Response of Table Beet to Different Organic Fertilization Regimes

Samir K. El-Seifi; Rewaa S. El-Shatoury; Khalid E. Abd El-Hamed; Ibrahim N. Nasef* and Ali M. Ayyad
Department of Horticulture, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt

Received: *27/7/2025*

Abstract: This research was carried out in a private organic farm in 10th of Ramadan Association, Ismailia Governorate, and Laboratory of the Horticulture Department, Faculty of Agriculture, Suez Canal University during two successive seasons of 2019-2020 and 2020-2021, to investigate the effects of organic farming systems on the growth, yield and the biochemical attributes, such as sugars, phenolic and betalains, macro-elements content of leaves and roots (N, P and K) and micro-elements content of roots (iron, copper, zinc, manganese) of table beet plants (*Beta vulgaris* L.) "cv. Detroit dark red". The experiment included four treatments, which were 100 % of the recommended fertilization dose (RFD) in the form of organic manure (poultry manure), 75 % RFD as organic manure (poultry manure) + 25% NPK, 50 % of the fertilization recommended dose as organic manure (poultry manure) + 50% NPK)and 100 % of the fertilization recommended dose in the form of chemical fertilizers organic manure (100% NPK) . The results showed that 75% organic farming system gave the highest values of the vegetative growth attributes, roots yield, sugars, betalains, phosphorus, potassium and micro-elements, under sandy soil conditions.
Keywords: Beta vulgaris L., poultry manure, betalains, phenolic, sugars.

INTRODUCTION

Table beet (*Beta vulgaris* L.) is a member of the Chenopodiaceae family, which includes spinach and chard. Also, it is called beetroot or garden beet. It is grown in Egypt, but in a small scale . It produces a swollen root used in the salad. It is a rich source of carbohydrates, vitamin C, phosphorus and calcium (Deuter and Grundy, 2004), and contains a high iron content (Petek et al. 2019), hence it is an ideal vegetable for the health of people. Red color of roots is attributed to betanine pigment. It has several medicinal properties and benefits in decreasing cardiovascular diseases and peripheral vascular diseases. Due to its nutritional composition, beet root consumption improves human health, helps in preventing various malignancies, and regulates blood pressure, triglycerides and cholesterol. Today, in modern agriculture, the challenge is the production of agricultural products with high quality, especially nutritional, not just high yield. Production of vegetables is based on huge investments, including fertilizers for achieving high yield and quality. The balance between all nutrients can reduces the environmental damage risks, improves the plant growth and provides enough minerals for human nutrition . This can be achieved by good agricultural practices such as optimal fertilization. Agriculture is an important economic sector, must carry out its activity with minimal impact on the environment, this can be achieved by sustainable agricultural production using an appropriate strategy for fertilizers, pesticides and irrigation systems. In vegetable production, the commercial yield and nutritional quality are affected by the application of NPK fertilizers. However, the mineral content in plants is affected by plant cultivar, soil conditions, fertilizers, and weather during the growth season (Lampkin, 1990). Organic farming is an ecological production management system that promotes biological cycles, biodiversity, and soil biological activity, minimizes the use of external inputs and uses cultural practices that maintain ecological harmony. Also, farming is not non-chemical agriculture, but it is also a system integrating relationships between plants, soil, water, micro flora and fauna of the soil. Likewise, organic farming aims to create a healthy soil without pollution (Lampkin, 1990). Indirectly, organic farming improves soil physical properties such as aggregation, aeration and water holding capacity. Organic farming replaces the synthetic chemical fertilizers with animal manures, cover crops and other biological sources. These tend to release nutrients relatively slowly compared to synthetic fertilizers and steady nutrient release, hence impacting plant physiology, including plant defense (Krey *et al.* 2020). Organic farmers rely mainly on crop rotation, animal and/or green manures, crop residues, and composts, since synthetic fertilizers are excluded. Insects, weeds and other pests are managed by appropriate cultural practices, mechanical cultivation and biological control. According to all reasons mentioned above, this study was done to test the hypothesis whether the organic fertilization will affect the vegetative growth, yield, biochemical compounds, and mineral content of table beet plants under the conditions of Ismailia Governorate or not.

MATERIALS AND METHODS

Two field experiments were carried out at the 10th of Ramadan association, Ismailia Governorate, Egypt, during the two successive winter seasons of 2019-2020 and 2020 - 2021 (from October 29, 2019, to January 30, 2020, and repeated in 2020-2021). The experiments were designed to investigate the effects of organic fertilization, on plant growth, yield and chemical constituents of table beet (*Beta vulgaris* L.) "cv. Detroit dark red".

3.1. Experimental Soil Analysis:

Samples were randomly collected from the experimental soil at 0.0 to 50.0 cm depth, before plantation to determine the physical and chemical properties in accordance with the methods of Black (1965) and Jackson (1973), respectively. Data of soil analysis are presented in Table (1).

3.2. Field experiment:

The soil was cleared, ploughed and harrowed. Then, organic manure and superphosphate (15.5% P_2O_5) were added at 20 m^3/feddan and 150 kg/feddan, respectively.

