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Effect of times and foliar concentration of iron on grain yield, diameter of cob, Plant height and dry weight of corn

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Abstract

Maize (*Zea mays* L) is the third most important cereal after wheat and rice all over the world as well as in Pakistan. Maize is grown on an area of 9622000 ha with an annual average production and yield of 1665000 tones and 1730 Kg ha^{-1}, respectively. Nanotechnology with materials having unique properties has promised applications in various fields. It has provided new solutions to problems in plants and food science (post-harvest products) and offers novel approaches to the rational selection of raw materials, the processing of such towards applying disease control molecules, slow-release pesticides and developing diagnostic tools. The experiment was conducted at the research Station in sohrabad khash (In Iran). The field experiment was laid out in randomized complete block design with split plot design with three replications. Analysis of variance showed that the effect of times of foliar on grain yield was significant. Analysis of variance showed that the effect of concentration of iron on all characteristics was significant.

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Introduction

Maize (*Zea mays* L) is the third most important cereal after wheat and rice all over the world as well as in Pakistan. Maize is grown on an area of 9622000 ha with an annual average production and yield of 1665000 tones and 1730 Kg ha^{-1}, respectively (Anonymous 2000). Superior position of maize is due to his very wide and variety utilization. During the centuries maize plant was known for its multifariously use. Maize is used like a human food, livestock feed, for producing alcohol and no alcohol drinks, built material, like a fuel, and like medical and ornamental plant (Alahdadi *et al.*, 2011; Khodarahmpour, 2011; Bekric and Radosavljevic, 2008). Maize had its origin in a semi-arid area but it is not a reliable crop for growing under dry land conditions, with limited or erratic rainfall (Arnon 1972). Maize is apparently more drought resistant in the early stages of growth than when fully developed. Extreme water stress at different stages of crop development has been reported to reduce the yield significantly (Dhillon *et al.* 1995). Water stress has been found to reduce leaf area; photosynthesis, leaf chlorophyll contents and consequently grain yield (Jun-Chen and Dai-Junying 1996). Micronutrient malnutrition affects over two billion people around the world especially in the developing countries (McGuire, 1993). Iron deficiency is widespread and is one of the most concerned to healthcare officials among almost all developing countries (Buyckx, 1993). Iron is one of the essential elements for plant growth and plays an important role in the photosynthetic reactions. Iron activates several enzymes and contributes in RNA synthesis and improves the performance of photosystems (Malakouti and Tehrani, 2005). Iron deficiency has increased from 30% in the 1960s to 40% in the 1990s among the world population (Welch and Graham, 2002). Nano-technology can present solution to increasing the value of agricultural products and environmental problems. With using of nano-particles and nano-powders, we can produce controlled or delayed releasing fertilizers. Nano-particles have high reactivity because of more specific surface area, more density of reactive areas, or increased reactivity of these areas on the particle surfaces. These features simplify the absorption of fertilizers and pesticides that produced in nano scale (Anonymous, 2009). Nanotechnology with materials having unique properties has promised applications in various fields. It has provided new solutions to problems in plants and food science (post-harvest products) and offers novel approaches to the rational selection of raw materials, the processing of such towards applying disease control molecules, slow-release pesticides and developing diagnostic tools. Nanosilver, a new class of material with remarkably different physicochemical and biological characteristics from convenient silver-containing substances, has been shown to have antibacterial, antifungal and antiviral effects and it can reduce damage and losses caused by diseases (Choi *et al.* 2009; Eo, Lee 2009). The alternative approach is to apply these micronutrients as foliar sprays. Six micronutrients including Mn, Fe, Cu, Zn, B and Mo are known to be required for all higher plants (Mortvedt, 1991) iron is one of the essential elements for plant growth and plays an important role in the photosynthetic reactions. Iron activates several enzymes and contributes in RNA synthesis and improves the performance of photosystems (Malakouti and Tehrani, 2005).Iron compound can use as foliar on leaves and seed coating (Debermann, 2006). There are a few reviews about the effects of nano-particles on plants. Studies showed that the effect of nano-particles on plants can be beneficial (seedling growth and development) or non-beneficial (to prevent root growth) (Zhu *et al*, 2008). Several approaches were taken to cope with Fe deficiency in wheat grain. Abbas *et al.* (2009) applied 0, 4, 8, 12 and 12 kg ha-1 in the form of iron sulphate to the soil and showed that iron fertilization increased Fe and protein contents of the wheat grain. With application of 150 g ha^{-1} iron in the form of Fe2O3, Habib (2009) reported that iron and protein contents of the wheat grain were enhanced. Zeidan *et al.*(2010) applied foliar Fe fertilizer (1.0% FeSO4) and reported that Fe application increased protein and Fe contents of wheat grain. Motivation of the study is effect of times and foliar concentration of iron on grain yield, diameter of cob, Plant height and dry weight of corn.

