate of 4.0, 2.0, 5.0, 2.0 and 1.0 kg $ha^{-1}$ as zinc sulphate (40.6% Zn), copper sulphate (39.85% Cu), ferrous sulphate (36.75% Fe), manganese sulphate (36.75% Mn), borax (11% B) respectively. An additional treatment of commercial micronutrients source called Zarzameen was included at the rate of 1 kg $ha^{-1}$ to compare with the combined micronutrients. The details of the treatments are shown in Table 1.

Phosphorus and potash with half dose of N were applied at the time of sowing and worked into the soil, while the remaining half dose of N was applied at knee high stage of crop. Calculated amount of zinc sulphate, copper sulphate, manganese sulphate, borax and Zarzameen were applied and thoroughly mixed into the soil at the time of sowing. All the recommended cultural practices were followed throughout the growing season. Upper most four leaves were taken from 20 plants randomly from each treatment plot at preheating stage (called boot stage) to determine the concentration of Zn, Cu, Fe, Mn and B. Soil samples were also collected from each plot at the time of leaf sampling and harvesting for the determination of micronutrients. Dry matter yield, total grain yield and 1000 grain weight were recorded after harvesting the crop.

**Analytical Procedures:** Composite soil sample taken before sowing was air dried, ground and sieved through 2 mm sieve and was analyzed for texture, lime, electrical conductivity, pH, organic matter, available P, potash and DTPA extractable Zn, Cu, Fe, Mn and also for hot water soluble B (Table 2).

Alkaline earth carbonate (lime) was determined by Alison and Moddie Acid Neutralisation method (Black, 1982). Texture was determined by hydrometer method. (Moodie *et al*., 1954). Organic matter was determined by Walkley and Black method (Black, 1982). Electrical conductivity and pH of 1:5 suspension was determined with the help of electrical conductivity meter and glass electrode pH meter respectively (Black, 1982). Available P in the soil was determined by Olsen method using sodium bicarbonate and potash was determined by ammonium acetate method (Black, 1982).

**Trace Elements Determination:** Zinc, Cu, Fe and Mn in soil samples taken before sowing at the preheating stage and after harvesting were determined by Diethylene triamine penta acetic acid (DTPA) method (Lindsay and Norvell, 1978). The extracting solution consisted of 0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M Tea (Triethenol amine $C_5H_{15}No_3$). The filtrates were analyzed for Zn, Cu, Fe and Mn using the Perkin Elmer Atomic Absorption spectrophotometer (Hitachi 170 -10 Variance 1275).

Respective leaf samples collected from each treatment plot were brought to the laboratory, air-dried and then oven dried at 70°C. After the complete drying leaf samples were ground and analyzed for Zn, Cu, Fe and Mn determination with the procedure involving wet digestion using sulphuric acid, nitric acid and perchloric acid (Walsh, 1971). In soil for B determination B was extracted in hot water soluble extract. In plants for B determination, dry plant material was ashed at 550°C. Both in soil and plant extract B was determined by developing color in curcumin oxalic acid solution and readings were taken with spectrophotometer at 540 nm ZEISS PM 4 (Jackson,1958).

## Results and Discussion

**Micronutrients in Soil:** It was evident from the data (Table 3) that there were significant differences in Zn contents of soil in various plots treated with different doses of fertilizers at both boot and harvest stage. The maximum Zn contents of were found in plots of T3, T4, T5, T6, T7 and T9 treatments at boot stage (Table 3). However, the Zn contents were reduced at harvesting time in the soil, probably either by uptake of plants or by leaching and absorption by soil particles. Copper contents of the soil remain the same with or without the addition of Cu fertilizers both at boot and harvest stages (Table 3). Also if we consider the Cu contents of the soil before the application of Cu fertilizer (Table 2), they were nearly 2 mg Cu $kg^{-1}$ soil. So the addition of Cu fertilizer did not significantly affect the Cu contents in the soil. As regards the Fe contents in soil are concerned, the results were significant only at boat stage but non-significant at harvesting stage of the crop (Table 3).

