SINAI Journal of Applied Sciences 12 (4) 2023 567-586

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS TrustScience | ItCreates

IMPACT OF SOIL STIMULATORS AND FOLIAR SPRAY BY SOME MICRONUTRIENT SOLUTION ON TWO SUGAR BEET VARIETIES AT EL-ARISH REGION

Ahmed S. Attaya*

Plant Prod. Dep., Fac. of Environ. Agric. Sci., Arish Univ., North Sinai, Egypt

ARTICLE INFO

Article history:
Received: 21/10/2023
Revised: 28/10/2023
Accepted: 02/11/2023

Keywords:
Sugar beet,
Varieties,
Soil stimulators,
Foliar spray,
Micronutrient.

Check for updates

ABSTRACT

The effects of foliar treatments of micronutrient solutions and soil stimulants on the growth, quality, and production of two sugar beet root types in North Sinai were investigated. A split-split plot design was used. The varieties had a significant variation for different traits, with Marathon variety performing better than Farida variety. Foliar application of micronutrient solutions also had a notable effect on different traits, with spraying 750 ml/fad resulting in the ultimate values for root productivity, root diameter, and root length. Spraying 500 ml/fad yielded the optimum values for sugar yield, TSS, purity, and sucrose. Soil stimulators had a statistical impact on various traits, with the Iquet compound being the most effective. The interaction between variety, micronutrient solution, and soil stimulator also had a significant effect on various traits, with the best combination being spraying 750 ml/fad., of micronutrient solution with Humic acid as a soil stimulator for the Marathon variety. However, the combination of 500 ml/fad., foliar spray with Iquet for the Marathon variety yielded the highest sucrose, TSS proportions, and sugar yield. The findings of this study will be useful for future investigations, such as usage of soil stimulators and foliar applications of micronutrient solution in sugar beet production.

INTRODUCTION

Sugar beet, scientifically known as *Beta vulgaris*, is a highly significant agricultural crop in newly reclaimed regions of Egypt. In comparison to sugar cane, sugar beet demonstrates a superior capacity for sugar production under these specific circumstances. Within the territory of North Sinai, sugar beet holds great strategic importance as a winter crop. This crop has proven to be immensely valuable due to its remarkable tolerance to the high salinity of the soil and water, as well as the scarcity of irrigation resources. Additionally, sugar beet serves as a non-traditional feed source for sheep, goats, and other large animals. Moreover, the cultivation of sugar beet can provide farmers with an additional source of income through the utilization of residual leaf and root materials for the production of various secondary industrial goods. According to the Foreign Agriculture Service of the United States Department of Agriculture (**FAS-USDA 2023**), Egypt achieved a sugar production of 2.76 million ton in the 2022/23 season (as depicted in Figs. 1 and 2). Of this total, 1.5 million ton were derived from beets, whereas 1.28 million ton were derived from cane. Furthermore, Egypt's annual sugar consumption amounts to approximately 3.3 million ton. The increase in sugar consumption can be attributed to the growth of the population, estimated at 2.4 percent per annum. To bridge the gap between sugar production and consumption, Egypt relies

* **Corresponding author: E-mail address:** ahmed.attaya@aru.edu.eg
https://doi.org/10.21608/sinjas.2023.242467.1237

on imports, which currently stand at nearly 830,000 ton. The expansion in the area devoted to sugar beet cultivation can be attributed to the government's policy of encouraging farmers to prioritize the cultivation of beets over cane. This policy aims to conserve water resources and capitalizes on the high sugar extraction potential of sugar beet, which ranges between 15 and 22 percent, in contrast to the 14 to 16 percent extraction potential of cane.

Several studies have compared the execution of different varieties of sugar beet in terms of production and quality. **Nemeat Alla *et al.* (2023)** found that the Zoom variety outperformed others in terms of root thickness, weight, and sucrose percentage, furthermore yielding the ultimate amounts of roots, tops and the production of sugar per fad. **Mubarak and Abd El Rahman (2020)** found that the Samba variety had the greatest sugar production and quality outperformed other varieties of sugar beet. **Khalil *et al.* (2018)** reported that the choice of variety had a significant impact, with Samba variety showing the greatest sugar productivity per fad, sucrose, and sugar extraction percentages. **Al-Sayed and Attaya (2015)** demonstrated significant variations among the varieties in sugar yield, root diameter and its length. Farida sugar beet var. had the ultimate amounts for root length and diameter, while Toro variety had the highest juice purity and sucrose. Additionally, the Halawa var. achieved the greatest production of sugar and root. In a study conducted by **LiangMin *et al.* (2014)** in Chinese soil conditions, the three evaluated varieties had substantial variations in sugar percentage and root production. **El-Hawary *et al.* (2013)** stated significant differences among sugar beet varieties in terms of sucrose, TSS, sugar and root production/ fad. Farida variety had optimum amounts of sucrose (%), TSS (%), sugar and root production/ fad compared to the others. Another study stated among four sugar beet varieties (Jambus, Tilman, Antek, and Fred), **Pacuta *et al.* (2013)** discovered that the Fred var. had the best production metrics.

In relation to the impact of foliar application on sugar beet, **Nemeat Alla *et al.* (2023)** studied the impact of zinc foliar application on sugar beet, finding that spraying with 4.50 g/L zinc created the optimum values for root diameter, sucrose and extracted sugar percentages, sugar and root productivity/fad. Similarly, **Artyszak *et al.* (2021)** examined the effects of silicon foliar application on sugar beet leaves, finding that it significantly altered the content of macroelements and silicon in sugar beet plants. **Ibrahim *et al.* (2020)** investigated the effects of potassium and boron foliar spraying on sugar beet, finding that certain treatments created the optimum amounts for nutrient concentrations, yield components, and quality characteristics. **Mubarak and Abd El Rahman (2020)** examined the impact of Capillin foliar spray on sugar beet production under salinity conditions, finding that it raised sugar and root production per fad. **Zewail *et al.* (2020)** investigated the effects of micronutrient foliar treatments, finding that certain treatments significantly improved growth and yield characteristics. In another study, **Gomaa *et al.* (2019)** studied the effects of growth regulators as foliar application on sugar beet, finding that spraying Kainten or IAA in association with either (Cerealine and Nitrobine) of biofertilizers and 50% mineral fertilizer or Nitrobine biofertilizer with 75% mineral fertilizer, resulted in the ultimate quality and production. **Dewdar *et al.* (2018)** studied the impact of nano-microelements mixtures and urea foliar application on Farida variety, finding that a combination of nano-microelements at 200 mgL^{-1} dose and urea at a concentration of 1%. treatment resulted in favorable results for root growth, as well as sugar and root productivity. **Abdelaal *et al.* (2015)** also investigated the effects of foliar treatment of Mn, Zn, Fe and B, finding that dose of 1.5 l/fad., resulted in greatest standards for sucrose percentage, root diameter, sugar and root productions. **Amin *et al.* (2013)** stated impact of micronutrient application on sugar beet, finding that a specific treatment (spraying a mixture of micronutrients twice) resulted in the highest values for various parameters. **Osman (2011)** investigated the effect of different levels of micronutrient foliar spray. They found that spraying micronutrients at a level of 1/2 l/fad resulted in the greatest amounts for fresh weight, root diameter, sugar production, sucrose and purity proportions. **Hussein (2011)** presented that the treatment of a mixture of Fe, Mn, Zn and B at a concentration of 2 cm/l/400 l water/fad significantly attained highest root growth, purity percentage, sucrose percentage, and sugar production per fad.

The importance of soil stimulators for the beet productivity was demonstrated with multiple studies. **Zaki *et al.* (2018)**, they found sugar beet plants that fertilized with 100 kg N/fad., ammonium sulphate plus inoculating them with 600 gm/fad., of biofertilizer (Ntrobin) enhanced the growth characteristics of beets in sandy soil conditions. **Attaya (2017)** found that soil stimulators had a vital role on sugar and root yields, purity percentage, and root diameter. **Abdelaal (2015)** studied the role of phosphorine, cerealine, and yeast as biofertilizers on sugar beet and concluded that combining them with mineral fertilizers maximized productivity. **Al-Sayed and Osman (2015)** conducted a study on the impact of potassium humate and Aquita on sugar beet attributes. They discovered that the treatments resulted in a significant or positive enhance on the root length and diameter, sucrose and purity percentages, root and sugar yield measurements. **Ambihai and Gnanavelrajah (2013)** determined that adding biomass charred improved soil properties and increased root yield. **Agamy *et al.* (2013)** assessed the influence of soil amendment with strains on the beets productivity and found positive outcomes. **Amin *et al.* (2013)** investigated the use of a biofertilizer mixture (rizobacterin + phosphorine) that resulted in increased sugar beet productivity and quality of Farida variety. **Zarishnyak and Sypko (2010)** discovered that using press mud application enhanced root and sugar yields.

