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Effect of different levels of boron and iron foliar application on growth parameters of wheat seedlings

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Abstract Pots experiment was conducted in Banats University of Agricultural Sciences and Veterinary Medicine ºRegele Mihai I al României º/ Romania under laboratory conditions during the winter season of 2013 to study the effect of foliar fertilizer application of different levels of boron (0, 250, 500 ppm) and iron (0, 500, 1000 ppm) either single or combined on the growth parameters of wheat seedlings (*Triticum aestivum* L.**,** var. "Alex"). A randomized complete block design (RCBD) with three replications was used. Source of boron was boric acid (B17%) while iron was Fe- DTPA (Fe 6%). Boron and iron solutions were sprayed after 24 days from sowing time on plant foliage with uniform coverage until the leaves were completely wet. Plants were harvested after 28 days from spray time. Results of the study indicated that foliar fertilizer application of boron at 500 ppm or iron at 1000 ppm gave significantly higher wheat seedling length, root length, shoot fresh weight, root fresh and dry weight and chlorophyll leaf contents compared to the control (0 ppm). The highest was obtained with the combination between 500 ppm B and 1000 ppm Fe gave the highest seedling height, root length, shoot dry eight, root fresh weight, root dry weight and chlorophyll leaf content as compared to the control.

Key words: Boron, foliar fertilizer, growth parameters, iron, micronutrients, wheat

Introduction

Macro and micronutrients are necessary for plant growth and development. If a plant does not obtain sufficient amounts of the nutrients it needs, the deficiency symptoms will appear as a general manifestation of the plant. In spite of being needed in small amounts, micronutrients are essential for the overall performance and health of the wheat plant (Palta & Karadavut, 2011). Micronutrients play a very important role in the growth and development of plant and occupy an important portion by asset of their essentiality in increasing crop yields. Their essential role in plant nutrition and increasing soil productivity makes their importance ever greater. Micronutrients have prominent effects on dry matter, grain yield and straw yield in wheat (Asad & Rafique, 2000). Deficiencies of micronutrient radically influence the growth, metabolism and reproductive phase in plants (Cartwright *et al*., 1983).

Boron is an important micronutrient required for plant growth and yield (Soomro *et al*., 2011). The main function of boron is related to cell wall formation, nitrogen fixation, sugar transportation, phenol, nucleic acid, membrane stability carbohydrate, indolic acetic acid (IAA) metabolism. Flower retention and pollen formation and germination also are affected by boron. Boron deficiency affects the reproductive more than biomass yield. Seed and grain production are reduced with low boron supply still in the absence of any observable indication of deficiency symptoms and so the requirement of B for reproductive increase appears to be more for reproductive development than for vegetative growth (Nalini *et al*., 2013).

Iron plays a role in many plant functions in plant growth and development, including chlorophyll synthesis, thylakoid synthesis and chloroplast development (Masoud *et al*., 2011). It also plays a role in energy transfer within the plant, as a constituent of certain enzymes and proteins, it has an essential role in plant growth and it enters root cells, and is involved in nitrogen fixation. Moreover, iron plays an active role in several enzymatic activities of photosynthesis as well as respiration (Ali, 2012).

Foliar spraying of microelements is very beneficial when the roots cannot provide or absorb nutrients (Grewal *et al*., 1997; Modaihsh, 1997; Torun *et al*., 2001; Babaeian *et al*., 2011; Parinaz *et al*., 2012). Also, soil pollution would be a major problem for micronutrients soil application, because people are concerned about the environment, in addition, plant leaves uptake nutrients better than soil application (Bozorgi *et al*., 2011). Several studies showed that foliar application of micronutrients on wheat crop has had significant positive effects on plant growth and yield parameters (Sajid Ali *et al*., 2009; Ai-Qing *et al*., 2011; Ali, 2012; Masoud *et al*., 2012; Nadim *et al*., 2012). Little information is available concerning combined application of iron and boron on the growth of wheat. Therefore, the objective of this study was to investigate the application of foliar fertilizer at different levels of boron and iron on the early growth parameters of wheat seedlings.

