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The Effect of Zinc, Boron and Copper Foliar Application, on Yield and Yield Components in Wheat (*Triticum aestivum*)

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ABSTRACT

Quantitative information regarding effects of micronutrients such as Boron, Zinc and Copper in wheat (Triticum aestivum) is scarce. Foliar application can guarantee the availability of nutrients to crops for obtaining higher yield. So to study the response of wheat to foliar application of these micronutrients, tow experiments were a factorial on randomized complete block design with four replications conducted at Chenaran and Mashhad, Iran during 2010-11. Treatments of these experiments were Type of elements (Zinc, Boron and Copper) Doses of Foliar application (0, 1 and 2 lit/ha) and Varieties (Gaskojen and Pishtaz). The experiments were conducted under well-watered conditions. Type of elements was significant on the number of spikes per plant, Grain per spike, Grain in square meter, Harvest Index (HI%) and Grain yield (kg/ha) but had no effect on thousand grain weigh. Boron and Zinc showed higher amounts in mentioned traits than Copper, although Boron in Chenaran, and Zinc in Mashhad were more effective. the number of spikes per plant, Grain in square meter, and Grain yield increased with raising in Doses of foliar application, so that highest of these were in dose of 2lit/ha. Varieties and locations resulted different in evaluated traits generally. Chenaran was better than Mashhad, and Gaskojen than Pishtaz in Yield and yield components. The findings found at this study can be used in management recommendations of wheat. Further, it is recommended that more attention should be paid to Zn and B nutrition in mentioned locations.

Keywords: Foliar application, Boron, Zinc, Copper, Wheat, Yield and Yield components.

INTRODUCTION

Wheat (*Triticum aestivum*) is the most important and strategic crop in Iran, so for sustainable production its reqirments precise managements and special attention to wheat nutrition [1]. The role of macro and micronutrients are crucial in wheat production in order to achieve higher yields [2]. Micronutrients deficiency have became a major constraint for wheat productivity in many Iranian farmlands. The deficiency of micronutrients may be due to their low total contents or decreasing availability of them by soil aggregate fixation [1, 3].

Among micronutrients, Zinc (Zn) and Boron (B) play a key role in pollination and seed set processes; so that their deficiency can cause to decrease in seed formation and subsequent yield reduction [4]. Zinc as a micronutrient in wheat production has been clearly proved. Effects of Zinc Deficiency and response to wheat growth stages have

been reported from various parts of the [5], also zinc shortage has a worldwide problem in human nutrition [3]. The studies have been shown that one of the effective and productive way to improvement in cereal grains is application of Zn fertilizer either to the soil or foliar application [6].

Similarly, boron deficiency also results in impaired crop growth and development. Application of these micronutrients results in better crop growth and thus in increased crop yield [7]. Boron plays a major role in plant vital activities such as cell division, leaf and flower bud formation, glucose metabolism and hydrocarbons and their transport, root growth, cell wall formation and material transportation between cells. Boron transport and transfer in plant is relatively low and thus its concentration in lower parts of the plant is higher. Most of boron transport is through xylem vessel. Boron is mostly concentrated in anther, stigma and ovary. According to boron effect in increasing sugar and hydrocarbons transport through phloem [8].

Also Copper as an essential micronutrient for normal growth and metabolism of plants is well documented [9]. This element plays role in protein and carbohydrate metabolism as well as enzymatic systems [10].

Different experiments have been conducted to evaluate the response of wheat genotypes to micronutrients application and a wide range of genotypic variation in response to these deficiency have been reported [7, 3, 11].

These micronutrients are readily fixed in soil and plant roots are unable to absorb these nutrients adequately from dry topsoil [7]. The application of macro and micronutrients fertilizer in the cultivation zone may not be meeting the crop requirement for root growth and nutrient use. The alternative approach is to apply these micronutrients as foliar sprays [2]. Foliar spray of these micronutrients has been reported to be equally or even more effective as soil application to overcome micronutrients deficiency in subsoil [7, 12]. Foliar application lead to increase in grain yield components and protein percentage in seed; for instance wheat, maize, rice, barley and sorghum showed increase in yield components by application of micronutrients [10]. Specially in wheat, improvement yield and yield components were affected by Foliar Application of Zinc, Boron and Copper, Although effects of copper didn't very sharp. Many researchers reported increasing in agronomic traits in with caused by foliar application of these elements [13, 14].