*Corresponding author e-mail: innasef@hotmail.com

Drip irrigation system was used. The treatments were as following:

1- 100% RFD as organic fertilizers (poultry manure) (100%O)
2- 75 % RFD as organic fertilizers (poultry manure) + 25% NPK 19-19-19 (75%O)
3- 50 % RFD as organic fertilizers (poultry manure) + 50% NPK 19-19-19 (50%O)
4- 0 % RFD as organic fertilizers (100% NPK 19-19-19) (0%O)

3.3. Experimental Design:

A simple experiment with four treatments were arranged in a randomized complete block design (RCBD) with three replicates. The experimental unit area (plot) was 12.6 m^2 containing 3 rows, each row was 1.4 m in width and 3 m in length.

3.4. Recorded data

3.4.1. Vegetative growth parameters:

Three plants were randomly harvested from the plot at 30, 55, 85 and 100 days after transplanting to measure the following parameters:

a- Number of leaves / plants: All leaves of the chosen plants were counted.
b- Leaves weight (g/plant)
c- Root weight (g/plant)
d- Plant weight (g/plant)

3.4.2. Root yield (tone /Feddan):

Total root yield (ton/Feddan): Plants of each experimental plot were harvested after 99 days from sowing and weighed then the total yield of whole plants was calculated.

Table (1): Physical and chemical properties of experimental soil

Soil properties Physical	Value	Soil properties Soluble cations (meq/l)	Value
Sand	84.21%	K^+	0.25
Silt	11.50%	Ca^{2+}	3.14
Clay	4.29%	Mg^{2+}	2.13
Texture	Sandy soil	Na^+	17.22
Bulk density	1.67 g/cm^3		
Chemical		**Soluble anions (meq/l)**	
SP	25.8	$HCO3^-$	3.11
EC (dsm^{-1})	2.33	Cl^-	5.63
pH	7.94	$CO3^-$	0.00
		$SO4^-$	14.00

Table (2): Analysis of poultry manure

Item	Value
Bulk density (kg/m^3)	129.7
N %	3
P%	1.5
K%	1.7

3.4.3. Biochemical constituents:

Two grams of fresh roots were homogenized in 20 mL of 80% ethanol for 2 min. The samples were centrifuged at 10,000×g for 30 min in a refrigerated centrifuge. Then the residue was subjected to ethanol extraction. The extracts were combined, and alcohol was removed by evaporation. An aliquot was taken and then made up to 50 mL with distilled water and used for the determination of total sugars and total phenolics.

a- Total sugars were measured with phenol–sulfuric acid reagents spectrophotometrically using a spectrophotometer (UNICO UV/Visible 2100, USA) at 480 nm according to Dubois et al. (1956). The data were expressed as mg/100g of fresh weight.
b- Total phenolic content: Total phenolic determination was carried out for roots according to Folin-Ciocalteu method using a spectrophotometer (UNICO UV/Visible 2100, USA), as described by Sadasivam and Manickam (1991). The data were expressed as mg/100g of fresh weight.
c- Betalains: The betalains content was measured spectrophotometrically at 536 nm and 476 nm, using a spectrophotometer (UNICO UV/Visible 2100, USA), according to von Elbe, (2001). The data were expressed as mg/100g of fresh weight.

3.4.4. Analysis of mineral elements:

Samples of plant leaves or roots were taken, oven dried at 70 ºC till constant weight. Dried samples were pulverized separately, and samples of 0.5 g each were acid digested with a mixture of sulfuric acid and hydrogen peroxide and then brought to a final volume of 100 ml with distilled water, to determine the following:

Macro-elements content of leaves and roots:

1-Total Nitrogen (mg/g dry weight): Total nitrogen was estimated using the semi-micro-kjeldahl method as described by Ling (1963).

2-Phosphorus (mg/g dry weight): P was analyzed by chlorostannus reduced molybdophosphoric blue color method, in sulfuric acid system at 660 nm using a Spectro 22 spectrophotometer as described by Jackson (1973).

3-Potassium concentrations (mg/g dry weight) were determined using a Perkin-elmer, Flame photometer (Page, 1982).

Micro-elements content of roots:

Iron, copper, zinc, and manganese were analyzed using an atomic absorption spectrophotometer according to the method described by (AOAC., 1995).

3.5. Statistical analysis:

The data were subjected to one-way analysis of variance (ANOVA) and differences between means of treatments were tested using the least significant difference (LSD) Test at 5% level of significance (Snedecor and Cochran, 1980).

RESULTS

The results of the two conducted experiments of the organic fertilization during 2019 – 2020 and 2020 - 2021 are presented as follows:

3.1. Effect of organic farming systems on table beet vegetative growth:-

3.1.1. Number of leaves:

Results in Figure (1) show the effect of organic farm system on leaves number of table beet at 30, 55, 85 and 100 days after planting (DAP) during 2019-2020 and 2020-2021 seasons. The results showed that the number of leaves at 30 DAP had no significant differences between the treatments during both seasons, while with progressing growth stage up to 55 DAP, a significant difference was found between the treatments during the second season. At 85 DAP, there were significant differences between the treatments, where treatment with 0% organic manure (100% mineral fertilization) had the minimum number of leaves in both seasons. At 100 DAP, the same trend was observed, and the maximum number of leaves were recorded with 100% organic fertilizer. There are no significant differences between the treatment of 100% and 75% at all the studied days after planting during both seasons.