Material and methods

Location of experiment

The experiment was conducted at the research Station in sohrabad khash (In Iran) which is situated between 28° North latitude and 68° East longitude and at an altitude of 1410m above mean Sea Level.

Composite soil sampling

The soil of the experimental site belonging loam. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out in randomized complete block design with split plot design with three replications.

Treatments

Times of foliar (stem (a1), tassel (a2) and stem+ tassel (a3)) were allocated to main plots and concentration of fe fertilizer (control (no fertilizer)(b1), 1 $gr.l^{-1}$ (b2), 2 $gr.l^{-1}$(b3) and 3 $gr.l^{-1}$ (b4) was allocated to sub plots.

Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

Results and discussion

Grain yield

Analysis of variance showed that the effect of times of foliar on grain yield was significant (Table 1). The maximum of grain yield (12330) of treatments stem+ tassel was obtained (Table 2). Analysis of variance showed that the effect of concentration on grain yield was significant (Table 1). The maximum of grain yield (12223) of treatments 3 $gr.l^{-1}$was obtained (Table 2). The minimum of grain yield (10921) of treatments control was obtained (Table 2).

Diameter of cob

Analysis of variance showed that the effect of times of foliar on diameter of cob was not significant (Table 1). The maximum of diameter of cob (54) of treatments stem+ tassel was obtained (Table 2). Analysis of variance showed that the effect of concentration on diameter of cob was significant (Table 1). The maximum of diameter of cob (53.4) of treatments 2 $gr.l^{-1}$was obtained (Table 2). The minimum of diameter of cob (49.2) of treatments control was obtained (Table 2).

Table 1. Anova analysis of the maize affected by times of foliar and concentration of fe.

		Ms			
S.O.V	df	grain yield	diameter of cob	Plant height	Plant dry weight
R	2	183.44	7.194	0.088	401144
times of foliar (a)	2	46.361**	2.778 ns	0.109 ns	48120000ns
Error a	4	79.444	6.319	0.035	25240000
concentration of fe (b)	3	193.96**	55.899**	0.480 **	100800000**
a*b	6	220.21 ns	12.778ns	0.013 ns	5163570.04 ns
Error	18	282.29	5.759	0.042	13870000

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

Plant height

Analysis of variance showed that the effect of times of foliar on plant height was not significant (Table 1). The maximum of plant height (207.1) of treatments stem+ tassel was obtained (Table 2). Analysis of variance showed that the effect of concentration on plant height was significant (Table 1). The maximum of plant height (208.7) of treatments 3 $gr.l^{-1}$was obtained (Table 2). The minimum of plant height (200.6) of treatments control was obtained (Table 2).

Plant dry weight

Analysis of variance showed that the effect of times of foliar on plant dry weight was not significant (Table 1). The maximum of plant dry weight (614.2) of treatments stem+ tassel was obtained (Table 2). Analysis of variance showed that the effect of concentration on plant dry weight was significant (Table 1). The maximum of plant dry weight (604) of treatments 3 gr.l-1was obtained (Table 2). The minimum of plant dry weight (548.6) of treatments control was obtained (Table 2).

Table 2. Comparison of different traits affected by times of foliar and concentration of fe.

Treatment	grain yield	diameter of cob	Plant height	Plant dry weight
times of foliar				
stem	10891b	53a	205a	553.1c
tassel	11943a	53.2a	206.4a	582.7b
stem+ tassel	12330a	54a	207.1a	614.2a
concentration of fe				
control	10921c	49.2b	200.6b	548.6b
1 gr.l^{-1}	11505b	55.1a	207.6a	589.1a
2 gr.l^{-1}	12236a	53.4a	208.7a	591.6a
3 gr.l^{-1}	12223a	53.1a	204.3ab	604.0a

Any two means not sharing a common letter differ significantly from each other at 5% probability.

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