Although various studies have evaluated various aspects, but it seems more accurate comment would require repeated experiments in different regions of Iran. Therefore, the present study was conducted to explore the effect of foliar application of Boron, Zinc and Copper on wheat yield and yield components, and find out the best portion of foliar application and also comparing respond of tow wheat varieties, to model and dose of applied micronutrients.

MATERIALS AND METHODS

Two field experiments were carried out at Mashhad and Chenaran, Iran, (36º 47´ N, 59º 48´ E, altitude 999m, and 36º 61´ N, 59º 16´ E, altitude 1221m respectively) during 2010-1011 growing seasons. Each location, soil samples were taken from surface horizon (0- 30 cm) of the soil, air-dried, passed through a 2-mm sieve and analyzed for the following properties. Particle-size distribution determined by hydrometer method [15], soil pH and ECe were measured in saturated paste and saturated extract, respectively, organic compound (OC) were determined by Walkley- Black method [16]. Available Zn, Fe and Cu were determined by DTPA extraction [17], and phosphorus by sodium bicarbonate extraction [18]. Soil availability of B was extracted by hot water [19] and measured by azomethine-H colorimetric method [20]. The characteristics of the soil materials were shown in Table 1.

The treatments were compared in a factorial experiment based on Randomized Complete Block Design (RCBD) with three levels foliar application , 3 types of micronutrients (Zinc, Copper, Boron), 2 levels of wheat varieties (Gaskojen and Pishtaz) and three levels of doses (control or water sprayed, 1 lit/1000, 2 lit/1000) in four replication. Each plot had 8 rows, 15 cm row spacing and 5 m plot length. Seeds were sown on the 27th October and 3th November, 2010 at Chenaran and Mashhad respectively.

Table 1. The characteristics of the soil in Chenaran and Mashhad.

Location	EC ds m^{-1}	pH	OC (%)	N (%)	P (ppm)	K (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)	Fe (ppm)
Chenaran	1.1	7.8	1.15	0.051	6	212	0.54	0.73	0.24	6.1
Mashhad	1.34	8	1.01	0.042	4.8	186	0.38	0.75	0.32	6

Final plant density was 300 plant in square meter. Also Foliar application were done at Mid-tillering, end-tillering, stem elongation and ear appearance stages with chelated fertilizers in format of EDTA %15. All of recommended crop production practices were applied uniformly to all treatments. First irrigation was given ten days after sowing and subsequent irrigations were applied to avoid drought stress and soil water in the 1 meter depth was kept above 50% of maximum available water during the all growing season.. Weeds were manually controlled in all treatments. Fertilizer recommendations based on soil analysis results (Table 1) were applied including 120 kg ha-' of triple superphosphate and 85 kg ha^{-1} potassium sulfate and 220 kg ha^{-1} urea . Phosphorus and potassium and one-third of urea fertilizers were applied at sowing and the remaining was applied during tillering and stem elongation growth stages.

At maturity, the inner four rows of each plot unit were harvested to estimate grain yield ($kg.ha^{-1}$) and sup sample of one square meter was obtained for determining Number of fertile tillers (spikes), Grain yield (kg/ha), Harvest Index (%), Thousand grain weight (gr), The number of grains per square meter and Number of grains per spike. Harvest index (HI) were determined by the formula given by Hunt [21].

HI = (Economic yield/Biological yield) × 100.

Plants were oven dried at 70 °C for 72 hours .Economic yield or Grain Yield, and Biological yield were obtained from means of 10 plant in each plots.

Data were analyzed by SAS software and multiple comparisons was done through least significant difference (LSD) test at 1% and 5% probability levels. Also Graphs were performed in Excel software.

RESULTS AND DISCUSION

Number of spike per plant

According to analysis of variance (Table 2), effects of Type of element, Variety and Dose of application were significant at 1% probability level. Also Interaction effects of Type of element in Dose of application, Type of element in location, Type of element in Variety in location, and Type of element in Dose of application in location were significant at 1% probability level (Table 2). Mean comparison showed that Gaskojen with 4.17 was dominant than Pishtaz variety (Table 3). the Highest and the lowest amount of Number of spike per plant were achieved in dose of application with 4.22 and no sprayed factor (control) respectively (table 3). Also Zinc had great result on thus trait rather than other element (table 3).