Manganese contents of the soil also remained un-affected with or without the addition of Mn fertilizer at both boot and harvest stages (Table 3). Mn contents were sufficiently high in this soil before the addition of Mn fertilizer in the soil (Table 2). Boron concentration of the test soil was increased with the application of B fertilizer at both boot and harvest stages (Table 3). The plots (T1, T2 and T4), which did not receive B fertilizer, they had B concentrations below 0.8 mg B $kg^{-1}$ soil. Among all micronutrients determined for this soil only B was found to be below the recommended concentration (<1 mg B $kg^{-1}$ soil, Gupta, 1993) but only in-B treatments (T1, T2 and T4). In conventional solution culture experiments 40 μM or 0.432 mg B $L^{-1}$ is required for the optimum growth of wheat *crop* (Hoagland and Arnon, 1950; Alhar, 1977). Our B concentration values in T1, T2 and T4 were above 0.432 mg $kg^{-1}$ (Table 3) but we could not get the optimum yield from treatment T4, probably because different methods for B determination were exercised. For example we used hot water extractable method for B determinations (see Material and Method). The lowest detectible range of B concentration by hot water soluble method is 0.1 mg B $kg^{-1}$ soil as compared to 0.02 mg B $kg^{-1}$ soil by inductively

Table 1: Detail of treatments (Nutrients Kg $ha^{-1}$)

| Treatments | N | $P_2O_5$ | $K_2O$ | 2n | Cu | Fe | Mn | B | Zart |
|---|---|---|---|---|---|---|---|---|---|
| T1 Control | 0 | 0 | 0 | - | - | - | - | - | - |
| T2 NPK | 100 | 75 | 50 | - | - | - | - | - | - |
| T3 NPK i-Zn,Cu,Fe,Mn,B | 100 | 75 | 50 | 4 | 2 | 5 | 2 | 1 | - |
| T4 As T3 (-8) | 100 | 75 | 50 | 4 | 2 | 5 | 2 | | - |
| T5 As T3 (-Cu) | 100 | 75 | 50 | 4 | - | 5 | 2 | 1 | - |
| T6 As T3 (-Fe) | 100 | 76 | 50 | 4 | 2 | - | 2 | 1 | - |
| T7 As T3 (-Mn) | 100 | 75 | 50 | 4 | 2 | 5 | - | 1 | - |
| T8 T3 (-Zn) | 100 | 75 | 50 | | 2 | 5 | 2 | 1 | - |
| T9 As T2 Zar* | 100 | 75 | 50 | - | - | - | - | - | 1 |

*1 kg Zarzmeen contains 70.4Zn. 51.0 g Fe, 50.4 g Mn, 57.6 g in fritted form

Table 2: Phsio-chemical properties of soil, NWFP, Pakistan

| CharacterIstics | Units | Values | Characteristics | Units | Values |
|---|---|---|---|---|---|
| Clay | g $kg^{-1}$ | 268 | Available P | mg $kg^{-1}$ | 8.1 |
| Silt | g $kg^{-1}$ | 472 | Available K | mg $kg^{-1}$ | 143 |
| Sand | g $kg^{-1}$ | 260 | DTPA extractable Zn | mg $kg^{-1}$ | 0.7 |
| EC | $Msm^{-1}$ | 145 | ″ ″ Cu | mg $kg^{-1}$ | 2.3 |
| Organic matter | g $kg^{-1}$ | 102 | ″ ″ Fe | mg $kg^{-1}$ | 12.4 |
| $CaCO_3$ | g $kg^{-1}$ | 112 | ″ ″ Mn | mg $kg^{-1}$ | 20 |
| pH | - | 8 | Hot water soluble B | mg $kg^{-1}$ | 0.7 |

Table 3: Micronutrients in soil at boot and harvest stages. Values are means of four replication