The main aim of this investigation was to examine the impact of different foliar application *via* micronutrient solutions with soil stimulators on the root growth, productivity and quality of two varieties of sugar beet in the novel land conditions of Arish region in North Sinai.

MATERIALS AND METHODS

Through winter seasons 2018/2019 and 2019/2020, two field experiments were carried out in the Experimental Farm of the Environ. Agric. Sci. Faculty at Arish University in North Sinai Gov., Egypt, to investigate the influence of foliar spray of three micronutrient solution levels i.e. 250, 500 and 750 ml/fad., and three soil improvers *i.e.* Agrispon, Humic acid and Iquet on root growth, yield and quality of two sugar beet varieties *i.e.* Farida and Marathon. Soil improvers Iquet powder, which was added to the soil before planting at the rate of 10 kg/fad., and Agrispon (liquid at the rate of 1 cm/10 m^2) and Humic acid (powder at the rate of 2 gram/ litre), which were added after planting. Foliar application of liquid chelated microelements, B, Fe, Zn, and Mn, where boron in the form of (boric acid 9 percent B), iron in the form of iron chelated (7.15 percent iron oxide), Zinc in the form of zinc chelated (7 percent zinc), and manganese in the form of manganese chelated (9.03 percent manganese oxide) were applied 60 and 90 days after sowing, using hand sprayer with 300 liter water/fad. Utilizing a split-split plot design, three replications of the tests were conducted. Main plots were randomly assigned to soil stimulators; sub-plots were randomly assigned for doses of micronutrient solutions; and sub-sub plots were randomly assigned to the sugar beet varieties. A 15 m^2 plot was made up of 6 rows, 0.5 m in width, and 5 m in length.

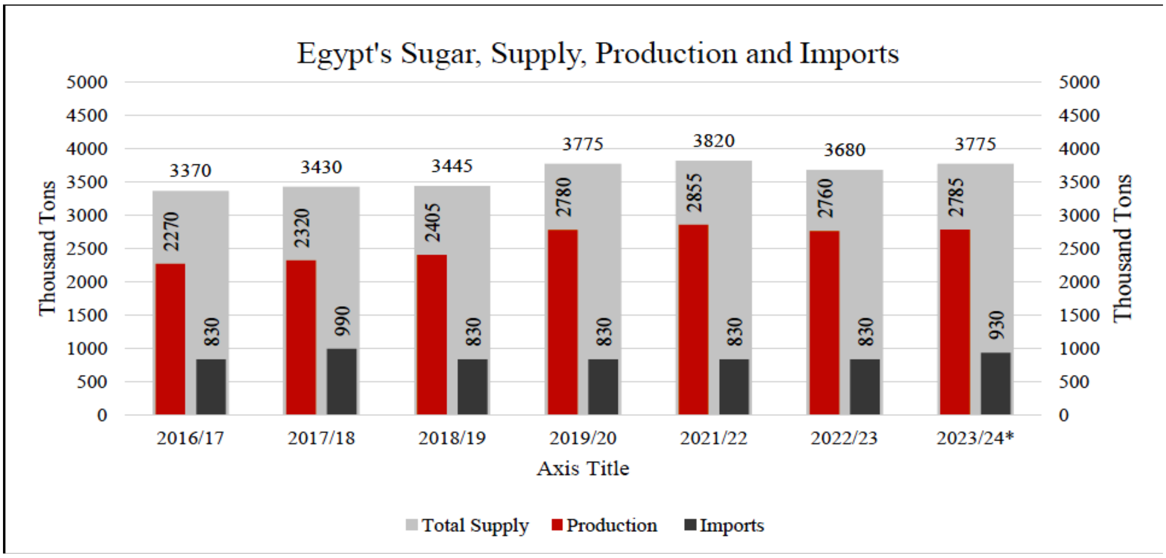

Fig. 1. Egyptian Sugar Production, Supply, and Imports, MY 2016/17 – MY 2023/24*

Source: Foreign Agriculture Service, United States Department of Agriculture **(FAS-USDA 2023)**

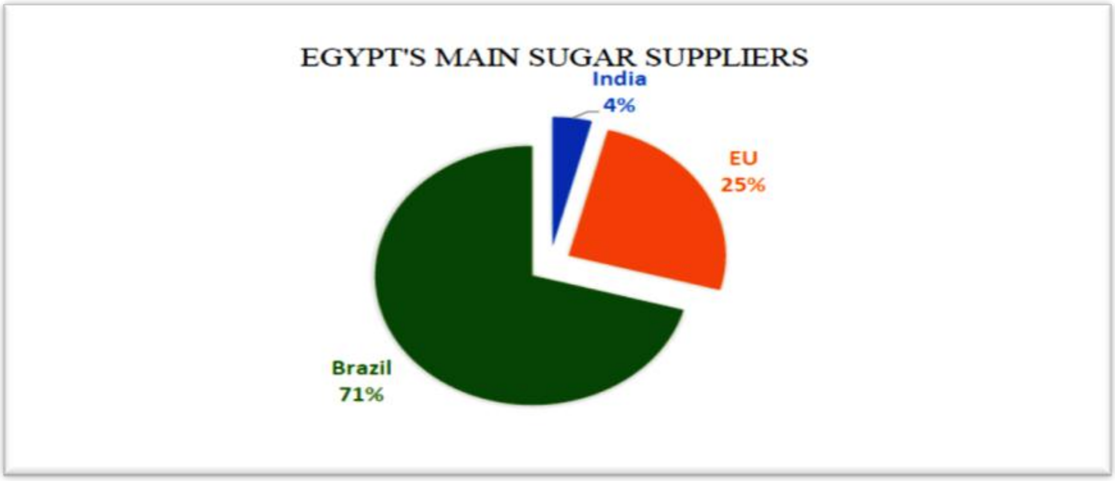

Fig. 2. Egypt's main sugar suppliers in calendar year 2022

Source: Foreign Agriculture Service, United States Department of Agriculture **(FAS-USDA 2023)**

The studied two varieties (Farida and Marathon) were obtained from the Sugar Crops Research Institute at the Agricultural Research Center, Giza, Egypt. In both seasons, the first week of November was designated for sowing. Seeds were placed in hills 20 cm apart and 50 cm among lines. Upon reaching the four-leaf stage, the plants were trimmed down to a single plant per hill. At planting, phosphorus was supplied at the dose of 30 kg P_2O_5/fad., in the form of calcium super phosphate (15.5% P_2O_5). Before applying the first nitrogen treatment, 50 kg K_2O/fad of potassium sulfate (48% K_2O) was administered. Ammonium sulfate (20% N) was used as nitrogen fertilizer at the level of 120 kg per fad in three equal doses: following thinning, one month later, and three weeks later. The proposed actions were taken for other cultural customs. Before seeding, soil samples were randomly collected from the several experimental field locations at a depth of 0 to 30 cm (from the soil surface). Table 1 presents the chemical composition of the irrigation water. Moreover, Table 2 presents the physical and chemical characteristics of the experimental soil. Meteorological data are shown in Table 3.

Studied Traits

Four guarded rows were taken, topped, and cleaned for every treatment when they reached maturity, which was 190 days after seeding. From each plot, ten randomly selected roots were used to calculate the following characteristics:

1- The length of root (cm/plant).

2- The diameter of root (cm/plant).

3- The percentage of sucrose was calculated using Sacchrometer in accordance with **AOAC (1990)** guidelines.

4- The percentage of juice purity was determined using the methodology outlined by **Carruthers and Old Field (1961).**

Purity percentage = {Sucrose percentage **x** 100 / TSS}

5- Root yield (ton/fad) was calculated *via* harvesting, topping, and weighting the four guarded rows.

6- Sugar yield (ton/fad) was calculated using the subsequent formula:

Sugar yield = Root yield (ton/fad) **x** Sucrose percentage

Analytical Statistics

The data statistically analyzed according to the technique of analysis of variance as a split-split plot design in a Randomized Complete Design with three replications **Steel *et al.* (1997)**. Using SAS (**SAS Institute, 2004**), Duncan's multiple range test; **Duncan (1955)** was used to examine the statistical difference among the means. The results were represented as the mean ± SE.