Evaluation of Interaction effect of Type of element in Dose of application showed that only boosting of zinc dose could gradually increase Number of spike per plant (table 3), although In Mashhad region Zinc caused increasing Number of spike per plant than Chenaran region (Fig 3).

Tahir et al., [22] expressed Among yield components, number of fertile tillers is very important because the higher number of fertile tillers can be formed the more final crop yield.

Zoz et al., [23] stated that The application of higher concentration of zinc foliar application allowed to obtain 26% raising in the number of wheat spikes per square meter compared to non-supply of nutrient. Similarly, Seadh et al. [24] showed that foliar Zn application provided 21% increase in the number of wheat spikes per m^{-2}.

Table 2. Combined Analysis of variance for Yield and Yield components (the numbers are Sum of Squares)

Sources of variations	d.f	Number of spike per plant	Number of grains per spike	The number of Grain per square meter	Thousand grain weight	HI (%)	Grain yield (kg/ha)
L	1	3.86 $^{n.s}$	3252.4*	3877192780**	88.75 $^{n.s}$	542.4*	59891824.34*
Error1	6	66.17	3412.81	2562244601	547.42	418.72	28790234.54
TE	2	19.87**	832.1**	773920152**	0.76 $^{n.s}$	162.9*	11395452.55**
V	1	10.71**	22.5 $^{n.s}$	971437471**	9.62 $^{n.s}$	3270.81**	63367928.36**
D	2	10.09**	3.66 $^{n.s}$	580378939**	45.82 $^{n.s}$	84.6 $^{n.s}$	22378497.12**
TE* V	2	0.65 $^{n.s}$	6.93 $^{n.s}$	60385537 $^{n.s}$	5.29 $^{n.s}$	74.98 $^{n.s}$	821421.54 $^{n.s}$
TE*D	4	11.01**	580.8**	565148848**	8.37 $^{n.s}$	189.85 $^{n.s}$	7504673.99**
V*D	2	1.27 $^{n.s}$	324.57**	719115835**	1.89 $^{n.s}$	68.44 $^{n.s}$	7068912.96**
TE*V*D	4	0.76 $^{n.s}$	10.34 $^{n.s}$	45233746 $^{n.s}$	9.57 $^{n.s}$	89.67 $^{n.s}$	615098.29 $^{n.s}$
TE*L	2	16.32**	42.36 $^{n.s}$	474079997**	11.04 $^{n.s}$	159.67*	4641988.06**
V*L	1	0.015$^{n.s}$	8.85 $^{n.s}$	112506151 $^{n.s}$	0.55 $^{n.s}$	708.88**	1885639.33*
D*L	2	1.46 $^{n.s}$	9.49 $^{n.s}$	103800518 $^{n.s}$	59.89 $^{n.s}$	82.39 $^{n.s}$	331319.46 $^{n.s}$
TE*V*L	2	0.2$^{n.s}$	3.3 $^{n.s}$	11219662 $^{n.s}$	4.98 $^{n.s}$	196.02*	71669.78 $^{n.s}$
TE*D*L	4	9.43**	107.12 $^{n.s}$	479942510**	5.52 $^{n.s}$	88.52 $^{n.s}$	5377894.5*
V*D*L	2	2.3$^{n.s}$	204.96*	150373942 $^{n.s}$	6.45 $^{n.s}$	31.44 $^{n.s}$	389644.87 $^{n.s}$
TE*V*D*L	4	1.43$^{n.s}$	131.42 $^{n.s}$	15220198 $^{n.s}$	11.95 $^{n.s}$	98.56 $^{n.s}$	64962.15 $^{n.s}$
Error2	102	56.91	3271.16	3053808157	2291.24	2685.62	43683737.5
C.V (%)		19.12	20.91	18.18	11.69	13.1	10.88

***: P<0.01; *: P<0.05; ns: non significant.*

The abbreviations: Type of element (TE), Dose of application (D), Variety (V) and Location (L)

Table- 3. Mean comparison of studies traits as affected by Type of element, Variety, Dose of application, Location and also some of their interactions

