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RESEARCH ARTICLE

EFFECT OF SPRAYING WITH MICROELEMENTS ON GROWTH AND PRODUCTIVITY OF TOP AND ELITE CUCUMBER VARIETIES

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ABSTRACT

Cucumber is an important vegetable crop. Fertilization with microelements increases production and improves its quality. In this study we tested the effect of foliar spraying with microelement on some production and quality parameters of cucumber genotypes. Complete randomized blocks design was used. Two cultivars of cucumber were tested (Top and Elite). Two treatments for each cultivar (spraying with microelements and control). Three replicates per treatment, with 5 plants for each replicate, were adopted. Treatment plants were sprayed weekly with 1 g/L of microelements. Our results show that genotypes differed in their response to microelements spraying. Where Top variety has surpassed the control in some traits (number of fruits/plant, number of fruits/m^2, total weight of the fruit/plant and total weight of fruits/m^2), while delayed for the control in the weight and length of the fruit. The Elite variety exceeded the control in the weight and length of the fruit and the total production per m^2. Finally, the treatment of microelements affected the total production and some quality characteristics in both studied cultivars.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae family. It is a warm season vegetable and grows worldwide under tropical and subtropical environments. The origin of cucumber is northern India and China which is one of the most important centers of genetic diversity of cucumber plants (Pursglove, 1969; Homedan and Zedan, 2004). Each 100 g of fresh cucumber contains 95.8 g water, 13 calories, 2.2 g carbohydrates, 0.6 g protein, 0.1 g fat, 0.3 g minerals (mainly potassium 141 mg, phosphor 23 mg, calcium 15 mg), 0.9 g fiber and trace of vitamin C. Cucumber contains 16-68 mg free organic acids due to the refreshing taste of cucumber, in addition to 1 mg volatile essential oils that give the characteristic odor of the cucumber, and also contains Cucurbitacin glycoside which is responsible for the bitter taste (Olabi and Al- Waree, 1997). Because of the high water and low energy content, the cucumber works to refresh and cool the body and full stomach without cause fat accumulation. So it plays a big role in the prevention of atherosclerosis and reduce blood sugar. Cucumbers also help to digest fatty and protein substances, adjust the acidity of the blood in the body, dissolve gravel and uric acid crystals in the kidney or urinary bladder, increase diuresis and prevent constipation, stop jaundice and indigestion (Nandkarni, 1927, Jallul and Samra, 2004).

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Cucumber is one of the most cultivated crops under field or protected conditions due to its short life cycle, high production and high consumption. However, global and demographic demand for agricultural products, including cucumber crops, is increasing dramatically, which requires increasing production and yield per unit area (Homedan and Zedan, 2004).The synthesis of biomass and the level of metabolism in the plant depends on many factors, the most important of which are mineral nutrition (Kazda *et al*., 2004). Several studies have shown that carbon dioxide uptake has decreased as a result of the lack of mineral supply of plants (Lima *et al*., 1999). Foliar spraying is very useful when the roots are unable to absorb the necessary nutrients (Kinaci and Gulmezoglu, 2007). According to Kołota and Osińska (2001), foliar fertilization is an effective means of supplying plants with nutrients during the period of intensive growth, helping to improve the mineral state of plants and increase crop productivity. The advantages of foliar nutrition are its rapid effect, reducing nutrient loss and restricting environmental pollution (Klamkowski *et al*., 2011). During its growth stages, plants need microelements. Although needed in very small quantities, they significantly affect growth, yield and product quality of plants (Olabi and Al-Waree, 1997). Narimani *et al*. (2010) reported that the spraying with microelement (Fe, Zn, Cu) improves the yield and its components. Singh (2002) informed that the microelements had an effect on the quality of grapes, T.S.S and the quality of fruits. Tamilselvi *et al*. (2002) also declared that foliar spraying with microelements significantly increased the number of fruits per plant, the proportion of fruit set, the weight of a single fruit, the total production and seed production per plant of tomatoes. Klamkowski *et al*. (2011) showed that fertilization with microelements reduced the leaf content of the P and N elements, the highest phosphorus content of the control, and explained that the high zinc decreases the phosphorus content because there is a competitive effect between phosphorus and zinc and this is contrary to the findings of Movchan and Sobornikova (1972). Jana and Kabir (1987) also reported the effect of foliar spraying of microelements on the growth of beans, and found that spraying with microelements at a concentration of 0.1 ppm recorded the highest plant height and number of branches. In an experiment by Meena *et al* (2017) to study the response of some cucumber varieties to spraying with humic acid and microelements. Foliar spraying with humic acid (0.1%) with microelement spraying (0.5% Zn, 0.2% B, 0.5% Mn) gave the best results in terms of studied parameters (length of branches, number of branches per plant, leafy surface, stem diameter, number of fruits per branch, fruit weight per plant, weight of fruit / m2 and length, diameter and size of fruit). Its findings coincided with a number of previous studies (Brownell *et al*., 1987; Boehme *et al*., 2005; Yildirim, 2007; Karakurt *et al*., 2009).

