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Original Research

Effects of micronutrient sprays and irrigation intervals on the medicinal plant blond plantain (*Plantago ovata* L.)

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ABSTRACT:

A split plot experiment using the randomized complete design with three replications was conducted in a field in the western Hesarooyeh region of Zahedan in the crop year 2013-2014. This was conducted to study the effects of irrigation intervals and sprays of the micronutrients zinc and iron on yield, its yield components, and essential oils of the medicinal plant blond plantain. The main factor included three levels of irrigation interval (I_1: the control: 7-day irrigation interval, I_2: 14-day irrigation interval, and I_3: 21-day irrigation interval), and the sub-factor at four spray levels (M_1: the control, not sprayed; M_2: zinc at 3 ppt; M_3: iron at 4 ppt; and M_4: zinc at 3 ppt+ iron at 4 ppt). Results showed that the 7-day irrigation interval resulted in the maximum values of the studied traits and, among the spray treatments, the combination of the micronutrients zinc and iron significantly increased all the measured traits compared to the control. However, no statistically significant differences were observed between spraying the combined micronutrients and spraying just the iron fertilizer.

Keywords:

Micronutrients, seed yield, irrigation, blond plantain, mucilage

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INTRODUCTION

Water scarcity is one of the main factors that limit production in the agricultural systems of arid and semi-arid regions, and affects the availability of other resources as well as the efficiency of their utilization (Stanhill, 2002). Blond plantain is a small annual herbaceous plant without stems, or with very short stems, at a height of 7-30 centimeters, and its stems and leaves are covered with fine hairs. Leaves are compound, alternately opposite, narrow, long, pointed and arranged in triplets on the stems. Flowers are compound and arranged in inflorescences on pedicels near the ends of the stems. Blond plantain is one of the laxative or mucilaginous medicinal plants and has hydrophilic properties that increase the volume of materials in the intestines and cure constipation (Zarbi, 2011).

Drought stress may change the amounts of elements absorbed by blond plantain plants through changing the potential difference and by affecting the ability of roots in absorbing water and salts; therefore, controlling water availability in the root region can improve the quality of medicinal plants. One of the effects of drought stress is to disrupt the equilibrium in plant nutrition (Lewis and McFarlane, 1986). Plant growth can be improved by complementing the soil contents of micronutrients, that a plant needs to grow. Zinc and iron are two of these micronutrients and their deficiencies are caused by high pH values, abundance of bicarbonates in the irrigation water, excessive use of phosphate fertilizers and, finally, the unpopularity of their application, which is commonly observed (Malakooti and Hamedani, 2010).

Based on the research carried out on crop plants including safflower (Sanavi and Sanavi, 2006), millet (Paigozar, 2008), mung bean (Jafardokht, 2013), and sunflower (Babaeian *et al.,* 2010), application of micronutrient fertilizers under conditions of water shortage can lead to increase the growth and yields of these crops. However, the question of applying micronutrients for medicinal plants including blond plantain had not been completely clarified yet. Nevertheless, it is thought that application of the micronutrients such as zinc and iron may increase yield of medicinal plants and their active ingredient content under conditions of drought stress.

MATERIALS AND METHODS

This experiment was conducted in a field with soil of clay loam texture in the crop year 2013-2014 in the western Hesarooyeh region of Zahedan with 60˚51' east and 29˚30' north, and altitude of 1385 meters. Based on Koppen climate classification, the region has an arid climate with warm and dry summers. The experiment was conducted in split plots using the randomized complete block design with three replications. The main factor included irrigation interval at three levels (I_1: the control: 7-day irrigation interval, I_2: 14-day irrigation interval, and I_3: 21-day irrigation interval) and the sub-factor at four sprays levels (M_1: the control, not sprayed; M_2: Zinc at 3 ppt; M_3: Iron at 4 ppt; and M_4: Zinc at 3 ppt + Iron at 4 ppt). There were 12 treatments in 36 plots with three replications. Workers carried out land preparation manually. After preparing the plots, and before planting, decomposed animal manure at the conventional rate of 50 t/ha and the chemical fertilizers concentrated superphosphate, potassium sulfate and urea at 150, 100, and 150 kg/ha, respectively, were incorporated into the soil in the experimental plots. The phosphorous and potassium fertilizers together with one-third of the urea were applied at planting. One third of the urea was applied at stem elongation and the other one-third at flowering (both at 50 kg/ha and in rills dug in strips at the foot of the plants). Zinc and iron sulfates (at 3 and 4 ppt, respectively) were sprayed twice (at stem elongation and inflorescence formation).

Data were analyzed using SAS, comparison of the means was performed employing Duncan's multiple range test at the 5% level, and the diagrams were drawn using Excel.