RESULTS AND DISCUSSION

Root Length

Results presented in Table 4 demonstrate that the variety of sugar beet had a statistically significant impact in both seasons on the average root length, for each level of micronutrient solution × soil stimulator. Farida variety outperformed Marathon, with the longest root length recorded in both seasons respectively (30.7 cm and 31.9 cm). This discovery aligns with **Al-Sayed and Osman (2015)**, **Mubarak and Abd El Rahman (2020) and Nemeat Alla *et al.* (2023),** who noted that there were significant variations in the length of root among sugar beet varieties, also the finding is aligned with **El-Hawary *et al.* (2013) as well as Al Sayed and Attaya (2015),** who found that the longest root was resulted from Farida variety. The variations in this trait among the different varieties may be attributed to their genetic factors.

The length of root differed among the micronutrient solutions determined in both seasons, depending on the variety × soil stimulator level. The highest root length values were observed at the 750 ml/fad level (30.0 in 1st and 31.5 in 2nd season), followed by the 500 ml/fad., level (28.4 and 29.9). Lowest root length values were recorded at the 250 ml/fad., level (26.7 and 27.4). Additionally, this is consistent with the research of **Amin *et al.* (2013) and Zewail *et al.* (2020)**, who noted that there were significant variations in length of the root among the varieties of sugar beet, also the finding is align with **Osman (2011)**, who observed that applying a micronutrient solution at a rate of 3/4 l/fad resulted in increased the length of root. Consequently, every two-way interaction and experimental component was analyzed. In the 1st season, the soil stimulator had a notable impact at every level of variety × micronutrient solution. The highest root length values were observed with the Iquet soil stimulator

Table 1. The Chemical composition of the irrigation water during 2018/2019 and 2019/2020 seasons

pH	EC		Soluble ions (mq/l)							
	dS/m	ppm	Cations				Anions			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCo_3^{-}	Co_3^{--}	So_4^{--}
First season 2018/2019										
7.55	5.93	35.14	20.50	16.80	18.50	0.24	45.92	2.90	-	7.22
Second season 2019/2020										
7.60	6.00	35.27	21.00	17.00	18.80	0.25	46.75	2.97	-	7.28

Table 2. The physical and chemical characteristics of the experimental soil during the two seasons

Season	2018/2019	2019/2020
Particle size distribution (%)		
Coarse sand	58.0	59.5
Fine sand	19.8	19.3
Silt	12.9	13.0
Clay	9.3	9.2
Texture class	Loamy sand	Loamy sand
Organic matter	0.153	0.171
Bulk density (mg/m)	1662	1661
Chemical analysis in extraction soil		
a) Cations (mq/l)		
Ca^{++}	3.90	3.90
Mg^{++}	3.62	3.43
Na^{+}	2.54	2.59
K^{+}	0.34	0.32
b) Anions (mq/l)		
HCo_3^{-}	4.30	4.40
Cl^{-}	4.70	4.35
So_4^{--}	1.50	1.45
$CaCo_3$ (%)	22.43	22.48
EC (ds/m) (1:5)	0.08	1.02
pH (1:2.5)	8.10	8.13

Source: Central laboratory, Env. Agric. Sci. Faculty, Arish University.

Table 3. Monthly average weather statistics in El-Arish for the seasons 2018/2019 and 2019/ 2020

Month	Maximum temperature (C^o)	Minimum temperature (C^o)	Relative humidity (%)	Rainfall rate (mm)
		2018/2019		
November	23.5	18.3	80.8	37.5
December	17.4	11.2	75.2	34.5
January	17.8	12.5	66.5	39.5
February	18.3	13.4	68.2	41.2
March	21.2	15.2	67.8	35.6
April	25.6	18.7	71.2	27.8
May	32.0	21.4	73.2	10.3
		2019/2020		
November	26.6	17.0	81.2	35.6
December	21.6	12.5	77.6	38.2
January	14.8	9.3	68.3	41.5
February	15.4	9.8	71.2	44.6
March	19.1	12.6	70.2	40.2
April	24.9	15.4	70.5	33.5
May	31.5	17.2	72.5	9.6

Table 4. Influence of interactions between micronutrient solution levels and soil stimulators on root length (cm) of Farida and Marathon sugar beet varieties.

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019				2019/2020			
		Variety		M.S.L. Mean	S.S. Mean	Variety		M.S.L. Mean	S.S. Mean
		Farida	Marathon			Farida	Marathon		
Agrispon	250	25.6^{fg}	23.1^{g}	**24.4^{e}**		27.6^{d-g}	24.8^{g}	**26.2^{e}**	
	500	27.7^{d-f}	25.0^{fg}	**26.3^{de}**	**26.4^{c}**	30.0^{b-e}	26.6^{e-g}	**28.3^{de}**	**28.4^{c}**
	750	32.1^{a-c}	24.8^{fg}	**28.5^{bc}**		34.4^{a}	26.9^{e-g}	**30.7^{a-c}**	
	V. Mean	**28.5^{c}**	**24.3^{e}**			**30.6^{b}**	**26.1^{d}**		
Humic acid	250	28.8^{c-f}	25.7^{fg}	**27.2^{cd}**		30.0^{b-e}	24.6^{g}	**27.3^{de}**	
	500	30.8^{b-e}	26.6^{fg}	**28.7^{bc}**	**28.6^{b}**	32.7^{ab}	28.1^{c-g}	**30.4^{bc}**	**29.6^{b}**
	750	32.8^{ab}	26.8^{e-g}	**29.8^{b}**		33.6^{ab}	28.7^{c-f}	**31.1^{ab}**	
	V. Mean	**30.8^{b}**	**26.3^{d}**			**32.1^{ab}**	**27.1^{cd}**		
Iquet	250	31.5^{a-d}	25.8^{fg}	**28.7^{bc}**		31.1^{a-c}	26.3^{fg}	**28.7^{cd}**	
	500	32.6^{ab}	27.7^{d-f}	**30.1^{ab}**	**30.2^{a}**	33.5^{ab}	28.6^{c-f}	**31.0^{ab}**	**30.8^{a}**
	750	34.4^{a}	29.1^{b-f}	**31.7^{a}**		34.6^{a}	30.7^{b-d}	**32.6^{a}**	
	V. Mean	**32.8^{a}**	**27.5^{cd}**			**33.0^{a}**	**28.5^{c}**		
Varieties total mean		**30.7^{a}**	**26.1^{b}**			**31.9^{a}**	**27.2^{b}**		
Micro. S. total mean	**250** (ml/fad)		**26.7^{c}**				**27.4^{c}**		
	500 (ml/fad)		**28.4^{b}**				**29.9^{b}**		
	750 (ml/fad)		**30.0^{a}**				**31.5^{a}**		

Means of each factor designated by the same letter in a column are not significantly different at 0.05 level using Duncans Multiple Range Test (DMRT).

(30.2 and 30.8), followed by humic acid (28.6 and 29.6). Agrispone had the shortest root length. The results are in agreement with **Attaya (2017)** who noticed that the use of Iquet soil improver led to the highest root length.

However, in the 2nd season, the average root lengths for the 750 level of the micronutrient solution had a notable impact for every soil stimulator, with Farida variety. The average root lengths had a notable impact for the 500 level across soil stimulators with Marathon variety. The mixed interaction of variety × micronutrient solution × soil stimulator was statistically difference in both seasons. The combination of 750 ml/fad., of micronutrient solution rate with Iquet as a soil stimulator for the Farida resulted in the longest roots in both seasons (34.4 and 34.6 cm).

Root Diameter

Results obtained in Table 5 demonstrate that the diameter of root was substantially influenced in both growing seasons by the different varieties. In first season, the sugar beet variety had a substantial impact on diameter of root at every dose of micronutrient solution × soil stimulator, not unless spraying with 500 ml/fad., in association with Iquet as a soil stimulator. Similarly, in the 2nd season, the sugar beet variety had a notable impact on root diameter at every dose of micronutrient solution × soil stimulator, not unless spraying with 250 ml/fad, in combination with Humic acid. Additionally, Marathon sugar beet variety outperformed Farida variety, with the highest recorded root diameter of 24.1 and 25.1 cm. This discovery aligns with the results recorded by **Mubarak and Abd El Rahman (2020) as well as Nemeat Alla *et al.* (2023),** who noted that there were significant variations in the diameter of root between varieties, also the finding is align with **Attaya (2017)** who noticed that Marathon variety gave the greatest standards of diameter. The variations regarding this trait among the various varieties could be linked to their inherited traits. Regarding the impact of micronutrient solution levels on the diameter of root, the results indicated that spraying with 750 ml/fad., yielded the ultimate standards of diameter in both seasons (23.2 and 24.7), followed by 500 ml/fad., which recorded root diameters of (23.2 and 24.4). Conversely, the level of 250 ml/fad., in both seasons had the shortest standards of root diameter, measuring 21.7 and 22.4. This finding is in line with **Amin *et al.* (2013), Abdelaal *et al.* (2015) and Nemeat Alla *et al.* (2023)**, who found that spraying a mixture of micronutrients resulted in the highest root diameter compared to the control treatment. Also, the finding is in line with **Osman (2011)**, who observed that applying a micronutrient solution at the dose of 1/2 l/fad increased the root diameter.