Goos and Johanson (2000) showed that foliar spraying twice with iron chelates increased seed yields for three soybean genotypes. Foliar iron spraying on tomato plants has improved the quality of fruits, increasing the quantity and quality of the crop in protected agriculture (Chohura *et al*., 2009). Foliar spraying with iron also increased photosynthesis, total biomass and relative growth in rice grown in marshes (Mousavi, 2011). Mishra *et al*. (2003) and Malawadi *et al*. (2004) observed that iron spraying increased the content of ascorbic acid, TSS and TA in hot capsicum fruits. Zaiter *et al*. (1993) showed that foliar fertilization with iron chelates increased the number of fruits in the strawberries. El-Shazly *et al*. (2000) also reported that apples sprinkled with iron increased TA, TSS and vitamin C at the end of storage. For zinc, spraying with ZnSO4 increased TSS in guava fruits (Dobroluybsikii *et al*., 1982). Moustafa *et al*. (1986) also observed that zinc sulphate spraying increased weight, number of fruits in clusters, T.S.S ratio and fruit content of juice. The positive effect of ZnSO4 on the number (Chaplin, 1980) size and quality of fruit (Archbold and Dennis, 1984) was confirmed. In a study by Kazemi (2013), to assess the effects of foliar spraying with zinc (15, 30 and 50 mg/L) and iron (50 and 100 mg/L) on cucumber plants, the results indicated that it significantly increased vegetative growth, fruit quality and yield. Leaf chlorophyll content increased with zinc spraying at 50 mg/L and iron at 100 mg/L. The best results were obtained when spraying both elements where there were significant increases in growth and the leaves content of chlorophyll, nitrogen and potassium, and also in the quality of the fruits. Fruit length and diameter increased when spraying cucumber plants with a concentration of 50 mg/L of zinc and 100 mg/L of iron (Klamkowski *et al*., 2011). It was noted that zinc and iron spraying have significant positive effects on growth parameters and yield in cumin (El-Sawi and Mohamed, 2002), sunflower (Mirzapour and Khoshgoftar, 2006) rice (Wissuwa *et al*., 2008), strawberries (Abdollahi *et al*. 2010), bean (Prasad *et al*., 1984), okra (Suryanarayana and Rao, 1981), Foliar spraying of 0.25% boric acid at a rate of 1 kg / ha / yr divided into 3-4 times resulted in a significant increase in yield, mainly due to an increase in leaf area (Gohian *et al*., 2000). Barua and Dutta (1972) showed a reduction in production when boron spraying at a rate of 6 kg / ha /year was attributed to the high utilization rate leading to toxic effects on the plant. Prasad and Dey (1979) found that foliar spraying was more effective than adding in to the soil in the event of boron deficiency. Njoloma (2012) showed that spraying with microelements (copper, zinc, boron) of the tea plant had no apparent effect in increasing productivity or improving the quality of the product except for some studied varieties. He attributed this to the different genotypes in their ability to absorb and represent these elements. In a study to determine the effect of boron leaf spray on beet and tomato plants grown in protected conditions, Gondim *et al*. (2015) found the highest increase in total dry weight and total productivity at a concentration of boron 26 mg / kg for beets and 72 mg / kg for tomatoes. Increased concentrations led to reduced production and poor plant growth.