| Treatments | | | | | Concentrations (mg $Kg^{-1}$) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Micronutrients g $Kg^{-1}$ | Zn | | Cu | | Fe | | Mn | | B | |
| | g $Kg^{-1}$ | | | | Boot | Hervest | Boot | Hervest | Boot | Hervest | Boot | Hervest | Boot | Hervest |
| T1 | 0 | 0 | 0 | - | 0.7c | 0.6c | 2.6 | 2.4 | 11.8c | 13.6 | 22.7 | 18.5 | 0.7b | 0.8a |
| T2 | 100 | 75 | 50 | - | 0.8c | 0.6c | 2.4 | 2.5 | 18.8b | 15 | 22.4 | 19.2 | 0.8b | 0.8a |
| T3 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, B | 1.21abc | 1.3c | 3.8 | 2.8 | 60.4a | 22.5 | 32 | 20.2 | 1.7a | 1.7a |
| T4 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-B) | 1.3ab | 0.8 | 3.2 | 2.7 | 27.4a | 16.9 | 29.5 | 28.9 | 0.7c | 0.6D |
| T5 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-Cu) | 1.3a | 0.7bc | 2.6 | 2.2 | 33.0a | 19.6 | 33.7 | 19.7 | 1.6a | 1.6B |
| T6 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-Fe) | 1.1abc | 0.8bc | 3.5 | 2.5 | 18.3bc | 16.8 | 27.9 | 20.8 | 1.6a | 1.7B |
| T7 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-Mn) | 1.5a | 1.1a | 3.7 | 2.9 | 24.1ab | 17.6 | 20.3 | 18.9 | 1.7a | 1.5bc |
| T8 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-Zn) | 0.8c | 0.5c | 3.7 | 3.2 | 28.5ab | 17.4 | 23.9 | 21.4 | 1.7a | 1.7a |
| T9 | 100 | 75 | 50 | Zarzamean | 1.1abc | 0.7c | 3.2 | 2.6 | 24.3ab | 17.9 | 30.7 | 19.3 | 1.7a | 1.6a |

Means followed by similar letter (s) do not differ significantly from each other at 5941evel of significance. Micronutrients were rate of Zn 4 kg, Cu 2 kg, Fe 5 kg, Mn 32 kg, B 1 Kg and Zarzmeen 1 Kg per hectare

Table 4: Effect of micronutrients on the yield of wheat crop. Values are means of four replication

| Treatments | | | | Micronutrients | Dry matter | Grain yield | Straw Yield |
|---|---|---|---|---|---|---|---|
| N | $P_2O_5$ | $K_2O$ kg $h^{-1}$ | | kg $h^{-1}$ | kg $h^{-1}$ | | |
| Ti | 100 | 0 | 0 | - | 8458c | 2292 d | 5939 b |
| T2 | 100 | 75 | 50 | Zn, Mn, Fe,Cu, B | 13125 c | 3542 d | 8208 a |
| T3 | 100 | 76 | 50 | Zn, Mn, Fe,Cu, (-B) | 14167 a | 3958 a | 10208 a |
| T4 | 100 | 75 | 50 | Zn, Mn, Fe,Cu, (-B) | 11192 c | 2750 d | 7166 a |
| T5 | 100 | 75 | 50 | Zn, Mn,Fe. B (-Cu) | 13958 b | 3750 ab | 9166 a |
| TO | 100 | 75 | 50 | Zn, Mn, Cu,B(-Fe) | 13167 b | 3750 ab | 9166 a |
| T7 | 100 | 76 | 50 | Zn, Fe, Cu, Eli-Mn) | 12208 ab | 3750 ab | 8333 a |
| T8 | 100 | 75 | 50 | Zn,Fe, Cu. 13(-In) | 13750 a | 3583 abc | 8750 a |
| T9 | 100 | 75 | 60 | Zarzameen | 13125 a | 3958a | 10208 a |

Means followed by similar letter (a) do not differ significantly from each other at 5%level of significance. Micronutrients were applied at the rate of Zn 4 kg. Cu 2 kg, Fe 5 kg, Mn 32 kg. B 1 Kg and Zarzmeen 1 Kg per hectare

Table 5: Effect of micronutrient on the yield components of wheat crops. Values are means of four replication