3. 1. 2. Leaves weight:

The weight of leaves was recorded in Figure (1) during 2019-2020 and 2020-2021 at 30, 55, 85 and 100 DAP, where leaves weight was significantly affected by organic manure treatments at different plant growth stages. At 30 DAP, the fertilized plants with 100% chemical fertilization had the lowest weight compared with other treatments (organic treatments). At 55 DAP, the fertilization with 75% organic manure gave the highest weight of leaves in the first season, but no significant differences were observed between the three levels of organic manure (100, 75 and 50%). In the second season, no significance levels were noted between all treatments. However, the treatment of mineral fertilization (0% organic manure) had the lowest value of weight at this stage of growth. With the advancement of the table beet age, the leaves weight increased gradually, at 85 DAP, the application of organic manure at 75 % recorded the highest weight in both season, with no significant difference between it and 50% in the first season, and 0% and 50% in the second season, however, the treatment of 100 % organic manure recorded the lowest weight in the both seasons at this stage of growth. At the final stage of growth (100 DAP), leaves weight of table beet increased when the organic manure increased up to 100 %, and recorded the highest weight compared the other treatments in both seasons.

3.3.1.3. Roots weight:

Results of Figure (2) represented the roots weight of table beet at various stages of growth (30, 55, 85 and 100 DAP) under difference systems of organic farming during both seasons. At the end of the first stage (30 DAP) of growth, significant differences were detected between the organic fertilization treatments , where 100% organic fertilization recorded the highest roots weight, while 100% mineral fertilization system recorded the lowest roots weight. At 55 DAP, no significant levels were detected between all treatments in the first season, while in the second season, significant differences were observed, where 100% organic fertilization had the highest roots, weight compared with other systems. With the development of table beet growth until 85 DAP, 75% organic fertilization enhanced the roots weight and had the highest value in both seasons. With increasing the age up to 100 DAP, the highest roots weight was obtained when 75% organic fertilization was applied, while the lowest roots weight was recorded with 100% mineral fertilization system.

3.1.4. Plant weight:

The effect of organic fertilization on plant weight of table beet during 2019-2020 and 2020-2021 seasons at 30, 55, 85 and 100 DAP was presented in Figure (2). These data showed that 100% organic manure treatment gave the highest plant weight compared with other treatments at the first growth stage (30 DAP), on the other hand, 100% mineral fertilization (0% organic manure) gave the lowest plant weight in both seasons. With increasing the age of table beet up to 55 DAP, 75% organic manure recorded the highest plant weight compared with other treatments, but there are non-significant levels between the three levels of organic manure at this stage of growth in both seasons. At 85 DAP, the application of 75 % organic fertilization produced significantly the highest weight of plant. No significant differences were detected between 100% organic fertilization and 100% mineral fertilization in both seasons. At 100 DAP, the plants were grown under 75% organic fertilization had the highest compared with other systems, while the plants under 100% mineral fertilization system had the lowest plant weight in both seasons.

3.2. Effect of organic fertilizations on yield of table beet:

Data in Figure (3) illustrate the effect of different organic fertilizations on yield of table beet during 2019- 2020 and 2020 – 2021 seasons. Application of mineral fertilization system (0% organic manure + 100% mineral fertilizer) recorded a minimum yield, while 50 % organic fertilization (50% mineral fertilizer + 50% organic manure from the recommendation dose of mineral fertilization resulted in increasing the yield by 8.53% than 0 % organic manure treatment in the first season and 16.56% in the second season. Results showed that no significant differences were found between 50% and 100% organic fertilization in both seasons, while application of 75% organic fertilization produced the highest yield compared to the other treatments in both seasons.