In a study by Arshad *et al*. (2011) to determine the effect of foliar spraying of copper element on the growth and productivity of pineapple, it obtained a significant effect of spraying at a rate of 1.6-3.3 kg/ha of copper sulfate. Barooah *et al*. (2005) found that the productivity of tea fields strongly correlated with the soil content of Cu and Mn. Gartrell (1981) also demonstrated the effectiveness of the addition of copper fertilizers in the soil, in particular foliar spraying of copper compounds, in the treatment of symptoms caused by copper deficiency. According to Squire (1977), spraying tea-deficient copper plants with copper sulfate concentration of 1% increased the activity of the enzyme polyphenol oxidase and greatly improved the quality of tea. Alaoui-Sosse *et al*. (2004) also noted that the growth of cucumber plants was stopped when copper content was increased after the addition of 20 mg/g copper chloride in the growth medium. The objectives of this study are to determine the effect of microelements spraying on cucumber plant growth and yield, and to compare the response of cucumber varieties (Top and Elite) and the extent to which genotypes were affected by foliar spraying of microelements.

MATERIALS AND METHODS:

Experiment location: The study was carried out in Sarjeh area of Idlib governorate. The village is located at latitude 35.757° north and longitude 36.627 ° east, rising about 700 m. Rainfall is estimated at about 520 mm per year, with an annual average temperature of 16.1 °C.

Plant material: Two cucumber hybrids were used: Top is characterized by early production, leaves are dark green, fruits are consistent and regular, but it is sensitive to fungal diseases. Elite is intermediate for early production, the leaves are green and it is resistant to disease.

Treatments Experimental: Only experimental treatments were sprayed (without the control) with microelements at a concentration of 1 g /L and by one spraying per week during the whole of planting period. Spraying continued until full plant coverage and spraying rate was 50 mL / plant at the beginning of planting with a gradual increase to 500 mL / plant at the end of planting season. Microelement fertilizers contained the following elements (g / 100 g): B (0.5), Cu (1), Fe (6), Mn (4), Zn (8). Irrigation was carried out for all treatments by drip in rate of 2 L/plant at the beginning of planting and gradually increased to 8 L/plant. Irrigation was conducted every two days. All necessary agricultural operations such as control, weeding, etc., were carried out for all treatments as needed.

Measured parameters: The following measurements were taken:

- Flowering beginning (day after sowing: DAS).
- Fruiting beginning (day after sowing: DAS).
- Fruits characters:
  - Length of fruit (cm);
  - Diameter of fruit (cm);
  - Weight of fruit (g);
  - Number of fruits/plant;
  - Number of fruits / m^2;
  - Weight of fruit/plant (kg);
  - Weight of fruit / m^2 (kg).

Experimental design: Complete randomized block design was used. Two cucumber cultivars were tested (Top and Elite). Two treatments for each cultivar (spraying with microelements, control without microelements treatment) with three replicates per treatment were adopted. Each block has been considered a duplicate and contains 5 plants. The parcel was divided into 12 experimental blocks, each block was 1 m^2.

Thus the total number of plants in the experiment = 2 × 2 × 3 × 5 = 60 cucumber plants.

Statistical analysis: All statistical analyzes of the results were performed by the statistical program (SigmaStat). ANOVA analysis of variance was done to calculate the least significant difference of LSD at the level of significance 5%.

RESULTS

In our study, where we tested the effect of foliar spraying with microelements on some productivity measures of Top and Elite cucumber varieties, we obtained the results shown in Table (1).

Production precocity: With regard to the beginning of flowering, flowers appeared on the Top variety after 60 and 61 days (test and control respectively). Flowers appeared on the Elite variety after 70 and 72 days (test and control respectively).

The fruiting began after 69 days of test and 71 days of control in the Top variety. Fruits were delayed up to 80 days of test and 79 days of control in Elite variety. These results show that there was an early production in the Top variety compared to the Elite variety by about 10 days. It was also found that there was no significant effect on precocious production trait when spraying with microelements (Fig. 1&2).