Treatments	Number of spike per plant	Number of grains per spike	The number of grain per square meter	Thousand grain weight	HI (%)	Grain yield (kg/ha)
Type of element						
Zn	4.42 a	24.99 b	30690 a	40.6 a	38 b	6205.6 a
B	3.6 b	30.44 a	32574 a	40.43 a	40 a	6214.5 a
Cu	3.68 b	25.78 b	26993 b	40.58 a	38 b	5613.3 b
Variety						
G	4.17 a	27.46 a	32683.1 a	40.28 a	43 a	6674.5 a
P	3.63 b	26.67 a	27488.4 b	40.79 a	0.34 b	5347.8 b
Dose of application						
0	3.57 c	27.1 a	27891 b	39.8 a	38 a	5498 c
1	3.91 b	26.86 a	29623 b	40.65 a	39 a	6079 b
2	4.22 a	27.24 a	32743 a	41.17 a	39 a	6456.5 a
Type of element * Dose of application						
Zn0	3.57 c	27.1 bc	27891d	n.s	n.s	5498 c
Zn1	4.56 b	24.07 c	29938 cd	n.s	n.s	6285.6 b
Zn2	5.14 a	23.8 c	34241 ab	n.s	n.s	6833.3 a
B0	3.57 c	27.1 bc	27891 d	n.s	n.s	5498 c
B1	3.58 c	30.17 ab	32063 bc	n.s	n.s	6275.6 b
B2	3.65 c	34.04 a	37768 a	n.s	n.s	6869.9 a
Cu0	3.57 c	27.1 bc	27891 d	n.s	n.s	5498 c
Cu1	3.6 c	26.34 bc	26868 d	n.s	n.s	5675.8 c
Cu2	3.86 c	23.89 c	26220 d	n.s	n.s	5666.2 c
Variety*Dose of application						
G0	n.s	25.37 b	27414 c	n.s	n.s	5857.5 c
G1	n.s	28.4 ab	33126 b	n.s	n.s	6828.1 b
G2	n.s	28.62 a	37510 a	n.s	n.s	7338 a
P0	n.s	28.83 a	28369 c	n.s	n.s	5138.5 e
P1	n.s	25.32 b	26120 c	n.s	n.s	5329.9 de
P 2	n.s	25.87 ab	27976 c	n.s	n.s	5574.9 cd
locations						
Chenaran	4.06 a	31.82 a	35274.7 a	41.32 a	41a	6656.1 a
Mashhad	3.74 a	22.31 b	24896.8 b	39.75 a	37 b	5366.2 b

Column means followed by the same letter are not significantly different at 5% probability level

Also Boorboori et al,. [10] declared zinc soil application increased 11.36 % compared to the control. According to their assay, foliar application of copper in EDTA fertilizer format had no effect on number of fertile tillers of Pishtaz

variety in wheat. Ali et al,. [7] Informed Foliar application of Boron and Zinc, resulted in more number of spikes m-2 as compared to control. The results of other experiment were in consistent with these findings [25, 26]. obviously elevation of number of spikes was affected by zinc foliar application could justify for the reason of the higher number of fertile tillers per plant at the vegetative stage, and also zinc application seems to avoid form weakness of stems so it lead to formation more fertile spikes [23, 27].

Number of grains per spike

result showed that (table 2) Type of element and location were significant at 1% and 5% probability level (table 2). Boron with 30.44 and copper with 25.78 had the highest and lowest Number of grains per spike respectively. Chenaran showed more Quantity with 31.82 than Mashhad (table 3).

The Interaction effects of Type of element in Dose of application, and Variety in Dose of application at 1% and Variety in Dose of application in location were significant at 5% probability level (table 2). Interaction effect of Type of element in Dose of application showed that with increasing in element concentration, Number of grains per spike didn't drastically change and this no response was distinct by copper application (table 3). Interaction effect of Variety in application dose revealed that Pishtaz with no foliar application had more than spraying methods (table 3).

Tahir et al., [22] expressed Number of grains per spike is an important yield formation factor and has a direct effect on the final wheat grain. It was manifested that Boron application had considerable effect on the number of grains per spike. Maximum grains per spike (54.75) were recorded where Boron was sprayed at booting stage [22]. Boorboori et al,. [10] reported foliar application with Zn and Cu increased number of fertile tillers to 0.10 % and 0.79 % compared to the control in Pishtaz variety of wheat.

Guenis et al., [28] and Soleimani [29] stated eminent increase in number of grains spike of wheat was observed by both zinc and boron application. Ali et al,. [7] assumed that the Highest number of grains spike was produced by combined application of both zinc and boron. it was reported that either foliar or soil application of zn could increase number of total grains per stalk [4].