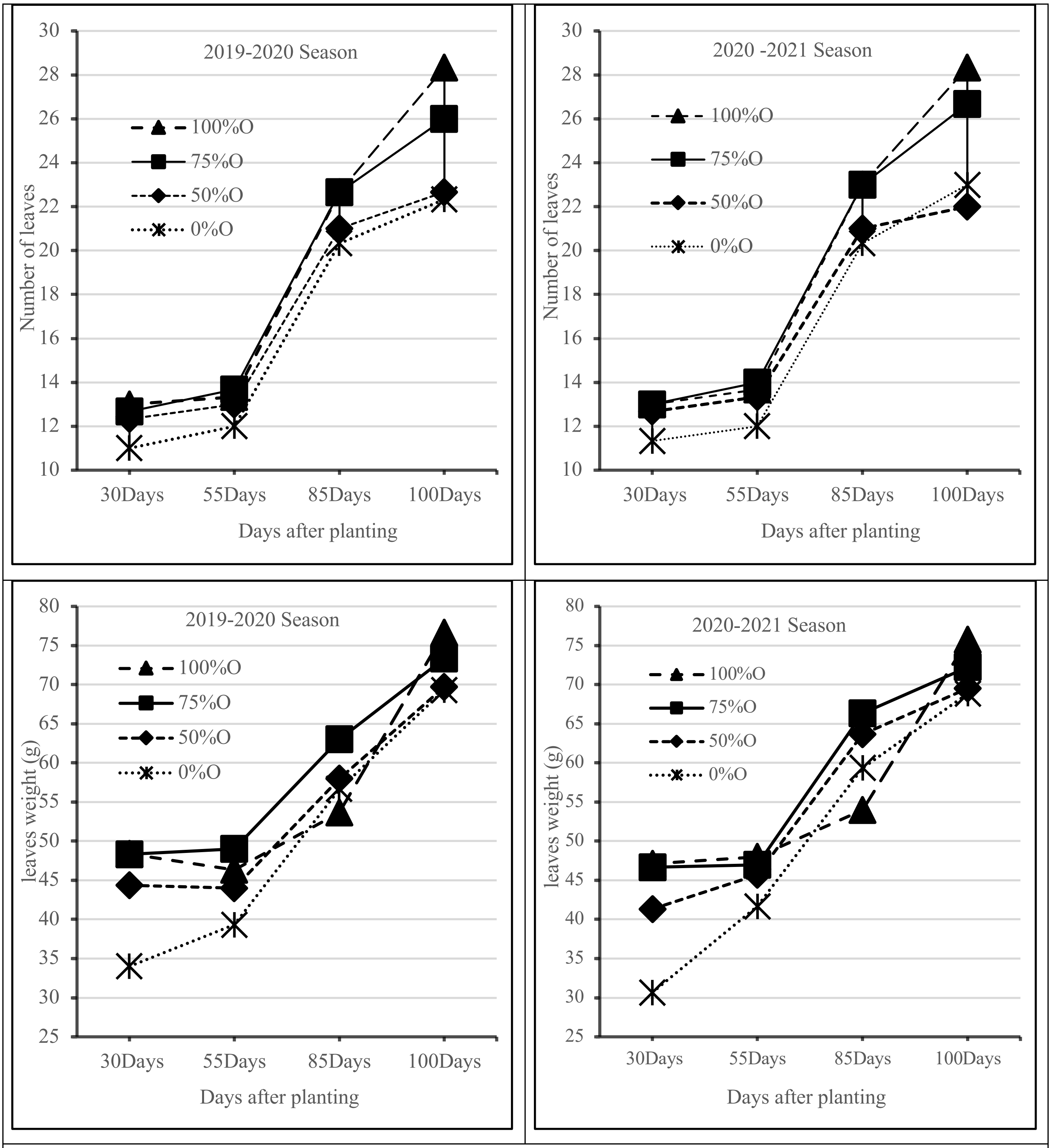

Figure (1): Effect of organic fertilization on leaves number and leaves weight of table beet after different growth stages during 2019 - 2020 and 2020 – 2021 seasons.

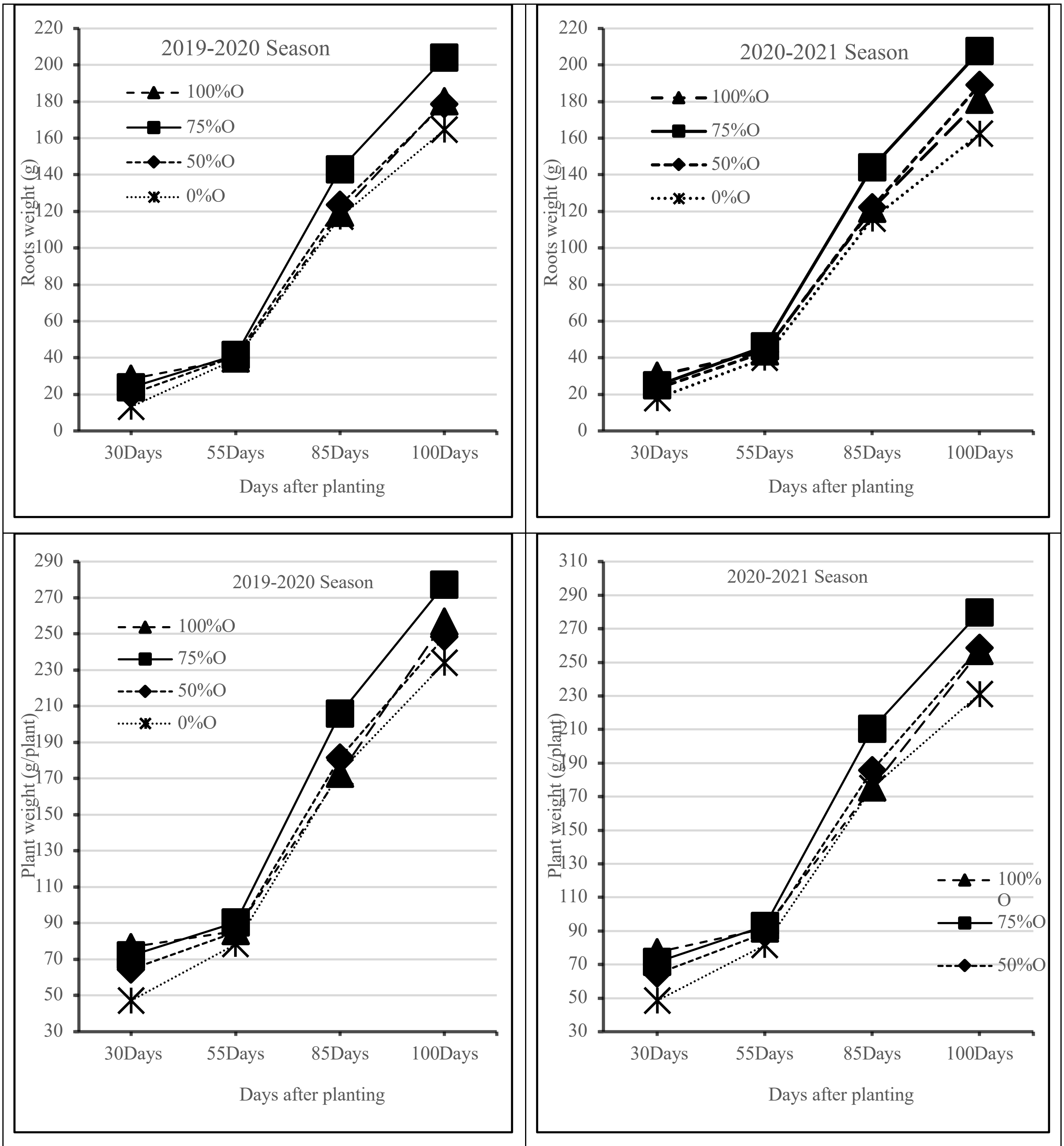

Figure (2): Effect of organic fertilizations on roots and plant weight of table beet after different growth stages during 2019 - 2020 and 2020 – 2021 seasons.