Length of fruit (cm): Comparing the length of the fruit in the two cultivars (Top and Elite) which were not treated with microelements, it was found that there were no significant differences between them so that the fruit length was 12.5 cm and 12.4 cm respectively. After treating the two cultivars with microelements, Elite showed a significant moral superiority compared to the control where the average fruit length increased to 13.2 cm. While the Top cultivar showed a significant decrease in fruit length and the average fruit length was 11.9 cm (Fig. 3).

Diameter of fruit (cm): There were no significant differences with respect to the diameter of the fruit either by comparing the two cultivars (Top and Elite) before spraying or after spraying with microelements (2.9 cm and 2.8 cm respectively), (Fig. 4).

Number of fruits/plant: There were no significant differences between the two cultivars in terms of the number of fruits, obtained during the production season in the case of the control, where the average number of fruits per plant was 21 fruit for both cultivars. After spraying with the microelements, we noticed that the cultivar Top responded and gave significant differences compared to the untreated control, increasing the number of fruits from 21 to 39 fruit/plant. While the cultivar Elite did not show any significant differences and did not respond to spraying in terms of the number of fruits per plant. Fig. (5) shows the results obtained.

Number of fruits / m^2: The spraying of the Elite cultivar with microelements did not achieve significant differences in terms of the number of fruits in the experimental piece (number of fruits/m^2), where the results were close between treatment and control (113 and 105 fruits respectively). The Top cultivar showed significant differences between the treatment and the control (195 fruits/m^2 for the treatment and 106 fruits/m^2 for the control). These results show that the two varieties studied differed in their response to foliar spraying with microelements (Fig. 6).

Weight of fruit (g): Comparing the weight of the fruit between Top and Elite varieties, we can see that the Top variety is superior to the Elite variety where the weight of the fruit was 61.2 g and 59.3 g, respectively, in case of without treatment. After spraying the two cultivars, we noticed that the fruit weight increased significantly compared to the control (62.4 g for the treated plants). While the Top cultivar decreased the weight of the fruit in the treated plants significantly (56.7 g). This can be attributed to the significant increase in the number of fruits per plant in the Top variety. Thus, competition between these fruits for manufactured materials increased, so that reflected on the average weight of one fruit (Fig. 7).

Yield/plant (kg): The results showed that there were no significant differences in the plant productivity for both cultivars studied in case of non-treated plants, where the total fruits weight was 1.3 g/plant. After spraying the two cultivars with the microelements, the cultivar Top showed a clear superiority in the weight of fruits per plant (2.2 g) compared to the control. Conversely, the Elite variety was not affected by spraying with microelements compared to the control (the fruits weight was 1.4 g/plant). The superiority of the Top variety is explained (in spite of the low weight of one fruit) by a significant increase in the number of fruits per plant (Fig. 8).

Yield/m^2 (kg): Comparing the productivity of the Top and Elite varieties without spraying with the microelements shows no significant differences and convergence in the production of the two cultivars per unit area (6.5 kg/m^2 and 6.2 kg/m^2, respectively). When spraying with microelements of two cultivars, both varieties showed superiority over the untreated control, and Top cultivar showed a clear superiority over Elite after treatment with microelements.

Table 1. Results of spraying varieties of cucumber (Top and Elite) with microelements*

Traits	Top		Elite		LSD
	Test	Control	Test	Control	(5%)
Flowering beginning (DAS)	60^{a}	61^{a}	70^{b}	72^{b}	6.4
Fruiting beginning (DAS)	69^{a}	71^{a}	79^{b}	80^{b}	5.1
Length of fruit (cm)	11.9^{c}	12.5^{b}	13.2^{a}	12.4^{b}	0.3
Diameter of fruit (cm)	2.9^{a}	2.9^{a}	2.8^{a}	2.8^{a}	0.2
Weight of fruit (g)	56.7^{c}	61.2^{a}	62.4^{a}	59.3^{b}	1.3
Number of fruits/plant	39^{a}	21.3^{b}	22.7^{b}	21^{b}	6
Number of fruits / m^2	195^{a}	106^{b}	113^{b}	105^{b}	11
Weight of fruit/plant (kg)	2.2^{a}	1.3^{b}	1.4^{b}	1.3^{b}	0.6
Weight of fruit / m^2 (kg)	11.1^{a}	$6.5^{b,c}$	7.1^{b}	6.2^{c}	0.7