| | Treaments | | | Micronutrients | 1000 grains | Tiller numbers $m^{-2}$ | Height of plants |
|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ kg $h^{-1}$ | kg $h^{-1}$ | weight (g) | (g) | (cm) |
| T1 | 0 | 0 | 0 | - | 35.9 cd | 102 | 35.6 |
| T2 | 100 | 75 | 50 | - | 36.6 c | 128 | 44.7 abc |
| T3 | 100 | 75 | 50 | Zn, Mn, Fa, Cu, B | 48.1 a | 115 | 44.5 abc |
| T4 | 100 | 75 | 50 | Zn, Mn, Fe, Cu, (-B) | 36.6 c | 117 | 44.7 abc |
| T5 | 100 | 75 | 50 | Zn, Mn, Fa, B (-Cu) | 39.3 b | 117 | 46.5 a |
| T6 | 100 | 75 | 50 | Zn, Mn, Cu, B(-Fe) | 39.8 b | 115 | 42.9 c |
| T7 | 100 | 75 | 50 | Zn, Fe, Cu, B(-Mn) | 40.4 b | 111 | 43.6 bc |
| T8 | 100 | 75 | 50 | Zn, Fe, Cu, B(-Zn) | 42.7 | 117 | 46.25 a |
| T9 | 100 | 75 | 50 | Zarzameen | 43.3 ab | 117 | 45.5 ab |

Means followed by similar letter (a) do not differ significantly from each other at 5%level of significance. Micronutrients were applied at the rate of Zn 4 kg. Cu 2 kg, Fe 5 kg, Mn 32 kg. B 1 Kg and Zarzmeen 1 Kg per hectare coupled plasma atomic emission spectrophotometry (ICP-AES) (Asad *et al.,* 1997). Also ions concentration requirement in soil medium are always higher because of adsorption-desorption reactions of ions with soil particles and a soil has been called complex heterogeneous material (Alhar, 1977).

**Yield Components of Wheat Crop:** Wheat plants did not show any nutrient deficiency symptoms in plots where all macro and micro nutrient were applied. However, plant growth was slow in treatments of-macro and micro nutrients (T1), -micronutrients (T2) and -B (T4). Wheat plants of T2 and T4 did not show any nutrient deficiency symptoms at vegetative stage compared with plants of T1 . At reproductive stage classical B deficiency symptoms were seen in non-B treated plots including splitting of the newer leaves along the leaf close to the midrib. This was accompanied by some unusual indentations also along the length of the leaf but on the opposite side of the midrib to the splitting. Similar B deficiency symptoms were reported by Snowball and Robson (1988) in wheat crop.

Dry matter yield is an important yield parameter. Dry matter yield obtained from different fertilizer treatments have been recorded in Table 4. The data showed that the results were significant at 5% level of significance. The maximum dry matter yield of wheat was obtained from treatments T3, T7, T8 and T9. Lowest dry matter yield was obtained from T1, T2 and T4 (Table 4). These results clearly demonstrated that the total grain yield was significantly depressed where micronutrients were absent. In T4, where all macro and micro nutrients were present but B was absent the grain yield was also less. This is because B concentration in the test soil before sowing (Table 2) was 0.7 mg $kg^{-1}$ soil. So due to less B concentration in soil the dry matter yield of wheat was less in treatment T4 because it has all essential macro and micronutrients as of treatment T3 except B. These results are in agreement with those of Zada and Afzal (1997) who after conducted an experiment in Peshawar soil, reported that significantly less dry matter yield of wheat was obtained with B concentration below 0.8 mg B $kg^{-1}$ soil.

The weight of grain is another important yield components of wheat. It depends upon the plumpness of grain and the transport of assimilates to the grains. The data of grain yield of all treatments were significantly high except in control (T1), -micronutrients (T2) and -B (T1) (Table 4). Total grain is lower even in NPK treatment (T2), when compared with the plants of T3 plots probably because of less soil B concentration in treatment T2, and B does has its role in grain formation (Romheld and Marschner, 1991; Gupta, 1993). This might be the reason that deficiency of all elements in T1, micronutrient in T2 and only of B in T4 treatments, the grain yield was significantly low than the other treatments (Table 4).

The data of straw yield of wheat as influenced by various fertilizer treatments were significant at 5% level of significance (Table 4). These results demonstrated that all the fertilizer treatments significantly increased the straw yields over control (T1) and also treatments T2 and T4. Higher straw yield (10208 kg $ha^{-1}$) was obtained from the application of NPK plus Zarzameen (T9). These results demonstrated that the combined application of micronutrients have significant affects on the straw yield. As compared to grain yield, straw yield is less affected by the application of micronutrients as the straw yield is more or less same in plots either treated with macro alone or in plots treated with macro and micro nutrients.