Also foliar application of copper with EDTA fertilizer had no effect on grain number per spike of Pishtaz variety in wheat [4], and this result was in consistent with our results .Whaley et al,. [31] said that nutrients deficiency may decrease spike length followed by decreasing in number of grain in spike. Promoting in number of grain in spike affected by Zinc and Boron caused by increasing in tryptophan synthesis and therefore amount of IAA hormone in plant [30, 32] and due to the reason that Boron plays a vital role in grain setting of wheat.

The number of grain per square meter

All of the main effects on this trait were significant at 1% probability level (table 2). among surveyed elements, boron with 32574 and zn with 30690 had the most influence on the formation of this yield component. Gaskojen with 32683.1 had more number of seeds per square meter than Pishtaz Variety. Increasing in dose application caused to meet more number of grain per square meter. Chenaran with 35274.7 was paramount than Mashhad (table 3).

The Interaction effects of Variety in Dose of application that was significant at 1% probability level (table 3), and interestingly outcomes showed that Gaskojen variety at control level was nearly equivalent of Pishtaz Variety in maximum dose (table3). Also results showed that increasing the Copper concentration unlike zinc and boron elements could increase The number of grains per square meter (table 3). Interaction of Type of element in location declared that boron in Chenaran (with 40320 number) caused highest amount of this trait, but in Mashhad, Zinc and Boron had same effects (Fig 1). Also results completed that increasing dose of boron in chenaran could stimulate raising of this trait but these results was not similar in Mashhad (Fig 3).

Baybordi and Malakouti [13] showed that Number of grain per plant was increased by boosting in Zinc application rates so differences were palpable between no treatment (control) and the most rate of zinc application (13 number per plant) Satore and Slafer [33] believed The number of grain per square meter has strong relationship with grain yield so the more number of grain in area made the more grain yield. This trait unlike grain 1000 weigh was influenced by agronomic managements such as fertilizer application and etc.

In this experiment because of many treatments were significant on the number of spike in plant and the number of grain per spike, certainly significance of The number of grain per square meter was logical. This confidence supported when observe grain 1000 weigh have not effect on differences of grain yield between various treatments.

Thousand grain weight

table 2 revealed that there were no considerable difference regarding this trait but Mean comparison pointed out that Chenaran appeared better than Mashhad at thousand grain weight (table 3). Also mean comparison of interaction effects showed that no significant differences were obseved (table 2).

Boorboori et al,. [10] Expressed solution spraying of Zinc and Copper elements in barley showed no significant effect on 1000 grain weight. Pahlevanrad et al, [34] reported that evaluated foliar spraying of Zinc element on wheat, didn't observe marked effect on 1000 grain weight. In other experiment no effect of zinc Foliar application on this trait in wheat reported [14]. Korzeniowska and Stanislawska-Glubiak [35] stated Copper application did not influence on grain size of any tested cultivars. In their investigation , no distinction observed about weight of 1,000 , from the rang of zero (no treatment) to cu application .

Boorboori and Tehrani [30] informed foliar application of zinc and copper with EDTA fertilizers had not effect on 1000 grain weight of Pishtaz variety in wheat. In comparison of Copper Foliar application with control statistically nothing differences was called in this respect , the similar results was reported by Ziaeyan and Rajaie [4] regarding boron application.

Donaldson et al,. [36] believed that 1000 grain weight can not compensate grain yield lack, also Satore and Slafer [33] daresay that stability in grain weight of wheat is a genetical farctor for survival.

Harvest Index

main effects were significant on Harvest Index, except dose of application (table 2). Boron application with 40% had the most effect on harvest index formation rather than other element also zinc and copper appeared same. Among cultivars , Gaskojen with 43% had more Harvest index than Pishtaz , Also Chenaran had priority in harvest index than Mashhad.

The Interaction effects of Type of element in Variety in location, Type of element in location at 1% and Variety in location were significant at 5% probability level (table 2). Results showed among elements , Boron in Chenaran had the highest amount of Harvest Index whereas Type of element in Mashhad didn't affected on Harvest Index (Fig 1).

Also Mean comparison showed that although Gaskojen was paramount than Pishtaz in both regions, but Gaskojen in Chenaran (with 48%) had higher amount than Gaskojen in Mashhad (with 39%) (Fig 2).