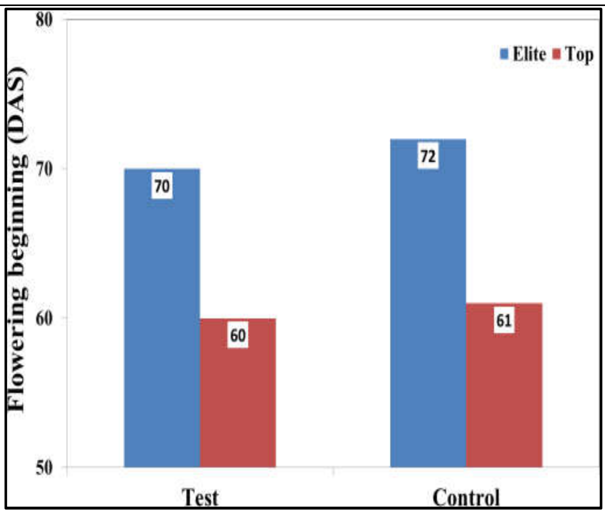

Figure 1. Beginning of flowering in experimental treatments (LSD5%=6.5)

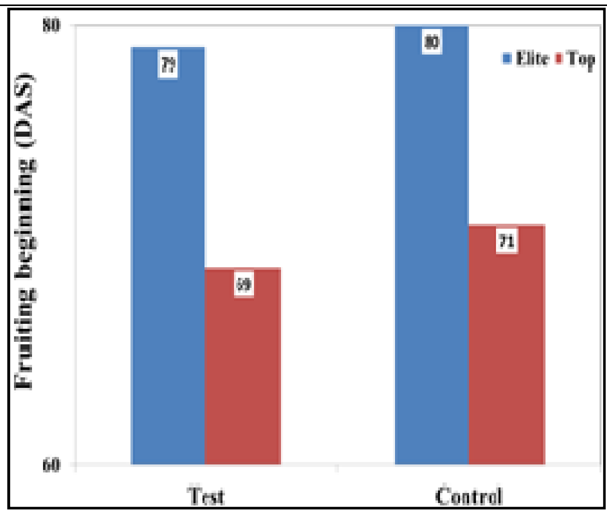

Figure 2. Beginning of fruiting in experimental treatments (LSD5%=5.1)

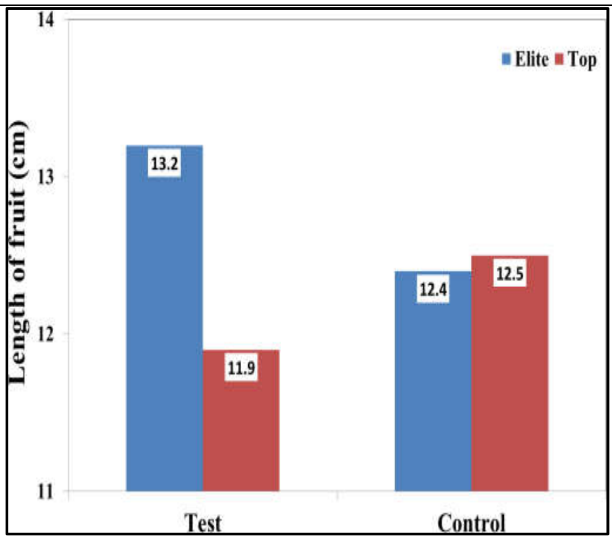

Figure 3. Effect of spraying with microelements on average fruit length (LSD5%=0.3)