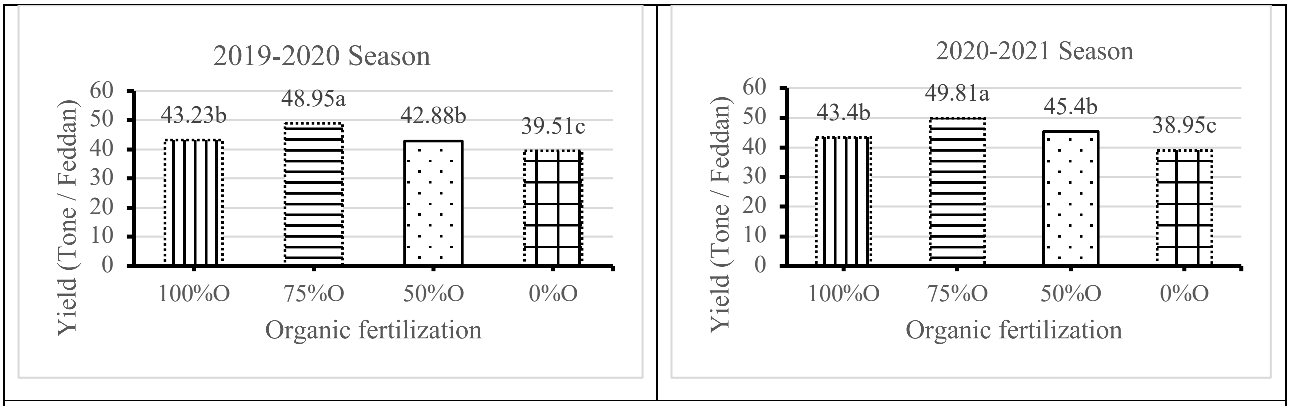

Figure (3): Effect of organic fertilizations on yield of table beet during 2019 - 2020 and 2020 – 2021 seasons

3.3. Effect of organic fertilizations on biochemical compounds of table beet:

The results of the effect of organic fertilizations on biochemical compound contents of table beet roots indicated that, generally, sugars, phenolics and betalains contents were significantly affected by the system of organic farming treatments as follow:

3.3.1. Sugars content of roots

Data in Table (3) show the effect of treatments on sugars content of roots during 2019 – 2020 and 2020 – 2021 seasons. No significant differences were detected between 0% and 50% organic manure in sugars content in both seasons. When organic manure increased to 75% high significant differences were detected, but no significant differences were observed between 75% and 100% organic manure in both seasons. However, 0% organic manure had the lowest sugars content compared with other treatments, while 75% organic manure had the highest sugars content compared with other treatments. The same trend was observed in both seasons between all treatments.

3.3.2. Phenolics content of roots

Results in Table (3) illustrate the effect of treatments on phenolics content of roots during 2019 – 2020 and 2020 – 2021 seasons. 0 % organic manure (100% mineral fertilization) provided the highest phenolics content compared with other treatments. Increasing the organic manure from 50% up to 100% organic manure resulting in decreasing the content of phenolics, where 100% organic manure recorded the lowest content of phenolics in both growing seasons.

3.3.3. Betalains content of roots

Concerning the effect of organic fertilizations on betalains content of table beet, the Table (3) show that there are significant differences among organic fertilizations. The treatment of 0% organic manure (100% mineral fertilization) gave the lowest betalains content. A gradually increase was found in betalains content with increasing organic manure up to 100% organic fertilization, Where the highest content of betalains was recorded with 100% organic fertilization compared with other treatments, followed by 75% organic fertilization in both seasons. No significant difference was found between 75% and 100% organic fertilization in the second season.

3.4. Effect of organic fertilizations on macro-elements content of table beet plants

3. 4. 1. Nitrogen content of leaves

Regarding the effect of organic fertilizations on nitrogen content of table beet leaves were presented in Table (4). Data indicated that leaves nitrogen content reached significantly the highest value when 50% organic manure + 50% mineral fertilization was applied, followed by 100% mineral fertilization with no significant levels between them in both seasons. Also, no significant levels were detected in leaves nitrogen content between the plants grown under 100 % mineral fertilization and 75% organic fertilization in both seasons. However, the lowest nitrogen content was detected in plant leaves under 100% organic fertilization in both seasons.

3.4.2. Nitrogen content of roots

Data presented in Table (4) display the effect of organic fertilizations on roots nitrogen content during 2019 – 2020 and 2020 – 2021 seasons. The plant grown under 100% mineral fertilization recorded the highest nitrogen content in roots compared with the three organic fertilization under study in both seasons. However, there were not significant differences in roots nitrogen content between the three organic fertilizations in the first season, while no significant difference was recorded between 100% mineral fertilization and 50% organic fertilization in the second season.

3.4.3. Phosphorus content of leaves

Results in Table (4) illustrate that no significant differences were found between the treatments in leaves phosphorus content in both seasons. However, plants grown under 75% organic fertilization recorded the highest content of phosphorus in leaves in both seasons.

