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Responses of Some Sweet Potato (Ipomoea batatas L.) Cultivars to Foliar Application of Micronutrients Under Sandy Soil Conditions


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ABSTRACT

The responses of sweet potato to foliar application of some micronutrients (Fe, Zn, Mn and B) under sandy soil conditions in Nubaria region (west delta region) were studied. Three cultivars of sweet potato were used in this study (A-193, Abees and Beauregard). The study indicated that the three cultivars responded differently to such conditions as the conditions in Nubaria region favored the high productivity of some cultivars more than others. Moreover, the application of micronutrients significantly enhanced plant growth parameters, root quality and yield of all cultivars. Similar trends were observed concerning the total chlorophyll content of leaves and the total soluble solids (T.S.S.) of roots. The effects of the treatments on vegetative growth, yield, total chlorophyll content and total soluble solids are discussed. Further results regarding the behavior of the cultivars under sandy soil conditions as well as the physiological effects of the micronutrients are also indicated.

Key words: Sweet potato, micronutrients, yield, sandy soils

Introduction

Sweet potato (Ipomoea batatas L.) is one of the important vegetable crops grown in Egypt and is considered as an important source of food world-wide. However, under sandy soils, the productivity and quality are negatively affected due to the poor fertility and low nutrients specially the micronutrients in such soils. Accordingly, foliar application of micronutrients such as Fe, Zn, Mn and B could be beneficial as to prevent nutrient deficiency and to avoid soil problems that affect their availability. Moreover, sandy soils in many semiarid regions are known to limit mobility and availability of soil-Zn to plant roots (Marschner, 1993). Karaman et al. (1999) found that increasing Zn concentrations applied to bean plants resulted in an increase in dry matter production. Moreover, El-Tohamy et al. (2009) indicated that essential oil, growth and yield of onion plants significantly increased by the application of Fe, Zn and Mn under sandy soil conditions compared to control plants. El Sayed Hameda et al. (2012) found that spraying pea plants with a mixture of microelements significantly increased yield components expressed as pod length, pod weight, number of green seeds/pod, weight of 100-green seed, seed index (1000-dry seed weight) and chemical constituents such as NPK, carbohydrates (%) and protein (%) of green seeds of pea plant.

Sweet potato plants responded positively to foliar application of Zn and the highest production of roots was obtained with the highest zinc dose as indicated by Abd El-Baky et al. (2010).

Bybordi and Malakouti (1998) found that some micronutrients such as Fe, Zn and Mn gave higher yield of onion. On the other hand, Khalid (1996) reported that trace elements such as Fe, Zn and Mn increased the vegetative growth characters and essential oil content of different plants such as anise, coriander and sweet fennel. Moreover, Echer et al. (2009) found that the maximum estimated sweet potato yield was obtained with combination of the rates of 2 kg ha⁻¹ of B applied to the application of 200 kg ha⁻¹ of K₂O.

However, the behavior of sweet potato cultivars in sandy soils and to micronutrient application under such conditions may not be very much expected. Gallo et al. (2001) evaluated several sweet potato cultivars and found variation in the performance of the cultivars under different environmental conditions. The present study aimed to explore the behavior of some sweet potato cultivars under sandy soil conditions in Nubaria region. The response of sweet potato cultivars to micronutrient applications were studied as well.

Material and Methods

The experiments were conducted at the experimental research station of the National Research Center in Nubaria (west delta region). Cuttings of three sweet potato varieties (A-193), Abees and Beauregard were grown during April for the seasons of 2011 and 2012 under drip irrigation system. The soil of the experimental site was deep and well-drained with 85.5% sand, 11.7% silt and 2.8% clay, an alkaline pH of 8.2, an EC of 0.85 dS m⁻¹.
and with 1.5% CaCO₃. The average available N, P and K in the top soil was 0, 2 and 17 mg kg⁻¹ soil, respectively before the onset of the experiment. Three weeks after cultivation, plants were sprayed twice (14 days interval) with the chelated form of the following micronutrients: Fe (1g/L), Zn (0.3g/L), Mn (1g/L) and B (0.3g/L) while control plants were only sprayed with water. All agricultural practices required for sweet potato production in sandy soils were followed as recommended by the ministry of agriculture in Egypt. The following measurements were recorded:

1- Plant growth, quality and yield measurements: including plant length, number of branches, number of roots, root length, root diameter and total yield.
2- Physiological measurements: including total chlorophyll content of leaves (as SPAD units) measured using TYS-A chlorophyll Meter (Zhe Jang Top Instrument Co. LTD., China) and total soluble solids (T.S.S.) of roots (measured by refractometer).

Statistical analysis:

Fifteen treatments were arranged in a completely randomized block design of two factors (cultivars and foliar application of micronutrients, 3x5) with 4 replicates and analysis of variance was calculated according to Snedecor and Cochran (1967). Least significant difference (L.S.D.) at 5% was used to compare between means.