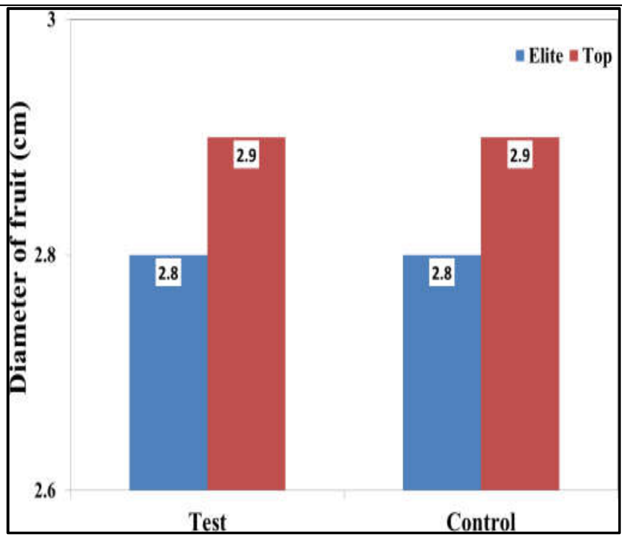

Figure 4. Effect of spraying with microelements on average fruit diameter (LSD5% = 0.2)

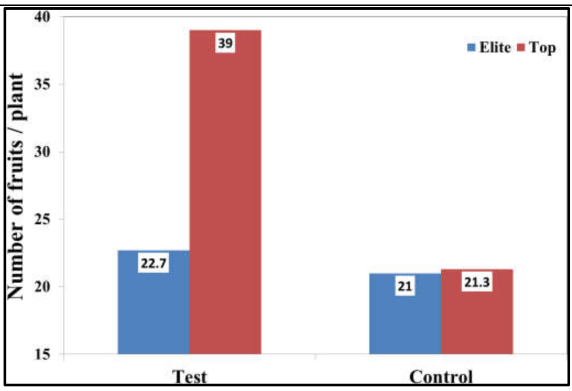

Figure 5. Effect of spraying with microelements on average number of fruits/plant (LSD5% = 6)

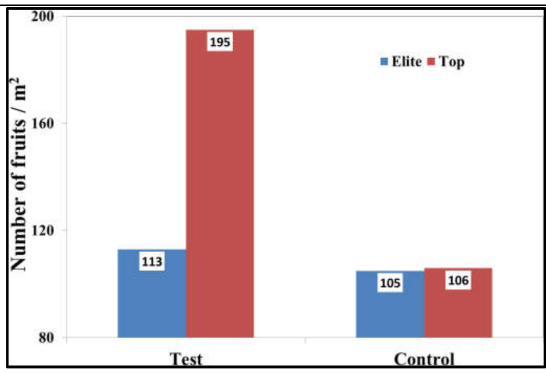

Figure 6. Effect of spraying with microelements on the average number of fruits/m^2 (LSD5% = 11)

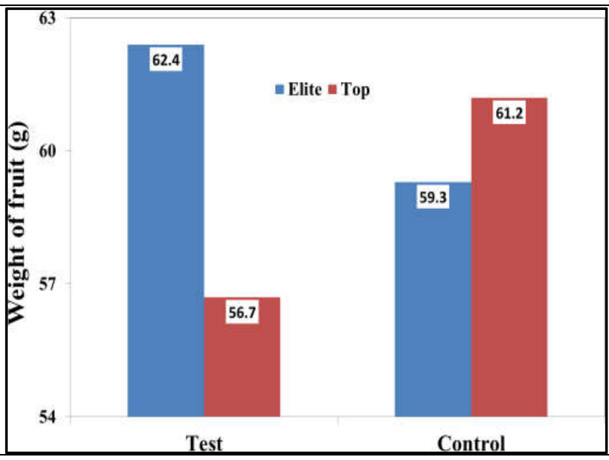

Figure 7. Effect of spraying with microelements on average of fruit weight (LSD5% = 1.3)

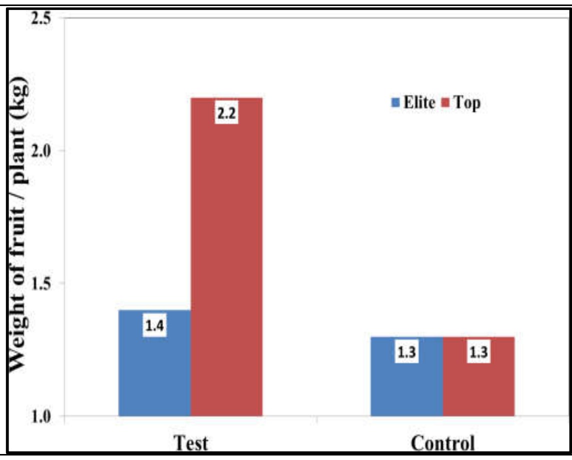

Figure 8. Effect of spraying with microelements on average yield/plant (LSD5% = 0.6)