3.4.4. Phosphorus content of roots

Data presented in Table (4) cleared that the root of plants grown under 100% organic fertilization had the highest content of phosphorus compared with the other treatments in both seasons. However, 100% mineral fertilization had the lowest phosphorus content with no

Table (3): Effect of organic fertilizations on Total sugars, total phenolics and Betalains content of roots during 2019 - 2020 and 2020 – 2021 season

Organic fertilization	2019-2020 Season	2020-2021 Season
	roots	
	Total sugars content (mg/g FW)	
100%O	180.37a	183.11a
75%O	183.38a	187.08a
50%O	170.57b	169.65b
0%O	165.15b	164.54b
	Phenolics content (mg/100g FW)	
100%O	41.36c	46.39c
75%O	47.58bc	53.11b
50%O	49.02b	56.11b
0%O	62.67a	65.28a
	Betalains content (mg/100g FW)	
100%O	141.42a	148.50a
75%O	123.73b	141.12ab
50%O	121.68bc	132.14b
0%O	105.85c	110.48c

Means of each column have the same letter/s are not significantly different at 0.05 level of probability according to LSD test.

significant differences between it and 50 % or 75% organic fertilizations in the first season. Whereas, in the second season, the treatment of 100% organic fertilization had the highest content of phosphorus with no significant difference between it and 75% organic fertilization. While 100% mineral fertilization had the lowest phosphorus content with no significant differences between it and 50% organic fertilization.

3.4.5. Potassium content of leaves

Data in Table (4) showed that there were significant differences among the organic fertilizations of potassium content in table beet leaves. The treatment of 100% organic fertilization gave the highest potassium content of leaves in the first season. While in the second season, the treatment of 75% organic fertilization had the highest potassium content, followed by 100 % organic fertilization. There was no significant difference between 50% organic fertilization and 100% mineral fertilization treatment.

3.4.6. Potassium content of roots

Results in Table (4) show the effect of organic framing systems on potassium content of roots during 2019-2020 and 2020 – 2021 seasons. There were no significant differences between 100% and 75% organic fertilizations in both seasons. At the same time, there was no significant difference between 50% organic fertilization and 100% mineral fertilization in both seasons. However, the treatment of 100% organic fertilization had the highest potassium content in the roots in the first season, while the treatment of 75% organic fertilization had the highest potassium content in the second season.

3. 5. Effect of organic fertilizations on micro-elements content of root

3. 5. 1. Iron content of roots

Data in Table (5) showed that there were significant differences among the treatments, where the treatment of 100% and 75% recorded the highest values of iron content of roots, without significant differences between them in both seasons. The treatment of 100% mineral fertilization had the lowest iron content of roots without significant difference between it and 50 % organic fertilization in both seasons.

3.5.2. Copper content of roots

The presented data in Table (5) illustrate the effect of organic framing systems on copper content of roots during 2019-2020 and 2020 – 2021 seasons. Copper content of roots recorded the highest values in 75%

organic fertilization plants, with significant differences in comparison with the other treatments, except for 100% mineral fertilization in the first season.

3.5.3. Zinc content of roots

Data in Table (5) show the effect of organic fertilizations on zinc content of roots during 2019 – 2020 and 2020 – 2021 seasons. It illustrated that there were no significant differences between the three organic fertilizations (50, 75 and 100%) in zinc content of roots, however, the treatment of 100% mineral fertilization recorded significantly the lowest content of zinc compared with the three organic fertilizations in both seasons, except with 75% treatment in the first season.

3.5.4. Manganese content of roots

Data in Table (5) show the effect of organic fertilizations on manganese content of roots during 2019 – 2020 and 2020 – 2021 seasons. The presented results showed that 100% mineral fertilization system recorded the lowest content of manganese compared with organic fertilizations in both seasons. However, no significant differences were recorded between the three organic fertilizations plants, but the treatment of 75% had higher manganese content than 50 % or 100% in both seasons.

Table (4): Effect of organic fertilizations on nitrogen content of leaves during 2019 - 2020 and 2020 – 2021 seasons

Organic fertilization	2019-2020 Season	2020-2021 Season	2019-2020 Season	2020-2021 Season
	Leaves		roots	
	N (mg/g DW)			
100%O	15.16c	16.57c	6.72b	7.25b
75%O	15.43bc	16.91bc	6.91b	7.34b
50%O	17.55a	18.31a	7.15b	8.38a
0%O	16.80ab	18.10ab	8.21a	8.72a
	P (mg/g DW)			
100%O	2.63a	2.87a	2.80a	2.97a
75%O	2.79a	2.98a	2.39b	2.67ab
50%O	2.67a	2.84a	2.39b	2.48bc
0%O	2.54a	2.67a	2.27b	2.32c
	K (mg/g DW)			
100%O	19.25a	19.72a	18.84a	19.26a
75%O	18.10b	19.90a	17.83a	19.94a
50%O	16.50c	17.63b	15.80b	17.33b
0%O	17.91b	17.51b	15.80b	17.07b

Means of each column have the same letter/s are not significantly different at 0.05 level of probability according to LSD test.

Table (5): Effect of organic fertilizations on iron, copper, zinc and manganese content of roots during 2019 - 2020 and 2020 – 2021 seasons.