RESULTS AND DISCUSSION

Plant height

Results of ANOVA indicated water stress and micronutrients had significant effects on the plant height of blond plantain, but their mutual effects on plant height were not significant (Table 1). Comparison of the means showed stress reduced plant height so that the tallest plants (with the average height of 38.65 cm) were belonged to the treatment with the 7-day irrigation interval (the control) and the shortest (with the mean height of 22.04 cm) to the treatment of 21-day irrigation interval (Table 2). Reduction in plant height resulting from water stress depends on the growth stage, and water stress in the early growing stages can have stronger effects on plant height (Mazaheri, 2013). Sprays with either of the nutrients somewhat increased plant height compared to the control. Zinc and iron applications resulted in plants with the average heights of 28.51 and 30.15 cm, respectively, which were not significantly different from each other and were placed in the same statistical group. Combined application of zinc and iron led to plants with the maximum height (36.28 cm on average), which was significantly different from those of the other three treatments and was 28.14% more than that of the control (that was not sprayed with the micronutrients) (Table 2).

1000-seed weight

Significance analysis using ANOVA indicated that the 1000-seed weight was only influenced by water stress, and the effects of the micronutrient fertilizers (and their mutual effects) on this trait were not statistically significant (Table 1). Based on the table of comparison of the means, the average 1000-seed weights of the water stress treatments (irrigation intervals of 14 and 21 days) with 1.14 and 1.19 g, respectively, did not show any statistically significant differences and were in the same statistical group, below the control with the average 1000-seed weight of 1.61 g. In the study, Tatari conducted on cumin in 2004, it appeared that in the treatment of full irrigation, because of the suitable soil moisture and the production of greater quantities of photosynthates, more of these materials were allocated to each seed, which increased the 1000-seed weight.

Seed yield

According to the results of ANOVA, the effects of water stress, micronutrients, and the mutual effects of spraying both micronutrients, on seed yield of blond

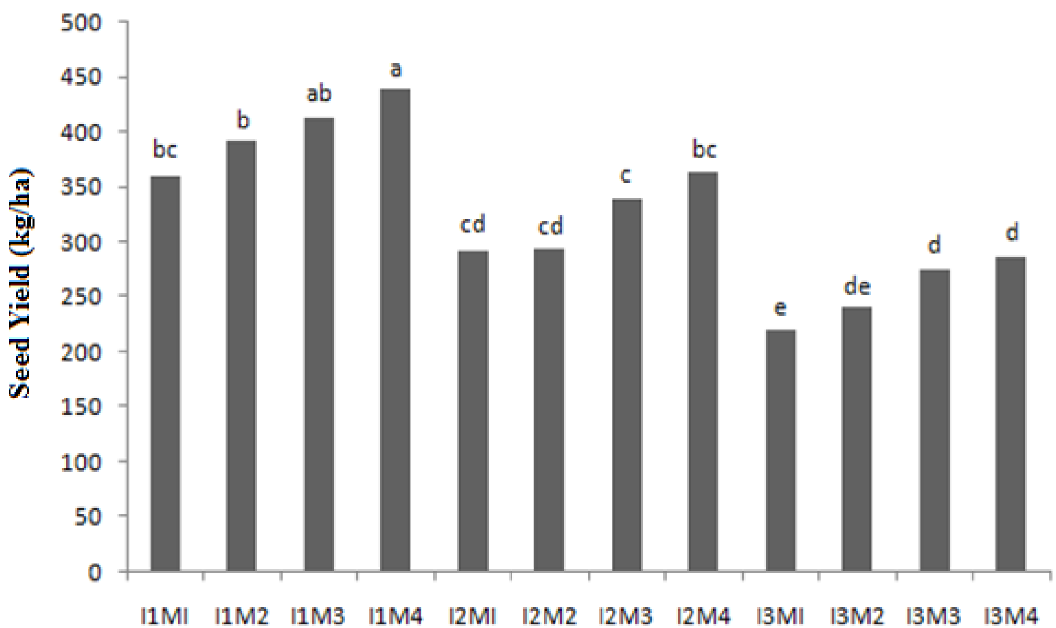

Figure 1. Comparison of the means of mutual effects irrigation and fertilizer treatments on the seed yield of blond plantain

plantain were significant (Table 1). Comparison of the means showed that the maximum seed yield (411.09 kg/ ha) was achieved in the treatment of full irrigation, which was significantly different from those of the treatments under water stress. The 21-day irrigation interval reduced seed yield to 203.00 kg/ha, which was 50.61% less than that of the treatment with full irrigation (Table 2). Micronutrient sprays increased seed yield of blond plantain, with the maximum yield (392.17 kg/ha on average) observed by the combined application of zinc and iron. Of course, this treatment was not significantly different from that of applying only iron (with the average yield of 381.56 kg/ha) (Table 2). It is noticed that applying zinc sulfate at 5 kg/ha increased yield and net nitrogen absorption efficiency in wheat. Results of comparison of the means related to the mutual effects showed applying micronutrients under conditions of full irrigation, and in the treatment with 14-day irrigation interval, somewhat reduced the adverse effects of drought stress on seed yield. Combined application of zinc and iron increased seed yield by 46.95 and 46.74% under irrigation intervals of 14 and 21 days, respectively, compared to the control (Figure 1).