Micronutrient solution levels had a notable impact on root diameter when applied with Farida variety using humic acid or Iquet, as well as when humic acid was applied with Marathon variety. Furthermore, in the second season, the micronutrient solution levels had a substantial variation when treated with Marathon variety using Agrispon or Iquet on root diameter. In relation to the impact of soil stimulators on this trait, the findings demonstrated that the Iquet application resulted in the highest root diameter measurements (23.7 and 24.6 cm), then came Humic that yielded measurements of (22.4 and 23.7 cm). Conversely, the lowest root diameter values were observed when Agrispone was applied during both seasons. This discovery aligned with **Al Sayed and Osman (2015)**, both of Aquita and Potassium humate compositions had a noteworthy and affirmative rise compared with control, and with that found by **Attaya (2017),** who mentioned that Iquit improver recorded highest root diameter.

Additionally, soil stimulator had a substantial impact with Farida variety at a micronutrient solution level of 500 ml/

Table 5. Influence of interactions between micronutrient solution levels and soil stimulators on root diameter (cm) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019				2019/2020			
		Variety		M.S.L. Mean	S.S. Mean	Variety		M.S.L. Mean	S.S. Mean
		Farida	Marathon			Farida	Marathon		
Agrispon	250	20.4^{e}	22.7^{a-e}	**21.5^{bc}**		20.4^{e}	23.8^{a-e}	**22.1^{cd}**	
	500	20.1^{e}	23.7^{a-d}	**21.9^{bc}**	**22.0^{b}**	21.7^{c-e}	25.7^{ab}	**23.7^{bc}**	**23.2^{c}**
	750	21.4^{c-e}	24.1^{a-d}	**22.7^{a-c}**		21.7^{c-e}	25.7^{ab}	**23.7^{bc}**	
	V. Mean	**20.6^{d}**	**23.5^{b}**			**21.3^{d}**	**25.1^{ab}**		
Humic acid	250	19.8^{e}	22.0^{b-e}	**20.9^{c}**		21.8^{c-e}	22.7^{b-e}	**22.2^{cd}**	
	500	21.8^{b-e}	25.0^{ab}	**23.4^{ab}**	**22.4^{b}**	23.0^{b-e}	25.6^{ab}	**24.3^{ab}**	**23.7^{b}**
	750	21.9^{b-e}	24.1^{a-d}	**23.0^{ab}**		23.8^{a-e}	25.3^{ab}	**24.6^{ab}**	
	V. Mean	**21.2^{cd}**	**23.7^{ab}**			**22.9^{c}**	**24.5^{b}**		
Iquet	250	20.9^{de}	24.7^{a-c}	**22.8^{ab}**		21.2^{de}	24.3^{a-d}	**22.8^{cd}**	
	500	24.1^{a-c}	24.7^{ab}	**24.4^{a}**	**23.7^{a}**	24.3^{a-d}	26.1^{ab}	**25.2^{a}**	**24.6^{a}**
	750	22.3^{b-e}	25.7^{a}	**24.0^{a}**		25.0^{a-c}	26.8^{a}	**25.9^{a}**	
	V. Mean	**22.4^{bc}**	**25.0^{a}**			**23.5^{c}**	**25.7^{a}**		
Varieties total mean		**21.4^{b}**	**24.1^{a}**			**22.5^{b}**	**25.1^{a}**		
Micro. S. total mean	**250** (ml/fad)	**21.7^{b}**				**22.4^{b}**			
	500 (ml/fad)	**23.2^{a}**				**24.4^{a}**			
	750 (ml/fad)	**23.2^{a}**				**24.7^{a}**			

fad., as well as on root diameter of the Marathon variety at a micronutrient solution level of 250 ml/fad. In the 1st season, the soil stimulator had a notable impact with Marathon at 750 ml/fad. In the 2nd season, the soil stimulator had a notable impact with Farida at a micronutrient solution level of 750 ml/fad.

The interaction between variety, micronu trient solution, and soil stimulator was only significant in the 1st season. Furthermore, the combination of 750 ml/fad., of micronutrient solution with Iquet for the Marathon resulted in the ultimate measurements in both seasons (25.7 and 26.8 cm respectively).

The Percentage of Sucrose

The percentage of sucrose is an important parameter that provides a brief indication of the expected sugar extractives. The results obtained in Table 6 demonstrate that sucrose percentage is substantially influenced among different varieties in both growing seasons. The application of 250 ml/fad., of micronutrient solution and Iquet as a soil stimulator had a variation impact on this trait. However, in the second season, the 500 ml/fad dose of micronutrient solution with Humic, 250 ml/fad., of micronutrient solution with Humic, and 750 ml/fad., of micronutrient solution with Iquet also had a notable impact on this trait.

Table 6. Influence of interactions between micronutrient solution levels and soil stimulators on sucrose (%) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019				2019/2020			
		Variety		M.S.L.	S.S.	Variety		M.S.L.	S.S.
		Farida	Marathon	Mean	Mean	Farida	Marathon	Mean	Mean
Agrispon	250	17.26^{c}	17.63^{bc}	**17.45^{e}**	**17.91^{b}**	17.90^{c}	18.03^{bc}	**17.96^{d}**	**18.39^{b}**
	500	18.06^{a-c}	18.36^{a-c}	**18.21^{cd}**		18.40^{a-c}	18.60^{a-c}	**18.50^{cd}**	
	750	18.10^{a-c}	18.03^{a-c}	**18.06^{de}**		18.60^{a-c}	18.83^{a-c}	**18.71^{c}**	
	V. Mean	**17.81^{c}**	**18.01^{bc}**			**18.30^{c}**	**18.48^{bc}**		
Humic acid	250	18.06^{a-c}	18.43^{a-c}	**18.25^{b-d}**	**18.71^{a}**	18.36^{a-c}	18.80^{a-c}	**18.58^{c}**	**19.06^{a}**
	500	18.83^{a}	18.96^{a}	**18.90^{a-c}**		19.13^{a}	20.00^{a}	**19.56^{ab}**	
	750	18.80^{ab}	19.16^{a}	**18.98^{ab}**		18.86^{ab}	19.20^{a}	**19.03^{bc}**	
	V. Mean	**18.56^{ab}**	**18.85^{a}**			**18.78^{b}**	**19.33^{a}**		
Iquet	250	18.20^{a-c}	18.80^{ab}	**18.50^{a-d}**	**18.83^{a}**	18.13^{a-c}	19.33^{ab}	**18.73^{c}**	**19.14^{a}**
	500	19.00^{a}	19.13^{a}	**19.06^{a}**		19.86^{a}	20.10^{a}	**19.98^{a}**	
	750	18.86^{a}	19.00^{a}	**18.93^{a-c}**		18.20^{a}	19.23^{a}	**18.71^{c}**	
	V. Mean	**18.68^{ab}**	**18.97^{a}**			**18.73^{b}**	**19.55^{a}**		
Varieties total mean		**18.35^{a}**	**18.61^{a}**			**18.60^{b}**	**19.12^{a}**		
Micro. S. total mean	**250** (ml/fad)	**18.06^{b}**				**18.42^{c}**			
	500 (ml/fad)	**18.72^{a}**				**19.35^{a}**			
	750 (ml/fad)	**18.66^{a}**				**18.82^{b}**			

Additionally, results indicated that Marathon variety had a higher sucrose percentage compared to the Farida variety, with values of 18.61% and 19.12% respectively. This discovery aligns of **Khalil *et al.* (2018) and Nemeat Alla *et al.* (2023)**, noted that there were substantial variations in this trait among sugar beet varieties, also the finding is aligned with **El-Hawary (2013)** as well as **Al-Sayed and Osman (2015)**, who noticed that the greatest measurements of sucrose percentage were resulted with Marathon variety.