Results and Discussion

Generally, all micronutrient application treatments significantly promoted vegetative growth as indicated by increased plant growth parameters such as plant length and number of branches and also significantly increased yield, number of roots, root length and root diameter (Figures: 1, 2, 3, 4, 5, and 6) compared to control plants. The most efficient treatment that enhanced the plant length was the foliar application of Fe while B had the highest results concerning the total yield.

Similar results regarding the positive effects of micronutrients were obtained for both total chlorophyll of leaves (Figure 7) and total soluble solids of roots (Figure 8) as micronutrient treatments had significant increase compared to control plants.

Sandy soils are generally poor in nutrient contents and availability. Marschner (1993) indicated that sandy soils in many semiarid regions are known to limit mobility and availability of soil-Zn to plant roots. On the other hand, foliar application of micronutrients could ameliorate the negative effects of nutrient deficiency under sandy soils. Under sandy soil conditions, essential oil, growth and yield of onion plants significantly increased by the application of Fe, Zn and Mn compared to control plants (El-Tohamy et al., 2009)

The three tested cultivars (A-193, Abees and Bearuegard) responded differently to sandy soil conditions. While these conditions favored the increase of yield of both A-193 and Bearuegard, the productivity of Abees cultivar was much lower than the other cultivars, indicating that the soil conditions of the experimental site were not suitable for optimum production of this cultivar although Abees had normal vegetative growth. Moreover, the results also indicated that there were some variations among cultivars concerning the total chlorophyll of leaves and the total soluble solids of roots. The results cleared that Abees obtained the highest total chlorophyll content while the highest T.S.S. of roots was obtained by A-193 cultivar (boron treatment). The interaction between cultivars and micronutrient treatments was significant for all parameters except for number of roots, root length and root diameter.

Concerning the impact of micronutrients on sweet potato in sandy soils, the results revealed that the application of Fe, Mn, Zn and B had pronounced effects on total yield for all the three cultivars tested in this study. The effects of micronutrients on improving growth and yield of plants were evident as Bybordi and Malakouti (1998) stated that some micronutrients such as Fe, Zn and Mn gave higher yield of onion plants. Abd El-Baky et al. (2010) found that the highest production of sweet potato roots was obtained with the highest zinc dose as a foliar spray.

Also, Khalid (1996) found that the application of Fe, Zn and Mn resulted in higher vegetative growth characters and essential oil content of different plants such as anise, coriander and sweet fennel. Boron has also an important role in improving sweet potato yield as indicated by Echer et al. (2009) who found that the maximum estimated sweet potato yield was obtained with combination of the rates of 2 kg ha⁻¹ of B applied to the application of 200 kg ha⁻¹ of K₂O. Moreover, Ahmed et al. (2011) found that foliar application of yeast at the rate of 5 g/l combined with foliar application of zinc at the rate of 300 ppm gave the highest total tubers yield of potato plants. They also indicated that tuber quality and chemical constituents showed the same trend of total tubers yield.
Fig. 1: Effects of micronutrient treatments on plant length of sweet potato cultivars.

Fig. 2: Effects of micronutrient treatments on number of branches (per/plant) of sweet potato cultivars.

Fig. 3: Effects of micronutrient treatments on number of roots of sweet potato cultivars.
Fig. 4: Effects of micronutrient treatments on total yield of sweet potato cultivars.

Fig. 5: Effects of micronutrient treatments on root length of sweet potato cultivars.

Fig. 6: Effects of micronutrient treatments on root diameter of sweet potato cultivars.
The results indicate that both Beauregard and A-193 are more suitable to soil conditions in Nubaria region (west delta region) than Abees variety. The interactions between soil, environmental conditions of the region and the varietal differences may explain the behavior of the different varieties of sweet potato to such conditions. Such varietal behavior differences are not very much expected unless experimental experiments are carried out under such conditions. The behavioral differences among sweet potato cultivars are mentioned by Gallo et al. (2001) who evaluated several sweet potato cultivars and observed a variation in the performance of some cultivars under different environmental conditions. In addition, El Sayed Hameda et al. (2012) indicated that the foliar spraying pea plants with a mixture of microelements significantly increased yield components expressed as pod length, pod weight, number of green seeds/pod, weight of 100-green seed, seed index (1000-dry seed weight) and chemical constituents such as NPK, carbohydrates (%) and protein (%) of green seeds of pea plant.

Our results revealed that in order to maximize sweet potato production under sandy soil conditions of Nubaria region, suitable cultivars (such as Beauregard and A-193) should be chosen. In addition, foliar application of micronutrients (Fe, Zn, Mn and B) can be used to maximize the yield of sweet potato under such conditions.
References