Tahir et al., (2009) expressed the more harvest index will be for the reason of the physiological potential for converting dry matter into grain yield. effects of boron application on harvest index was claimed (Tahir et al., 2009) .the most effect of boron application on harvest index was reported at anthesis stage in wheat . These results are supported by the findings of Alam *et al*. [37]. Dehghanian and Madandoost [14] showed Harvest index increased as linear versus increasing in dose of zinc application, so that maximum rate of HI (47%) was in higher dose of application.

The increase in the Harvest index due to micronutrients may be attributed to its influences in enhancing the photosynthesis process and translocation of photosynthetic products to economic parts as well as increase enzymatic activity and other biological activities [38].

Grain Yield (kg/ha)

According to analysis of variance (Table 2), effects of Type of element, Variety, and Dose of application were significant at 1% probability level. Boron and Zinc were same and showed higher amount in Grain yield (kg/ha) than Copper element (table 3). Gaskogen with 6674.5 kg/ha was more than Pishtaz with mean of 5347.8 kg/ha. Highest Grain yield achieved in higher dose of application with 6456.5 kg/ha, and lowest of this related to non sprayed level (table 3). Mashhad with 5366.2 kg/ha than Chenaran with 6656.1 kg/ha, indicated lower Grain yield, like many other traits (table 3).

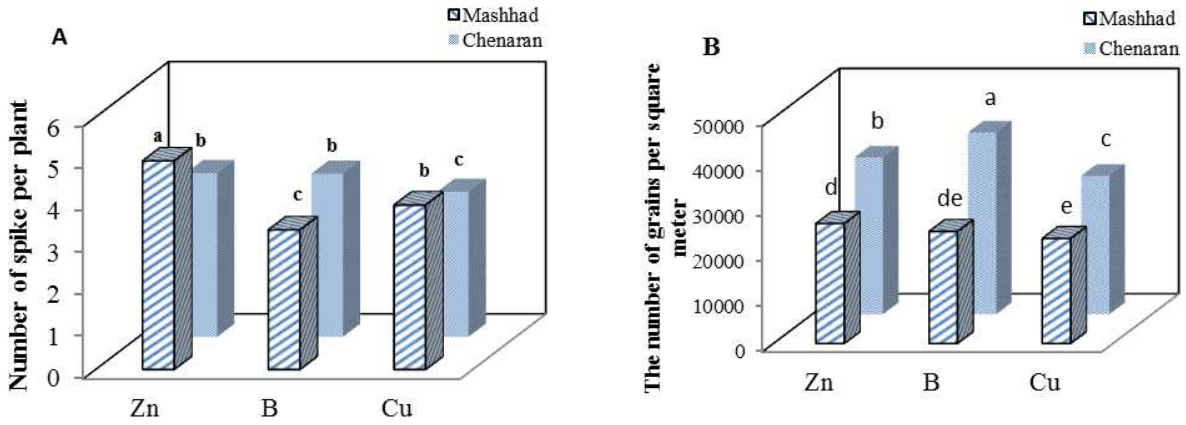
The Interaction effects of Variety in Dose of application that was significant at 1% probability level (table 2), indicated that Grain yield of Gaskojen variety than Pishtaz Variety has greater response to increasing in dose of application (table 3). Also results showed that increasing in dose of Zinc and Boron elements increase Grain yield meter unlike the Copper (table 3). Interaction of Type of element in location declared that boron in Chenaran (with 7096.7 kg/ha) caused the most amount of Grain yield, but in Mashhad Zinc (with 5757.6 kg/ha) had same effect (Fig 1). Also this result showed that about Type of element in dose of application in location, in Chenaran , yield increased by means of increasing In dose of elements application, but this interaction effect didn't observe in Mashhad (Fig 3). Although Gaskojen variety yielded more in Mashhad than Chenaran, but difference between Varieties were more distinguished in Chenaran (Fig 2).

Tahir and et al., [22] observed in their assay minimum grain yield (3946.13 kg ha^{-1}) was observed in control i.e. without boron application. Also They have on opinion that Grain yield increased be with Boron treatment due to the reason that the application of Boron enhanced pollen tube germination and grain setting. These inferences are in accordance with the Moeinian et al,. [8] that believe boron application has a key role in plant metabolism, root growth will increase and by better use of nitrogen and synthesis of more carbohydrates and proteins and plants use water more efficiently.