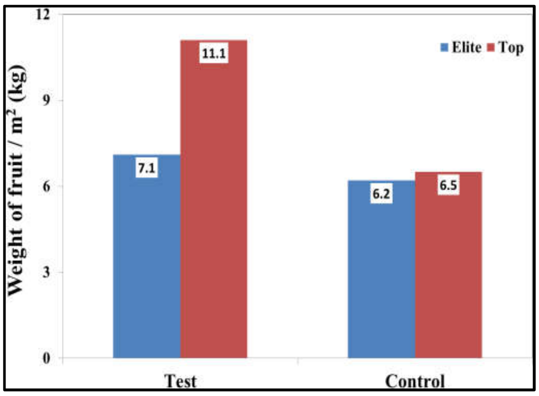

Figure 9. Effect of spraying with microelements on yield/m^2 (LSD5% = 0.7)

DISCUSSION

The previous results showed the convergence of the two studied varieties (Top and Elite) in most traits (length and diameter of the fruit, number of fruit/plant, number of fruit/m2, weight of fruit/plant and weight of fruit / m2) in the control treatments. While there were significant differences between the two studied varieties in some characteristics (beginning of flowering and fruiting and weight of fruit), where the Top cultivar was significantly superior. Top variety showed a clear response and appeared significant differences as a result of spraying with microelements, where were increased the number of fruits/plant, the number of fruits/m2, the total weight of the fruit/plant and the total weight of fruits/m2. While the weight of fruit was decreased as a result of spraying with microelements. Which can be explained by the high number of fruits on the plant, these fruits compete among themselves for manufactured food and thus reduce the proportion of each fruit and therefore reduced weight. However, we have increased the total production per unit area (m2) as a result of spraying microelements. There were no significant differences on the Elite cultivar when sprayed with microelements, especially with regard to fruit diameter, number of fruits per plant, number of fruits per unit area (m2). While there were significant differences in the length of fruit and weight of fruit, this was reflected in a significant increase in the total weight of fruits per unit area (m2). Consequently, the total production was increased by the result of spraying with microelements. The results obtained after spraying with microelements (increase the number of fruits) correspond to those of Boehme et al. (2005) in their study of the effect of microelement spraying on cucumber plant and Tamilselvi et al. (2002) in studying the effect of microelement spraying on tomato plant. Our results were also consistent with Meena et al. (2017), who obtained significant differences in fruit length, fruit weight per plant, and fruit weight per square meter. It also corresponds to the findings of Brownell et al. (1987), Yildirim (2007), Karakurt et al. (2009), who showed that microelements spraying increases the amount of fruit for many plant species.

Its correspond to the results of Kazemi (2013) and Klamkowski et al., (2011), who reported that the productivity of cucumber plants and the length and number of cucumber fruits were increased, and the best results were obtained when the two elements were combined. Also, the results resembled with those of Prasad et al. (1984), whose pointed out that zinc and iron spraying increases the number of bean pods, the length of pod and the productivity of each plant. Finally, our results matched to what Gohian et al. (2000) and Gondim et al. (2015) indicated that spraying with boron, copper and zinc gave a significant increase in the yield of beets and tomatoes. Concerning the difference in the response of the Top and Elite varieties to the spraying of microelements, these results are consistent with the those of Njoloma (2012), who attributed that to the different genotypes in their ability to absorb nutrients and assimilate these elements and thus the impact on the factors of production and quality.

Conclusion

As a result of our research, in order to determine the effect of spraying two cucumber hybrids with microelements, we can conclude the following:

- Top variety showed significant superiority on the control in some studied traits (number of fruits/plant, number of fruits/m2, total weight of the fruit/plant and total weight of fruits/m2).
- Top variety significantly retreated of the control in the weight and length of fruit.
- Elite variety significantly surmounted the control in fruit length, fruit weight and total weight of fruit in m2.
- Total productivity per unit area (m2) increased for both cultivars

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