Biological yield

Water stress and miconutrients had significant effects on biological yield of blond plantain (Table 1). Comparison of the means of the data revealed that the maximum amd minimum biological yields with averages of 1451.72 and 509.15 kg/ha, respectively, belonged to the treatments of full irrigation and 21-day irrigation interval (Table 2). Zinc application, iron application, and their combined application, increased biological yields by 18.05, 40.11, and 44.11%, respectively, compared to the control (in which micronutrients were not applied). There were no significant differences between the treatment of combined application of the nutrients and that of iron application. The minimum biological yield was that of the control in which no micronutrients were applied (Table 2). Bybordi (2008) stated that increased yield of dry matter caused by application of these micronutrients could have various reasons including increased biosynthesis of auxin in the presence of zinc, increased chlorophyll concentration, increased activity of phosphoenolpyruvate carboxylase and ribulose biphosphate carboxylase, and reduces sodium accumulation in plant tissues in the presence of zinc. Comparison of the means of the mutual

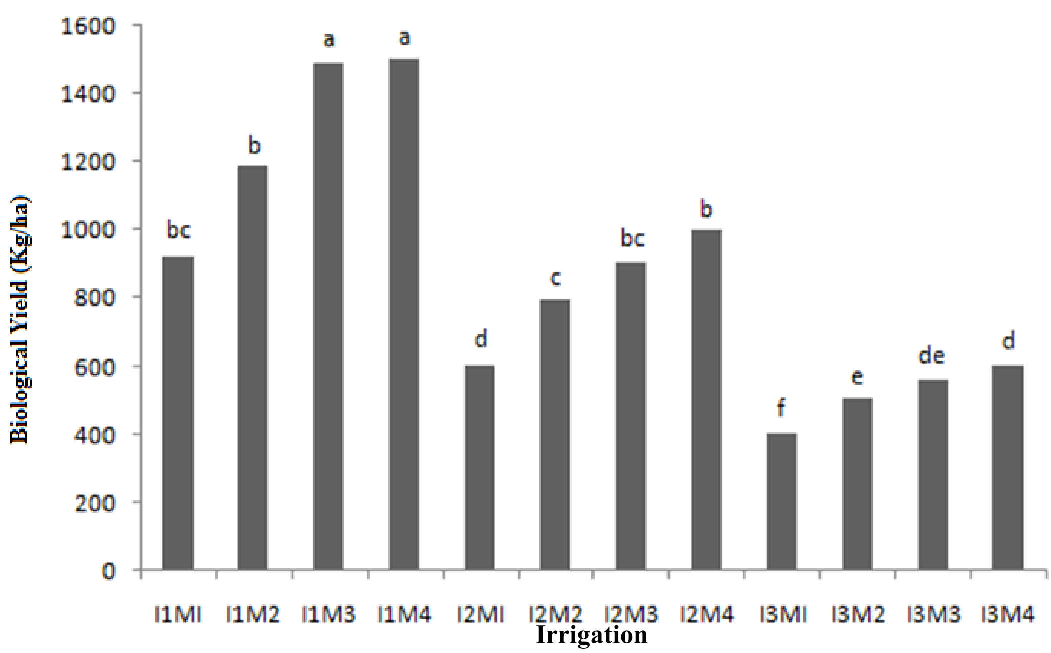

Figure 2. Comparison of the means of the mutual effects of irrigation and micronutrient application treatments on the biological yield of blond plantain

effects of water stress and micronutrient application indicated the maximum biological yield was that of the treatment of combined application of zinc and iron under normal irrigation (which did not show any statistically significant differences with the treatment of applying iron under normal irrigation) , and the minimum that of the treatments of not applying the micronutrients under the 21 -day irrigation interval (Figure 2).

CONCLUSION

The present study showed that the 7-day irrigation interval resulted in the maximum values of the studied traits and, among the spray treatments, the combination of the micronutrients zinc and iron significantly increased all the measured traits compared to the control. However, no statistically significant differences were observed between spraying the combined micronutrients and spraying just the iron fertilizer.

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