Abbas et al., [39] daresay Consumption of more Zinc, increase grain yield than control treatment. Also Zoz et al,. [23] observed The application of 216g ha^{-1} Zn allowed obtaining 14% increase in wheat yield compared to the absence of Zn supply that can be attributed to the increased number of spikes per unit area.

Boorboori and Tehrani [30] expressed that foliar application of zinc increased grain wheat yield whereas copper foliar application had no effect on this trait. daresay the increase in the grain yield is attributable to the improved physiology of plants with the added Zn consequently correcting the efficiency of different enzymes, chlorophyll content, IAA hormone and improvement in nitrate conversion to ammonia in plant leading to higher yield [40, 10, 38, 39, 41]

Finally must be say According to Ozturk et al. [42], the highest wheat yield is closely related to the cultivar potential to produce fertile tillers.



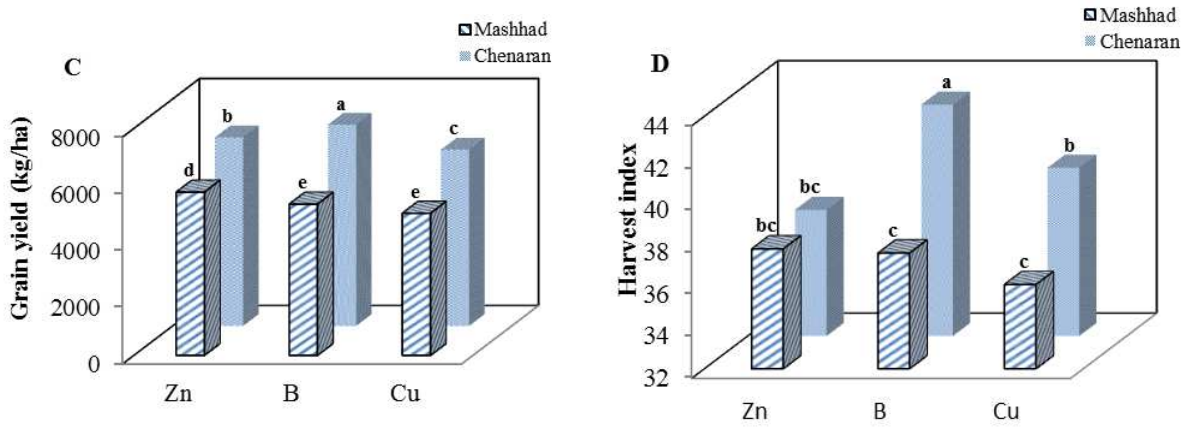


Figure 1. Effect of Type of element in Location on traits that significant, in tow Locations.
Column means followed by the same letter are not significantly different at 5% probability level