Regarding the impact of various doses of micronutrient solution, the results demonstrated that the application of 500 ml/fad had the ultimate standards for this trait in both seasons (18.72% and 19.35%), followed by the application of 750 ml/fad., which recorded values of (18.66% and 18.82%). In contrast, 250 ml/fad., had the least sucrose percentage (18.06% and 18.42%). This finding is in consistent with the research of **Abdelaal *et al.* (2015), Ibrahim *et al.* (2020) and Nemeat Alla *et al.* (2023),** who found that spraying a mixture of micronutrients had the ultimate sucrose% compared to the control treatment. Also, the finding is in line with **Osman (2011)**, who reported that applying a micronutrient application at the dose of 1/2 l/fad., resulted in the highest sucrose percentage.

Therefore, the levels of micronutrient solution had a notable impact on most of varieties in combination with the soil stimulator, except in the case of Marathon when Iquet was applied. Furthermore, results demonstrated the impact of soil stimulators on sucrose percentage. The greatest proportion was noted using Iquet as a stimulator (18.83% and 19.14%), followed by Humic which resulted in values of 18.71% and 19.06%. Conversely, Agrispone gave the least sucrose percentage. This trait may be positively varied regarding the appropriate soil treatments, specifically in terms of soil moisture content. The improved soil condition allows for better absorption of available nutrients, which in turn promotes root growth. This ultimately affects the net assimilation rate, resulting in a higher sugar content in the root juice. The results are consistent with **Al-Sayed and Osman (2015),** mentioned that both of Aquita and Potassium humate compositions had a noteworthy and affirmative rise on sucrose percentage in contrast to the control and Aquita compound recorded the highest sucrose percentage, in line with **Attaya (2017)**.

However, in the first season, the soil stimulator had a notable impact for each dose of micronutrient solution and variety, while in the second season, soil stimulator did not significantly impact at the 250 ml/fad., level of micronutrient solution with Farida variety. Additionally, stimulator did not significantly impact at the 750 ml/fad., level with Marathon variety. The mixed combination of variety, micronutrient solution, and soil stimulator did not have significant impact on this trait in the first season. However, in the second one, the mixed combination had a notable impact. Furthermore, the combination of 500 ml/ fad., of micronutrient solution with Iquet stimulator for Marathon resulted in the ultimate percentage (19.61% as an average of both seasons), then came Marathon with the same level of micronutrient solution but with Humic acid stimulator, which produced a value of 19.48% as an average of both seasons.

The Percentage of TSS

Results represented in Table 7 indicate the total soluble solids percentage; it is substantially influenced by the different varieties examined in the first season. Sugar beet varieties had a significant effect on TSS when sprayed with 500 ml/fad., of micronutrient solution with Agrispon and when sprayed with 750 ml/fad., of micronutrient solution with Iquet. Additionally, the results showed that Marathon variety had a higher TSS percentage compared to Farida variety, with percentages of 19.77% and 20.10%. This finding aligns with **El-Hawary *et al.* (2013)** as well as **Mubarak and Abd El-Rahman (2020)**, who noticed significant variations among the varieties in terms of TSS (%).

The micronutrient solution levels also had a substantial impact on the TSS for most beet varieties and soil stimulators in both seasons. In the first season, the ultimate percentage of this trait was obtained with 750 ml/fad., (19.81%), while in the second season, the greatest % was found with 500 ml/fad. (20.22%). The least TSS was recorded with 250 ml/fad., in both seasons (19.38% and 19.59%). This is consistent with the research of **Zewail *et al.* (2020)**, applying a micronutrient solution resulted in the highest TSS percentage. The soil stimulators had varying effects on the total soluble solid's percentage, with Humic soil stimulator recording the highest percentages in the first season (19.90%) and Iquet soil stimulator recording the optimum percentages in the second one (20.02%). Agrispone had the least TSS. This discovery aligns with **Zaki *et al.* (2018)**, who mentioned notable variations among soil compounds in terms of TSS percentage.

The mixed combination of variety, micronutrient solution, and stimulator did not attain a notable impact on the TSS in the 1st season, but it did have in the 2nd one. Furthermore, the combination of 500 ml/ fad., of micronutrient solution level with Iquet stimulator with Marathon resulted in the optimum total soluble solids (20.42% as a mean of both seasons), then Marathon

Table 7. Influence of combinations among micronutrient solution levels and stimulators on total soluble solids percentage (%) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019 Variety Farida	2018/2019 Variety Marathon	2018/2019 M.S.L. Mean	2018/2019 S.S. Mean	2019/2020 Variety Farida	2019/2020 Variety Marathon	2019/2020 M.S.L. Mean	2019/2020 S.S. Mean
Agrispon	250	18.54^{c}	19.11^{bc}	**18.82^{d}**		19.22^{de}	19.16^{de}	**19.19^{c}**	
	500	19.24^{bc}	19.53^{ab}	**19.39^{c}**	**19.18^{b}**	19.50^{b-e}	19.67^{a-e}	**19.59^{bc}**	**19.53^{b}**
	750	19.34^{bc}	19.34^{bc}	**19.34^{c}**		19.68^{a-e}	19.94^{a-e}	**19.81^{b}**	
	V. Mean	**19.04^{b}**	**19.33^{b}**			**19.47^{b}**	**19.59^{b}**		
Humic acid	250	19.51^{ab}	19.77^{ab}	**19.64^{bc}**		19.41^{c-e}	20.20^{a-d}	**19.80^{b}**	
	500	19.97^{ab}	19.67^{ab}	**19.82^{b}**	**19.90^{a}**	20.07^{a-e}	20.68^{a}	**20.37^{a}**	**19.99^{a}**
	750	20.08^{ab}	20.39^{a}	**20.23^{a}**		19.64^{b-e}	19.97^{a-e}	**19.80^{b}**	
	V. Mean	**19.85^{a}**	**19.94^{a}**			**19.70^{b}**	**20.28^{a}**		
Iquet	250	19.33^{bc}	20.05^{ab}	**19.69^{bc}**		19.10^{e}	20.44^{a-c}	**19.77^{b}**	
	500	19.77^{ab}	20.04^{ab}	**19.90^{a}**	**19.81^{a}**	20.64^{a-b}	20.80^{a}	**20.72^{a}**	**20.02^{a}**
	750	19.61^{ab}	20.07^{ab}	**19.84^{b}**		19.08^{e}	20.05^{a-e}	**19.57^{bc}**	
	V. Mean	**19.57^{b}**	**20.05^{a}**			**19.61^{b}**	**20.43^{a}**		
Varieties total mean		**19.49^{a}**	**19.77^{a}**			**19.59^{b}**	**20.10^{a}**		
Micro. S. total mean	**250** (ml/fad)	**19.38^{b}**				**19.59^{b}**			
	500 (ml/fad)	**19.70^{ab}**				**20.22^{a}**			
	750 (ml/fad)	**19.81^{a}**				**19.73^{b}**			

with 750 ml/fad. of micronutrient solution level with Humic acid as a soil stimulator, which gave a mean of 20.18% for both seasons.

Juice Purity Percentage

Results presented in Table 8 indicate that the purity percentage is substantially influenced *via* different varieties in the first season. When sugar beet varieties were sprayed with 500 ml/fad., of micronutrient solution with Agrispon, and when sprayed with 750 ml/fad., of micronutrient solution with Iquet, there was a significant effect on purity. However, the sugar beet varieties did not cause any significant differences in purity percentage. In the first season, Farida had a higher purity percentage (92.35%) compared to Marathon variety. However, in the 2nd one, Marathon had a greater purity (93.28%) compared to Farida variety. Overall, Marathon variety had a higher purity percentage than Farida variety when considering both seasons. This finding aligns with **El-Sayed and Osman (2015) and Attaya (2017)**, who noticed Farida variety attain the optimum purity percentage.

The impact of micronutrient solution levels on purity, showed that using 500 ml/fad., recorded the optimum purity values (93.16% and 93.89%). Using 750 ml/fad., recorded the second highest purity values (92.36% and 93.51%). On other hand, using 250 ml/fad., resulted in the lowest purity values (91.42% and 92.23%). Moreover, this agreed with **Ibrahim *et al.* (2020)**, who noticed treating sugar beet with micronutrient spray attained the greatest purity. Also, the finding is in line with **Osman (2011)**, who reported that applying a micronutrient solution at a rate of 1/2 l/fed., found to be the best treatment for purity trait.