Organic fertilization	2019-2020 Season	2020-2021 Season	2019-2020 Season	2020-2021 Season
	Iron (ppm)		Copper (ppm)	
100%O	1.99a	2.10a	0.080b	0.088b
75%O	2.10a	2.24a	0.092a	0.096a
50%O	1.26b	1.37b	0.073b	0.082bc
0%O	1.08b	1.18b	0.082ab	0.081c
	Zinc (ppm)		Manganese (ppm)	
100%O	0.119a	0.128a	0.179a	0.187a
75%O	0.113ab	0.125a	0.181a	0.192a
50%O	0.124a	0.123a	0.174a	0.184a
0%O	0.102b	0.105b	0.154b	0.162b

Means of each column have the same letter/s are not significantly different at 0.05 level of probability according to LSD test.

DISCUSSION

Organic food consumption has been growing all over the world, and much attention was paid to the pro-health vegetable properties offered on the market. Additionally, the many beneficial qualities of beet root were positively assessed by nutritionists and consumers. Red beet root is a natural source for betalain pigments, which is permitted as a food ingredient (Kujala et al., 2002). Therefore, organic farming is a technology replaces synthetic chemical fertilizers with animal manures, cover crops, and other biological sources of fertilizer, which lead to high quality of vegetables, avoid the negative effects of chemical fertilizers and regulate the plant defenses by inducing the plants to deploy a variety of physical and chemical defenses to protect themselves against pathogens and herbivores (Krey *et al.,* 2020).

4.1. Effect of organic fertilization on table beet vegetative growth

The application of organic fertilization enhanced significantly leaves number and, leaves and roots weight of table beet plants. these results clearly indicated that 75% organic fertilization is more effectives in improving the vegetative growth parameters of table beet. These results may be attributed to improve the soil properties by adding the organic manure. Samandasingh *et al.* (1988) reported that organic manure application to the soil, physical conditions were improved by the aggregation of soil particles. These aggregates effect the fertility of soil and often determine the movement and retention of water, gas diffusion, roots growth and development in the soil, which contributed to the plant growth (Jagadeesh *et al.,* 2018). The results agree with findings of Malshe and Desai (2020) who found that application of poultry manure enhanced the vegetative growth of cabbage. The results of the current study indicated that the positive effect of organic manure on table beet growth could be due to the contribution of manure in increasing the fertility status of soil when it decomposed and enhanced the physic-chemical properties of soil. This is in agreement with the findings of Dawuda *et al.* (2011) who reported that organic manure probably improved the soil properties and enhanced the soil nutrition level, which promoted the vegetative growth of plant. Also, Amartey *et al.* (2022) illustrated that poultry manure has the ability to supply the required essential nutrients for plant during early and later plant growth stages to promote the growth of plant.

4.2 Effect of organic fertilizations on yield of table beet

The yield of table beet was significantly affected by the application of organic fertilization. The highest yield of root was obtained with application of 75% organic fertilization (75 % organic manure + 25 % mineral fertilization). A similar result was reported by Arora (2008) who cleared that the integrated nutrient source makes a balance in plant nutrient better than a single source of nutrient supply. Another study on potato found that tuber yield increased after using organic manure in comparison with the recommended inorganic fertilizers dose only (Boke, 2014). The synergistic effects of the integration of nutrient combinations in supplying available nutrients and improving physical and chemical characteristics of soil resulted in greater the height of plant and canopy width, hence increasing interception and utilization solar radiation. This resulted in greater root yield (Amartey *et al.,* 2022). These results might explain why the integration of fertilizers is better than single doses of inorganic and organic fertilizers. In the same line, Somanath and Syeenivasmuthy (2005) reported that dry matter yield increased due to the integration of farmyard manure with NPK than NPK alone. Also, a combination between organic manure and chemical fertilizers gave the best quality and yield of carrot (Ahmad *et al.,* 2014). Application of organic manures help the micro-organisms of soil to produce polysaccharides and thus leads to better structure of soil useful for growth of table beet root (Jagadeesh *et al.,* 2018).

4. 3. Effect of organic fertilizations on biochemical compounds of table beet

Total sugars content of table beet was significantly affected by organic fertilizations. The obtained results clearly indicate that the combination between 75% organic manure and 25 NPK is an effective organic system in sugars content of table beet. These results are in harmony with the results of Kumar *et al.* (2014$_b$), who found that the sugars content of carrot increased using the organic fertilization compared to 100% NPK. In the same trend, an increase in total sugars content of carrot was reported by Hailu *et al.* (2008), when application of organic nutrient sources. Higher available nitrogen level in the conventional plants lead to increase the amino acids synthesis and proteins, which inhibits carbon-reach compounds synthesis, including carbohydrates (Szopinska and Gaweda, 2013). Concerning the effect of organic fertilizations on phenolics content, 100% organic farming recorded the lowest phenolics content, while the 100% NPK recorded the highest phenolics content of table beet root. Our results agree with the results of AL-Subeihi *et al.* (2022) on carrot. But several studies show the effect of fertilizer sources on total phenolic content in plant, some studies show an increasing in the content of phenolic in organic potato and carrot root compared with conventional, while other studies show undefined trend in the content of phenolic in relation to fertilizer (Faller and Fialho, 2010). However, several investigations have linked the phenolics accumulation to the level of nitrogen (Aina *et al.,* 2019), also, Heimler *et al.* (2016) found that a higher content of phenolic was recorded when less nitrogen fertilizer was added to the soil. Additionally, Yusuf *et al.* (2021) reported that phenolic activities can be influenced by numerous of factors such as plant species and varieties, climate and abiotic and biotic stress. Polyphenols are considered a stress metabolite, and in this connection, many factors should be considered through interpret the results and no general role actually can be drawn Heimler *et al.* (2016). In this context, the exposure of plant to stressful and aggressive situations and lead to induce secondary metabolism, resulting in higher phenolic synthesis by the activity of phenylalanine ammonia lyase, this enzyme has been shown to be stimulated according to the plant species, due to the variation of genetic or the specific role of polyphenols in the plant physiology and metabolism (Reyes *et al.,* 2007). With regard to betalains content, betalains are water soluble nitrogen-containing pigments, are derived from tyrosine. These pigments are found only in a limited number of plants, which specifically belonging to Caryophyllales order. In most families, the betalains are replaced with anthocyanin pigments. All betalain pigments comprise betalimic acid as a chromophore. Depending on the betalamic acid residue nature, the betalains can be classified as betacyanins (red/violet color) and betaxanthins (yellow/orange color). These pigments protect plant from damage caused by visible light and UV (Carrillo *et al.,* 2019). The current study indicated that 100% organic fertilization had the highest total betalains of table beet root. These results are in agreement with the findings of Szopinska and Gaweda (2013) and Carrillo *et al.* (2019), who found that the highest betalains content was recorded in organically produced table beet root. Nutrient quality attributes may be improved by better availability and uptake of nutrients from organic manures, which might have led to the balance carbon/nitrogen ratio and enhanced the plant metabolism activity.