Materials and methods

An experiment was conducted in pots in Banats University of Agricultural Sciences and Veterinary Medicine "Regele Mihai I al României"/ Romania under laboratory conditions during the winter season of 2013. Soil samples were collected from surface horizon (0-25) cm of the soil, air dried and passed through a 2-mm sieve. Soil texture was clay having the following characteristics; sand 27%, silt 28.3%, clay 44.7% , pH 6.86, EC 0.44 dS m^{-1}, humus3.22%, total N 2.27%, P 11.43, K 184.87 ppm, available B 0.36 and Fe 2.14 ppm. Plastic pots were filled with 1600 g air–dry soil. These pots were of 16 cm in diameter, and 10 cm deep. 30 seeds of "Alex" wheat variety were sown in each pot and distilled water was added in amount sufficient to bring soil water content to field capacity. Soil moisture content was kept at field capacity during the period of the experiment through weighing the pots daily. The experiment was set up in a randomized complete block design (RCBD) with three replications. Foliar application of boron treatments included (0, 250, 500 ppm) and iron (0, 500, 1000 ppm). Source of boron was boric acid (B17%) and iron was Fe- DTPA (Fe 6%). Tween-20 at 1 ml/ 1 liter as surfactant was mixed with the foliar solution to increase adhesion of solution to plant foliage. A volume of 5mL of the solution was sprayed on each pot with a manual sprayer. The plants were sprayed with the solutions with uniform coverage until the leaves were completely wet, 24 days after sowing. At the time of spray soil was covered with plastic sheet to prevent the pollution of the soil from the sprayed nutrients. Plants were harvested from each pot after 28 days from spray time. At harvest time the plastic pots were split with fine knife and the soil was removed from roots using fine shower of tap water. Wheat seedlings were evaluated as follows:

The length of the seedling from the seed to the tip of the first leaf was recorded and expressed in centimeters. The root length of the seedling from the seed to the tip of the root was recorded and expressed in centimeters.

Both shoots and roots were separated softly; plants were blotted gently with soft paper towel to remove any free surface moisture then immediately weighted to obtain fresh weights of roots and shoots of seedling in each replicates. The weight of seedling shoots and roots were measured and expressed in grams. The weight of seedling shoots and roots were recorded and expressed in gm after oven drying at 70 °c for 48 h. While chlorophyll leaf content was determined using the SPAD.

All data were statistically analyzed using the analysis of variance (ANOVA) through MSTAT-C (1991) software package. Differences between means were compared by Least Significant Difference (LSD) at 5% level of significant (Steel & Torrie, 1997).

Results and discussion

Boron. Data presented in Table 1 showed that shoot length, root length, shoot fresh weight, root fresh and dry weight, and chlorophyll leaf content significantly ($P \leq 0.05$)increased by foliar application of boron as compared with the control. The highest plant length, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and chlorophyll leaf content (25.81, 25.80 cm, 2.556, 0.3426, 0.6206, 0.05904 gm and 41.71, respectively) were obtained when wheat seedlings were treated with foliar application of 500 ppm boron solution. Boron is a micronutrient required for plant nutrition. It is necessary for root and meristematic tissue extension, cell wall formation, membrane integrity, cell wall syntheses, carbohydrate metabolism, and calcium uptake and may assist in the translocation of sugar (Mengel & Kirkby, 2001; Nalini *et al*., 2013). These results could be explained by the role of boron in plant metabolism, which encourages growth and reflex in the growth characteristics studied.

The results also showed that foliar spray of iron significantly increased the growth parameters of wheat seedlings compared with the control (Table 2). The results indicated that the highest plant length, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and chlorophyll leaf content were obtained when wheat seedling treated with iron at 1000 ppm. The lowest values were recorded in the control treatment. The reasons for the improvement in characteristics of growth parameters of wheat seedling may be due to the fact that iron plays a role in the physiological processes such as chlorophyll synthesis, photosynthesis, thylakoid synthesis, respiration and chloroplast development. Iron is also involved in the oxidation process that releases energy from sugars and starchs and the reaction that converts nitrate to ammonium in plant, as well as its role in increasing the absorption of nitrogen (Nisar *et al*., 1996; Manal *et al.*, 2010). All of these reasons may lead to increase in plant height, root depth, shoot fresh weight, root fresh and dry weight and chlorophyll leaf content in wheat seedlings. This result is supported by the finding of (Pervaiz *et al.*, 2003; Erdal *et al*., 2004; Manal *et al*., 2010; Ali, 2012) who reported that application of iron increased most parameters of growth and yield components.

Table 1. Effect of different levels of boron foliar application on growth parameters of wheat seedlings.