Table 8. Influence of interactions between micronutrient solution levels and stimulators on purity (%) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019 Variety Farida	2018/2019 Variety Marathon	2018/2019 M.S.L. Mean	2018/2019 S.S. Mean	2019/2020 Variety Farida	2019/2020 Variety Marathon	2019/2020 M.S.L. Mean	2019/2020 S.S. Mean
Agrispon	250	91.46^{cd}	90.59^{d}	**91.02^{d}**		91.34^{b}	92.32^{ab}	**91.83^{d}**	
	500	92.11^{a-d}	92.22^{a-d}	**92.16^{c}**	**91.60^{c}**	92.54^{ab}	92.44^{ab}	**92.49^{cd}**	**92.31^{b}**
	750	91.78^{b-d}	91.46^{cd}	**91.62^{cd}**		92.66^{ab}	92.55^{ab}	**92.60^{c}**	
	V. Mean	**91.78^{bc}**	**91.42^{c}**			**92.18^{c}**	**92.44^{bc}**		
Humic acid	250	90.79^{d}	91.46^{cd}	**91.12^{d}**		92.76^{ab}	91.24^{b}	**92.00^{cd}**	
	500	92.43^{a-d}	94.51^{a}	**93.47^{ab}**	**92.18^{b}**	93.42^{ab}	95.16^{a}	**94.29^{ab}**	**93.49^{a}**
	750	91.78^{b-d}	92.11^{a-d}	**91.94^{cd}**		94.18^{ab}	94.18^{ab}	**94.18^{ab}**	
	V. Mean	**91.67^{c}**	**92.69^{ab}**			**93.45^{ab}**	**93.52^{a}**		
Iquet	250	92.33^{a-d}	91.89^{b-d}	**92.11^{c}**		93.09^{ab}	92.65^{ab}	**92.87^{c}**	
	500	94.18^{ab}	93.53^{a-c}	**93.85^{a}**	**93.16^{a}**	94.75^{a}	95.05^{a}	**94.89^{a}**	**93.83^{a}**
	750	94.29^{ab}	92.76^{a-d}	**93.52^{ab}**		93.53^{ab}	93.96^{ab}	**93.75^{b}**	
	V. Mean	**93.60^{a}**	**92.73^{ab}**			**93.78^{a}**	**93.89^{a}**		
Varieties total mean		**92.35^{a}**	**92.28^{a}**			**93.14^{a}**	**93.28^{a}**		
Micro. S. total mean	**250** (ml/fad)		**91.42^{b}**				**92.23^{b}**		
	500 (ml/fad)		**93.16^{a}**				**93.89^{a}**		
	750 (ml/fad)		**92.36^{ab}**				**93.51^{a}**		

Micronutrient solution level had a notable impact on the purity with sugar beet varieties × stimulator combinations, except when Agrispon was applied with Farida variety. In the second season, the micronutrient solution level did not have a positive impact in terms with Agrispon and Marathon variety. Regarding the influence of stimulators on this trait, the results reveled the optimum percent that achieved with the Iquet stimulator (93.16% and 93.83%), followed by Humic (92.18% and 93.49%). Agrispone produced the lowest purity values during both seasons. The discovery aligns with **Al-Sayed and Osman (2015)**, who mentioned that both of Aquita and Potassium humate compositions had a noteworthy and affirmative rise compared with control with purity percentage and Aquita compound recorded highest purity percentage, in line with **Attaya (2017)**.

In the first season, the stimulator had a notable impact on purity at the interaction of variety × micronutrient solution. In the second one, the stimulator had a notable impact for variety × micronutrient solution, not unless spraying with 250 ml/fad., of micronutrient solution on Marathon variety. The combination of variety × micronutrient solution × stimulator did not have a substantial variation in the first season. However, in 2nd one, the three-way interaction had a notable impact on purity percentage. Furthermore, using 500 ml/fad., of micronutrient solution level in terms with Humic acid for Marathon resulted in the greatest values in both seasons (94.51% and 95.16%).

Root Yield (ton/fad.)

Results shown in Table 9 indicating root yield which statistically influenced by the different varieties. In the first season, the differences in root yield showed a significant effect at most levels of micronutrient solution × soil stimulator, except when spraying with 500 ml/fad., in combination with Agrispon, spraying with 250 ml/fad., in combination with Agrispon, and spraying with 750 ml/fad., in combination with Agrispon. Similarly, in the 2nd one, the differences in root yield had a notable impact at most levels of micronutrient solution × soil stimulator, except when spraying with 250 ml/fad in combination with Agrispon and when spraying with 750 ml/fad., in combination with Agrispon. However, Marathon variety outperformed Farida, with the highest recorded root yields of (25.88 and 27.48 ton/fad). This finding aligns of **El-Hawary *et al.* (2013), Al-Sayed and Attaya (2015) and Nemeat Alla *et al.* (2023),** noticed that there were significant variations in varietal root yield.

Effect of micronutrient solution levels on root yield, the results clearly showed that the level of 750 ml/fad., produced the greatest yield productivity (26.37 and 27.75 ton/ fad.), then came the level of 500 ml/fad., which recorded 25.51 and 27.14 ton/fad., In contrast, the least productivity was observed with 250 ml/fad., in both seasons. This is consistent with various researches of **Dewdar *et al.* (2018), Ibrahim *et al.* (2020) and Nemeat Alla *et al.* (2023),** who observed applying a mixture of micronutrient solution significantly increased the root yield compared to the control treatment.

The findings of the study on the impact of soil stimulators on root yield showed that Iquet created the highest root output, generating 27.35 and 28.57 ton/fad. Humic acid produced 25.72 and 27.82 ton/fad. Conversely, Agrispone produced the lowest figures in both seasons. Obtained results are agreed with those of **Zarishnyak and Sypko (2010) and Ambihai and Gnanavelrajah (2013)**, who noted that adding charred biomass and press mud as a soil improver had the ability to boost the root production by improving soil attributes.

Stimulator substantially influenced on root productivity at every stage of variety × micronutrient solution. The combination of variety×micronutrient solution × stimulator also had a notable impact on root productivity in both seasons. Furthermore, the use of 750 ml/fad., of micronutrient solution in association with Humic acid stimulator with Marathon which resulted in the greatest root productivity (28.84 and 31.10 ton/fad., respectively).

Sugar Yield (ton/fad.)

Results represented in Table 10 indicate that varieties had a notable effect on most levels of micronutrient solution × soil stimulator in the 1st season, except when spraying with 500 ml/fad., in combination with Agrispon. However, the varieties did not have a notable impact when spraying with 250 ml/fad., in combination with Agrispon and when spraying with 750 ml/ fad., in combination with Agrispon. Therefore, the results demonstrated that Marathon sugar beet variety outperformed Farida variety in terms of sugar yields, with recorded values of 4.93 and 5.38 ton/fad. This finding aligns of **El-Hawary *et al.* (2013), LiangMin *et al.* (2014) and Khalil *et al.* (2018),** who noticed that the sugar productivity of different sugar beet cultivars varied greatly.

The levels of micronutrient solution had a notable impact on this trait for each stage of variety × stimulator. The results clearly showed that the level of 750 ml/fad resulted in the highest productivity (5.03 ton/fad), while in 2nd season, the level of 500 ml/fad attained the greatest productivity (5.38 ton/ fad). Conversely, the level of 250 ml/fad produced the lowest sugar yield values in both seasons. This is consistent with the research of **Abdelaal *et al.* (2015), Dewdar *et al.* (2018) and Ibrahim *et al.* (2020),** who represented that applying a mixture of micronutrient solution significantly increased the sugar yield compared to the control treatment.