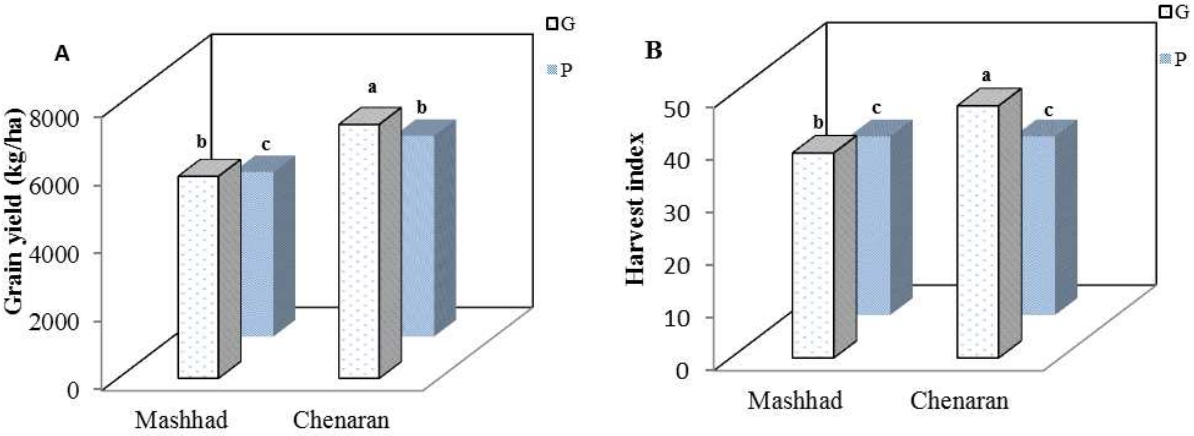
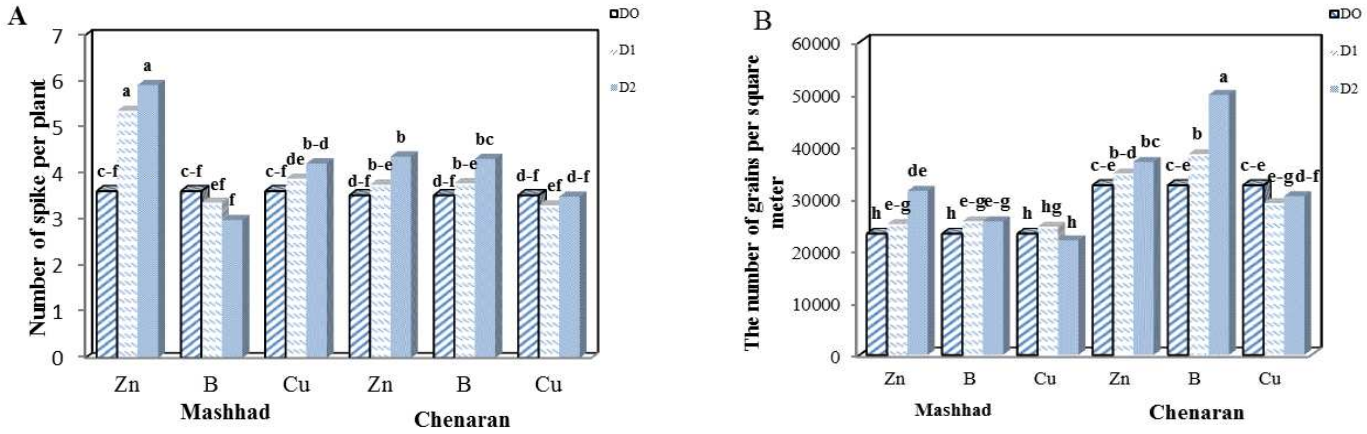


Figure 2. Interaction of variety in Location on a. Grain Yield and b. Harvest Index.
Column means followed by the same letter are not significantly different at 5% probability level



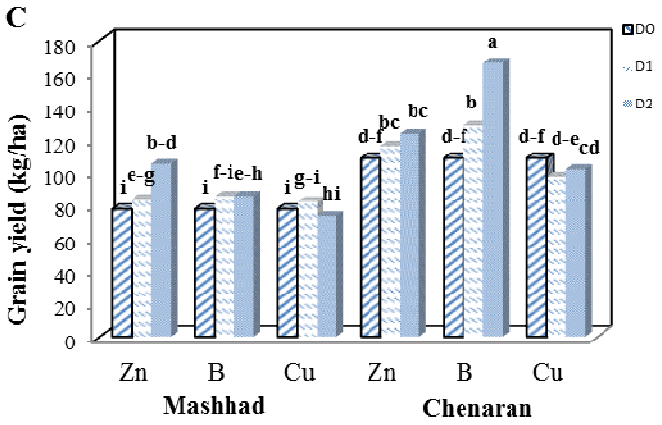


Figure 3. Interaction of Dose of application in Type of element in Location on a. number of spike per plant, b. Grain per spike and c. Grain Yield.

Column means followed by the same letter are not significantly different at 5% probability level

CONCLUSION

1- It could be concluded that, use of micro nutritious elements especially Boron, Zinc had positive effect on yield and yield components.
2- Tow wheat varieties had different nutritional demands regarding boron and zinc but generally Gaskojen had better response to mentioned elements than Pishtaz.
3- According Soil analysis table (table1), higher response of tested traits to Boron in Chenaran, and to Zinc in Mashhad is logical. So more attention to Boron application in Chenaran and Zinc Application in Mashhad, in agronomic management may improvement wheat yield in these regions.
4- Chenaran showed higher amounts in traits, that may refer to long-term conditions such as higher soil fertility, or short-term conditions such as better environmental conditions especially precipitation that in tested growth season was higher than Mashhad.
5- For achieving overview results recommend, that replicate experiments on these elements in other locations and regions and evaluation combined methods for elements application.

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