Boron concentration (ppm)	Shoot length (cm)	Root length (cm)	Shoot fresh weight (gm)	Shoot dry weight (gm)	Root fresh weight (gm)	Root dry weight (gm)	Chlorophyll leaf content (SPAD %)
T1= 0	22.95 b	22.82 c	2.308 b	0.3096 b	0.5611 b	0.05574 b	39.68 c
T2= 250	25.22 a	24.61 b	2.529 a	0.3248 ab	0.6077 a	0.05776 ab	40.87 b
T3= 500	25.43 a	25.80 a	2.556 a	0.3426 a	0.6206 a	0.05904 a	41.71 a

Table 2. Effect of different levels of iron foliar application on growth parameters of wheat seedlings.

Iron concentration (ppm)	Shoot length (cm)	Root length (cm)	Shoot fresh weight (gm)	Shoot dry weight (gm)	Root fresh weight (gm)	Root dry weight (gm)	Chlorophyll leaf content (SPAD %)
T1= 0 ppm	23.67 c	23.30 b	2.324 b	0.2996 b	0.5408 c	0.05361 c	38.80 c
T2= 500 ppm	24.79 b	23.61 b	2.529 ab	0.3310 ab	0.6041 b	0.05772 b	41.00 b
T3= 1000 ppm	25.88 a	26.32 a	2.540 a	0.3463 a	0.6444 a	0.06121 a	42.46 a

Table 3. Combined effect of B and Fe foliar application on growth parameters of wheat seedlings.

B (ppm)	Fe (ppm)	Shoot length (cm)	Root length (cm)	Shoot fresh weight (gm)	Shoot dry weight (gm)	Root fresh weight (gm)	Root dry weight (gm)	Chlorophyll leaf content (SPAD %)
0	0	21.26 e	21.40 e	2.050 b	0.2527 b	0.4597 d	0.04967 d	37.40 g
	500	23.39 d	22.10 e	2.531 a	0.3327 a	0.5910 bc	0.05651 c	40.30 def
	1000	25.37 bc	24.19 cd	2.503 a	0.3240 a	0.5980 bc	0.05720 bc	40.77cde
250	0	24.89 bc	23.56 d	2.340 ab	0.3163 a	0.5800 c	0.05500 c	39.37 gf
	500	25.54 bc	24.52 cd	2.552 a	0.3363 a	0.6233 abc	0.05947 ab	41.93 bc
	1000	24.20 cd	25.51 bc	2.582 a	0.3433 a	0.6327 abc	0.06107 a	41.33 bcd
500	0	24.86 bc	24.96 bcd	2.535 a	0.3297 a	0.5827 c	0.05617c	39.63 ef
	500	26.19 ab	26.07 ab	2.456 a	0.3340 a	0.6450 ab	0.06107 a	42.47 ab
	1000	27.04 a	27.38 a	2.629 a	0.3617 a	0.6557 a	0.06150 a	43.57 a

Interaction between boron and iron. The foliar application of boron and iron together caused a significant ($P<0.05$) increase in growth parameters of wheat seedling compared with the control (Table 3). The results indicated that the highest seedling shoot length , root length, shoot dry weight, root fresh weight, root dry weight and chlorophyll leaf content were obtained when wheat seedlings were treated with B+Fe at 500+1000 ppm (27.04, 27.38 cm, 0.3617, 0.6557, 0.0615 gm, and 43.57%, respectively), and the lowest of them were observed in the control treatment . Foliar application of B and Fe fertilizer together had significant ($P < 0.05$) effect on early growth components of wheat seedling compared with the control. These results are in agreement with those of (Ai-Qing *et al*., 2011; Ali, 2012; Masoud *et al*., 2012; Nadim *et al*., 2012) who reported that the foliar application of micronutrients on wheat crop had significant positive effects on plant growth and yield parameters. Components of wheat seedling growth parameters affected by foliar application of Iron and Boron because the role of combinations of elements (boron, iron) mentioned above when discussing the impact of individual factors.

Conclusion

The present results indicate that, foliar application of boron and iron micronutrients both alone or with each other significantly increased seedling height, root length, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and chlorophyll leaf content. The best treatment was 500 ppm B + 1000 ppm Fe. Foliar sprays of micronutrients are recommended for enhanced nutrient status and augmented crop growth to ensure higher yields.

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