Table 9. Influence of interactions between micronutrient solution levels and stimulators on root productivity (ton/fad.) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019				2019/2020			
		Variety		M.S.L. Mean	S.S. Mean	Variety		M.S.L. Mean	S.S. Mean
		Farida	Marathon			Farida	Marathon		
Agrispon	250	21.50^{jk}	20.99^{k}	**21.25^{f}**		21.71^{k}	21.76^{k}	**21.74^{e}**	
	500	22.77^{h-j}	22.66^{ij}	**22.71^{e}**	**22.67^{c}**	24.04^{j}	25.08^{i}	**24.56^{d}**	**23.73^{c}**
	750	23.96^{f-h}	24.14^{fg}	**24.05^{d}**		24.74^{ij}	25.07^{i}	**24.91^{d}**	
	V. Mean	**22.75^{d}**	**22.60^{d}**			**23.50^{d}**	**23.97^{d}**		
Humic acid	250	23.04^{g-i}	25.00^{ef}	**24.02^{d}**		25.64^{hi}	27.20^{fg}	**26.42^{c}**	
	500	25.76^{de}	26.73^{cd}	**26.24^{c}**	**25.72^{b}**	27.04^{fg}	28.92^{b-d}	**27.98^{b}**	**27.82^{b}**
	750	24.96^{ef}	28.84^{a}	**26.90^{bc}**		27.04^{fg}	31.10^{a}	**29.07^{a}**	
	V. Mean	**24.58^{c}**	**26.85^{b}**			**26.57^{c}**	**29.07^{a}**		
Iquet	250	24.94^{ef}	27.66^{a-c}	**26.30^{c}**		26.57^{gh}	28.49^{de}	**27.53^{b}**	
	500	27.05^{b-d}	28.12^{ab}	**27.58^{ab}**	**27.35^{a}**	27.85^{ef}	29.94^{b}	**28.89^{a}**	**28.57^{a}**
	750	27.52^{bc}	28.83^{a}	**28.17^{a}**		28.85^{cd}	29.73^{bc}	**29.29^{a}**	
	V. Mean	**26.50^{b}**	**28.20^{a}**			**27.75^{b}**	**29.38^{a}**		
Varieties total mean		**24.61^{b}**	**25.88^{a}**			**25.94^{b}**	**27.48^{a}**		
Micro. S. total mean	**250** (ml/fad)	**23.85^{c}**				**25.23^{c}**			
	500 (ml/fad)	**25.51^{b}**				**27.14^{b}**			
	750 (ml/fad)	**26.37^{a}**				**27.75^{a}**			

Table 10. Influence of reaction among micronutrient solution levels and stimulators on sugar yield (ton/fad.) of Farida and Marathon sugar beet varieties

Soil stimulator	Micronutrient solution level (ml/fad.)	2018/2019				2019/2020			
		Variety		M.S.L. Mean	S.S. Mean	Variety		M.S.L. Mean	S.S. Mean
		Farida	Marathon			Farida	Marathon		
Agrispon	250	3.80^{ij}	3.78^{j}	**3.79^{e}**		3.97^{h}	4.01^{h}	**3.99^{f}**	
	500	4.20^{hi}	4.25^{gh}	**4.22^{d}**	**4.15^{c}**	4.52^{g}	4.76^{fg}	**4.64^{e}**	**4.46^{c}**
	750	4.43^{f-h}	4.45^{f-h}	**4.44^{d}**		4.70^{fg}	4.82^{fg}	**4.76^{e}**	
	V. Mean	**4.14^{e}**	**4.16^{e}**			**4.39^{d}**	**4.53^{d}**		
Humic acid	250	4.25^{gh}	4.70^{ef}	**4.48^{d}**		4.81^{fg}	5.22^{de}	**5.01^{d}**	
	500	4.95^{c-e}	5.17^{b-d}	**5.06^{c}**	**4.92^{b}**	5.28^{d}	5.92^{ab}	**5.60^{b}**	**5.42^{b}**
	750	4.79^{d-f}	5.64^{a}	**5.21^{bc}**		5.21^{de}	6.09^{a}	**5.65^{b}**	
	V. Mean	**4.66^{d}**	**5.17^{b}**			**5.10^{c}**	**5.74^{a}**		
Iquet	250	4.63^{e-g}	5.31^{a-c}	**4.97^{c}**		4.92^{ef}	5.62^{bc}	**5.27^{c}**	
	500	5.24^{a-c}	5.49^{ab}	**5.37^{ab}**	**5.26^{a}**	5.67^{bc}	6.16^{a}	**5.91^{a}**	**5.59^{a}**
	750	5.30^{a-c}	5.59^{a}	**5.44^{a}**		5.36^{cd}	5.83^{ab}	**5.60^{b}**	
	V. Mean	**5.06^{c}**	**5.46^{a}**			**5.32^{b}**	**5.87^{a}**		
Varieties total mean		**4.62^{b}**	**4.93^{a}**			**4.94^{b}**	**5.38^{a}**		
Micro. S. total mean	**250** (ml/fad)	**4.41^{b}**				**4.76^{b}**			
	500 (ml/fad)	**4.88^{a}**				**5.38^{a}**			
	750 (ml/fad)	**5.03^{a}**				**5.33^{a}**			

Regarding the influence of stimulators on sugar productivity, the results indicated that Iquet soil stimulator resulted in the ultimate yield (5.26 and 5.59 ton/fad.), followed by Humic acid with values of (4.92 and 5.42 ton/fad.). The findings are in line with **Zarishnyak and Sypko (2010)**, they stated that by enhancing the qualities of the soil, a mix of press mud and burned biomass may raise the sugar output. On other hand, Agrispone yielded the lowest sugar yield values. The stimulator had a notable impact on this trait for each stage of variety × micronutrient solution. The mixed combination of variety × micronutrient solution × stimulator had a substantial impact on sugar productivity in both seasons. Additionally, using 750 ml/fad of micronutrient solution with Humic acid stimulator on Marathon resulted in ultimate productivity in the 1st season (5.64 ton/fad), while in the 2nd season, using 500 ml/fad of micronutrient solution with Iquet stimulator on Marathon resulted in the greatest production (6.16 ton/fad.).

Conclusion

Based on the findings, it is evident that Marathon sugar beet variety, when treated with 750 ml/fad., of micronutrient solution as a foliar spray and combined with Humic acid as a soil stimulator, can be suggested for enhancing sugar beet productivity. Similarly, the use of Marathon sugar beet variety with 500 ml/fad., of micronutrient solution as foliar spray, along with Iquet as a soil stimulator, can be recommended for improving juice quality in El-Arish region of North Sinai, Egypt.

REFERENCES

Abdelaal, Kh. A.A. (2015). Pivotal role of bio and mineral fertilizer combinations on morphological, anatomical and yield characters of sugar beet plant (*Beta vulgaris* L.). Middle East J. Agric. 4 (4): 717-734.

Abdelaal, Kh.A.A.; Badawy, S.A., and Neana, S.M. (2015). Effect of foliar application of microelements and potassium levels on growth, physiological and quality characters of sugar beet (*Beta vulgaris* L.) under newly reclaimed soils. J. Plant Production, Mansoura Univ., 6 (1):123-133.

Agamy, R.; Hashem, M. and Alamry, S. (2013). Effect of soil amendment with yeasts as bio-fertilizers on the growth and productivity of sugar beet. Afr. J. Agric. Res., 8 (1): 46-56.

Al-Sayed, H.M. and Osman, A.M. (2015). Yield and quality of two sugar beet varieties as affected by water regimes and soil treatments. Zagazig J. Agric. Res., 42 (5):927-938.

Al-Sayed, H.M. and Attaya A.S. (2015). Effect of seed treatment and weed control methods on yield and quality of some sugar beet varieties. Zagazig J. Agric. Res., 42 (5):939-951.

Ambihai, S. and Gnanavelrajah, N. (2013). Improving soil productivity through charred biomass amendment to soil. Ame-Euras. J. Agric. and Environ. Sci., 13(10):1345-1350.

Amin, G.A.; Badr, E.A. and Afifi, M.H.M. (2013). Root yield and quality of sugar beet (*Beta vulgaris* L.) in response to bio fertilizer and foliar application with micronutrients. World Appl. Sci. J., 27 (11): 1385-1389.

AOAC (1990). Official Methods of Analysis. Association of Official Agricultural Chemists, 15th Ed. Washington, DC, U.S.A.

Artyszak, A.; Kondracka, M.; Gozdowski, D.; Siuda, A. and Litwinczuk-Bis, M. (2021). Impact of foliar application of various forms of silicon on the chemical composition of sugar beet plants. Sugar Tech., 23 (3):546-559.

Attaya, A.S. (2017). Influence of drip irrigation rates and soil improvers on the performance of some sugar beet varieties in North Sinai. Zagazig. J. Agric. Res., 44 (2): 419-435.

Carruthers, A. and Old Field, J.F.T. (1961). Methods for the assessment of sugar beet quality. Int. Sug., 63 (1):103-105.

Dewdar, M.D.H., Abbas, M.S., El-Hassanin, A.S. and Abd El-Aleem, H.A. (2018). Effect of nano micronutrients and nitrogen foliar application on sugar beet (*Beta vulgaris* L.) of quantity and quality traits in marginal soils in Egypt. Int. J. Curr. Microbiol. App. Sci. 7(8):4490-4498.

Duncan, D.B. (1955). Multiple Range and Multiple F tests. Biomet., 11: 1-42.

El-Hawary, M.A., E.M. Soliman, I.M. Abdel-Aziz, M. El-Shereif and S.A. Mohamed (2013). Effect of irrigation water quantity, sources and rates of nitrogen on growth, yield and quality of sugar beet. Res. J. Agric. and Biol. Sci., 9 (1): 58-69.