By Comparing the control with various fertilizers applied treatments, it was found that the 1000-grain weight was increased with the application of macro and micro nutrients. In treatment T4, where B was absent, 1000-grain weight was significantly less along with treatments T1 and T2 where B was also absent (Table 5). Flowering and fruit set have often been observed to be sensitive to B deficiency (Rerkasem and Jamjod, 1997a). The effect of B deficiency on grain set failure was associated with male sterility, i.e. poorly developed anthers and pollens (Rerkasem and Jamjod, 1997b). Because at flowering time, B was deficient in the soil (0.7 mg $kg^{-1}$) (Table 3) in treatments T1, T2 and T3, therefore poor development of reproductive parts, results in poor grain set in the plants of these treatments. One thousand grain weight of Zarzameen treatment was also significantly high than T1, T2 and T4. However, the highest 1000 grains weight was 48.07 grams, which was found in treatment (T3).

The results of tiller number $m^{-2}$ were non-significant at 5% level of significance. The data of tillers numbers have been summarized in Table 5. All the fertilizer treatments increased the number of tillers considerably over control. The maximum number of tillers 128 per meter square were recorded in the case of treatment receiving NPK fertilizers only. It may be concluded from the results that this yield component was not affected by micronutrients and the main role for increasing the tillers number was played by NPK or the major elements. These results are supported by the previous work of Khattak *et al*. (1983). Rerkasem *et al.* (1989) who also reported that tiller number per ear are generally unaffected by B deficiency. However, our these results are not in agreement with those of Zada and Afzal (1997) probably because of difference in wheat varieties used in different experiments. As previously reported by Alkan *et al.* (1996), Subedi *et al.* (1997 and 1999) that significant differences might occur among wheat genotypes in response to increased B supply. Plant height taken at harvesting time and the data of plant height showed that the plant height was significantly affected by the application of micronutrients (Table 5). No significant difference was found plant in height among NPK treatment and in treatments receiving the various micronutrients. These results indicated that plant height was unaffected by the application of micronutrients and NPK required to increase the plant height.

**Concentration of Micronutrients in Leaves at Boot Stage:** Chemical analysis of the leaf samples collected at boot stage demonstrated that apart from B concentration in the leaf blades, Zn, Cu, Fe and Mn concentration remained unaffected with or without their application to the soil. Leaf contents of Zn, Cu, Fe and Mn ranged from 15-19.9, 13.6-20.8, 377-440, 39.7-54.1, respectively. Moreover, all these micronutrient concentrations were in the range of optimum growth for wheat crop (Weir and Cresswell, 1994).

Boron concentrations in the leaf blades were increased with the application of B fertilizer. In non-B treatment plots (T1, T2 and T3) B concentration ranged from 1.6 to 1.8 mg B $kg^{-1}$ dry matter. However, in B-treated plots B concentration remained above 4 mg B $kg^{-1}$ dry matter. Our these values of B concentrations in leaf blades at late vegetative and early reproductive stage are well in agreements with the values of B for wheat crop as previously reported by Martens and Westerman (1991) and Reuter and Robinson (1997). However, B concentration in leaf tissues increased to 8-10 mg $kg^{-1}$ at reproductive stage (Rerkasem *et al.,* 1997). The results of experiment demonstared that the soil was deficient in one or the other major elements that is NPK. Among micronutrients, B concentration in the soil was found to be deficient. Boron concentration of the soil and dry plant material increased significantly with the application of borax in the soil. Yield components i.e. dry matter, grain yield, straw yield, 1000 grain weight, number of tillers and height of plants, were also affected by the addition of macro and micro nutrients. Combined application of all the fertilizers that is NPK, and Zn, Cu, Fe, B and Mn in most cases proved to be better. Zarzameen found to be the most economical source of micronutrients being having exceptionally higher VCR than the other treatments (Data not shown). Soil Zinc (at both boot and harvesting stages) and Fe (only at boot stage) contents were significantly increased with the application of micronutrients. But their effect in the yield and yield components of wheat crop could be not distinguished; probably because of soil In and Fe contents were high enough. This might be the reason that leaf Zn and Fe contents of control and fertilized treatments were more or lees the same. Boron contents of the soil were found to be less and therefore the addition of B fertilizer increased not only the soil B contents at both boot and harvesting stage but also increased the leaf B contents as well as compared to the control and non-B treated plots.

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