FAS USDA (2023). Sugar: World Markets and Trade. Foreign Agricultural Service/ United States Department of Agriculture. Office of Global Analysis.

https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Sugar%20Annual_Cairo_Egypt_EG2023-0006.pdf

Gomaa, M.A., Kandil, E.E. and Yousif, H.Y.I. (2019). Sugar beet yield and quality as affected by growth regulators, mineral and bio-fertilization in Nubaria Region. Alex. Sci. Exch. J., 40 (3): 419-426.

Hussein, M.Y. (2011). Using some microelements and fungicide in controlling root rot disease of sugar beet. Egypt. J. Appl. Sci., 26 (2): 20-28.

Ibrahim, M.E.M.; Faiyad, R.M.N. and Gamal, I.S.H. (2020). Impact of foliar spraying of some potassium sources and boron levels on sugar beet quantity and quality. J. Soil Sci. and Agric. Engin., Mansoura Univ., 11(12):835-844.

Khalil, M.R.; Abd El-Razek, A.M.; Abdalla, M.Y. and Mubarak, M.H. (2018). Quality of some sugar beet varieties under different environmental conditions. Sinai J. Appl. Sci., 7 (1):17-34.

LiangMin, W.; Ming, G.; QingDe, J.; GuiRong, S.; ChunXin, L. and AnJiang, G. (2014). Adaptability analysis of new sugar beet varieties in Xinjiang of China. Sugar Crops of China, (2):30-32.

Mubarak, M.H and Abd El Rahman D.M. (2020). Effect of capillin foliar spray on productivity and quality of sugar beet varieties. Scient. J. Agric. Sci., 2 (1): 15-25.

Nemeat Alla, H.E.A.; Helmy, S.A.M. and Bassiony, N.A.M. (2023). Response of some sugar beet varieties to nitrogen and zinc application in sandy soil. Env. Biodiv. Soil Security, 7:205-217.

Osman, A.M.H. (2011). Influence of foliar spray of some micronutrient and nitrogen fertilizer on productivity of sugar beet under new reclaimed soils. J. Plant Production, Mansoura Univ., 2 (9): 1113-1122.

Pacuta, V., Cerny I. and Pulkrabek J. (2013). Influence of variety and foliar preparations containing bioactive substances on root yield, sugar content and polarized sugar yield of sugar beet. Listy Cukrovarnicke a Reparske, 129 (11): 337-340.

SAS (2004). SAS/STAT User's. Guide. SAS, *Institute Inc.*, Cary, N.C.

Steel, R.G.D.; Torrie J.H. and Dicky D.A. (1997). Principles and Procedures of Statistics, A Biological Approach. 3rd

Ed. MacGraw Hill Book Co. New-Yourk, 172 – 177.

Zaki, M.S.; El-Sarag E.I.; Maamoun H. A. and Mubarak, M.H. (2018). Agronomic performance sugar beet (*Beta vulgaris* L.) in Egypt using inorganic, organic and biofertilizers. Egypt. J. Agron., 40: (1): 89- 103.

Zarishnyak, A.S. and Sypko A.A. (2010). Chemical improvement of soil and sugar beet productivity. Sakharnaya Svekla., (1):21-24.

Zewail, R.M.Y.; El-Gmal, I.S.; Khaitov, B. and El-Desouky, H.S.A. (2020). Micronutrients through foliar application enhance growth, yield and quality of sugar beet (*Beta vulgaris* L.). J. Plant Nutr., 43 (15): 2275-2285.

الملخص العربي

تأثير محسنات التربة والرش الورقي بمحلول بعض العناصر الصغرى على أداء صنفين من بنجر السكر بمنطقة العريش

أحمد سعد عطايا

قسم الإنتاج النباتي - كلية العلوم الزراعية البيئية - جامعة العريش – شمال سيناء - مصر

الهدف من هذه الدراسة هو دراسة تأثير الرش الورقي بمحلول بعض العناصر الصغرى ومحسنات التربة على نمو الجذور والمحصول والجودة لصنفين من بنجر السكر خلال موسمين شتويين متتاليين (٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩) تحت ظروف محافظة شمال سيناء، مصر. تم استخدام تصميم القطع المنشقة مرتين. وأظهرت نتائج الدراسة أن لمحسنات التربة تأثير معنوي على صفات قطر الجذور والسكروز والمواد الصلبة الذائبة وإنتاجية الجذور والسكر في كلا الموسمين، وعلى طول الجذور ونسبة النقاوة في الموسم الأول فقط. وكان مركب الاكويت من أكثر محسنات التربة فعالية حيث حقق أعلى القيم لجميع الصفات المدروسة في كلا الموسمين. بالإضافة إلى ذلك، كان للرش الورقي بمحلول العناصر الصغرى تأثيراً كبيراً على طول الجذر، قطر الجذر، السكروز، المواد الصلبة الذائبة، محصول الجذر والسكر في كلا موسمي النمو، وعلى نسبة النقاوة في الموسم الأول فقط. حيث أدى الرش بـ ٧٥٠ مل/فدان إلى الحصول على أعلى قيم لطول الجذر وقطر الجذر وحاصل الجذر في كلا الموسمين، بالإضافة إلى المواد الصلبة الذائبة والسكر في الموسم الأول. من ناحية أخرى، أدى الرش بـ ٥٠٠ مل/ فدان إلى أعلى قيم السكروز والنقاوة في كلا الموسمين، و المواد الصلبة الذائبة وإنتاجية السكر في الموسم الثاني. كما اظهرت نتائج الدراسة اختلاف صنفي البنجر اختلافاً معنوياً في صفات طول الجذور، قطر الجذور، نسبة السكروز، محصول الجذور والسكر في كلا الموسمين، وكذلك نسبة المواد الصلبة الذائبة والنقاوة في الموسم الأول فقط. تفوق صنف ماراثون على صنف فريدة، حيث أظهر أعلى قيم لقطر الجذر، ونسبة السكروز، ونسبة المواد الصلبة الذائبة، ونسبة النقاوة، وإنتاجية الجذر والسكر للفدان. ومع ذلك، كان للصنف فريدة اعلى طول للجذر. كان للتفاعل بين الصنف ومحلول العناصر الصغرى ومحسن التربة تأثير ذو دلالة إحصائية في طول الجذور وإنتاجية الجذور والسكر في كلا الموسمين وقطر الجذور في الموسم الأول ونسب السكروز والمواد الصلبة الذائبة والنقاوة في الموسم الثاني. وكانت أفضل توليفة هو الرش بـ ٧٥٠ مل/فدان من محلول العناصر الصغرى مع حمض الهيوميك كمحسن للتربة للصنف ماراثون. وأعطت هذه التوليفة أعلى قيم لإنتاج الجذور (٢٨,٨٤ و٣١,١٠ طن/فدن، على التوالي، في كلا الموسمين) وأعلى إنتاجية سكر (٥,٦٤ طن/فدان في الموسم الأول). ومع ذلك، فإن التفاعل بين ٥٠٠ مل/فدان رش ورقي مع إكويت للصنف ماراثون أدى إلى الحصول على أعلى نسبة سكروز (١٩,٦١% كمتوسط لكلا الموسمين)، وأعلى نسبة مواد صلبة ذائبة (٢٠,٤٢% كمتوسط لكلا الموسمين)، وأعلى نسبة للسكروز (٢٠,٤٢% كمتوسط لكلا الموسمين). وأعلى إنتاجية للسكر (٦,١٦ طن/فدان في الموسم الثاني). وتوصي الدراسة باستخدام الرش الورقي بمعدل ٧٥٠ مل/فدان بمحلول العناصر الصغرى مع استخدام حامض الهيوميك كمحسن للتربة للصنف ماراثون للحصول على اعلى إنتاجية لمحصول الجذور كما توصي باستخدام الرش الورقي بمعدل ٥٠٠ مل/ فدان بمحلول العناصر الصغرى مع استخدام الاكويت كمحسن للتربة مع نفس الصنف ماراثون للحصول على اعلى صفات للجودة ومحصول السكر.

الكلمات الإسترشادية: بنجر السكر، الاصناف، محسنات التربة، الرش الورقي، العناصر الصغرى.

REVIEWERS:
Dr. Ahmed Ali El-Hossary | ahmed.alhossary@fag.bu.edu.eg
Dept. Agrono., Fac. Agric., Benha Univ, Egypt.
Dr. Mohammed Saad Maghazi | abdelaty2009@yahoo.com
Dept. Crops, Wheat Breeding, Fac. Agric., Kafr Univ., Egypt.