4.4. Effect of organic fertilizations on minerals content in table beet

The results of the presented study revealed that nitrogen was higher in table beet leaves and roots under mineral fertilizer (100%NPK dose) compared with the organic fertilizations (50, 75 and 100% organic manure). These results are in agreement with findings of Domagala-Swiatkiewicz and Gastol (2012), who illustrated that at conventional farm, the nitrogen available majority to the production of plants is applied as a synthetic fertilizer, which is very easily and rapidly available for plant, while at organic farm, nitrogen is applied as an organic matter based fertilizer, this form and source of nitrogen is slowly released and available to the plant. Also, (Kiran *et al.,* 2016) reported that organic manure increased nitrogen uptake of carrot.

Regarding the phosphorus and potassium, the current study showed that the higher phosphorus and potassium contents were recorded in table beet leaves and roots under organic fertilization (50, 75 and100 organic manure). Similarly, the cultivation method significantly influenced phosphorus and potassium content, where organically produced table beet contained more phosphorus and potassium than conventionally (Domagala-Swiatkiewicz and Gastol, 2012). This may be attributed to good availability of phosphorus and potassium from the organic manure during the growth stages of table beet. In the same line, Rutkowska *et al.* (2014) found that phosphorus and potassium application as well as farmyard manure resulted in a significant increase of available phosphorus and potassium forms in soil. Concerning micro-elements (Fe, Cu, Zn and Mn), the presented study revealed that organic fertilizations (50, 75 and 100 organic manures) significantly enhanced the micro-elements content in table beet roots. The concentration of Fe and Zn in the soil solution significantly increased using application of farmyard manure (Rutkowska *et al.,* 2014). In this context, organically produced celery contained higher concentration of Fe, Cu, Zn and Mn (Domagala-Swiatkiewicz and Gastol, 2012). These results indicated that organic manure or integration between mineral fertilizers and organic manure may be improved the availability of micro-elements to plants.

Generally, it can be concluded that organic manure alone or combination between organic and inorganic fertilizers can improve the structure and water holding capacity, microbial activity of the soil, and uptake of nutrients, hence promote the vegetative growth and enhance productivity and quality of table beet. Also, Kumar *et al.* (2014b) illustrated that the beneficial effects of combined organic manure application and chemical fertilizers might be attributed to the improved inorganic fertilizers efficacy.

CONCLUSION

The results of the present study inferred that organic fertilization with 75% organic manure plus 25% NPK is the best combination between organic and inorganic fertilizers to cultivation of table beet under sandy soil conditions at Ismailia governorate, where this organic fertilization produced the highest vegetative growth, roots yield, sugars, betalains, phosphorus, potassium and micro-elements content of table beet plant.

REFERENCES

Ahmad, T., M. Amjad Q. Iqbal , A. Nawaz and Z. Iqbal (2014). Integrated nutrient management practices improve growth and yield of carrot. Bulgarian Journal of Agricultural Science 20(6):1457-1465.

Aina, O. E., S. O. Amoo, L. L. Mugivhisaand J. O. Olowoyo(2019). Effect of organic and inorganic sources of nutrients on the bioactive compounds and antioxidant activity of tomato. Applied Ecology and Environmental Research, 17(2): 3681-3694. DOI: http://dx.doi.org/10.15666/aeer/1702_36813694.

AL-Subeihi, A. A., A. Awal, MD. W. Ahmed, M. Ahmed, T. Alam, MD. S. I. Khanand M.A. Islam, M. A. (2022). Effect of organic and chemical fertilizers on the content of major phenolic compounds of carrot. Poll. Res., 41(1): 347-352. DOI No.: http://doi.org/10.53550/PR.2022.v41i01.051.

Amartey, J. N. A., J. Sarkordie-Addo, M. E. Essilfie and H. K. Dapaah (2022). Growth and yield of carrots affected by integrated nutrient management of organic and inorganic fertilizers. African Journal of Agricultural Research, 18(7):576-585. DOI: 10.5897/AJAR2022.15967.

AOAC. (1995). Official methods of analysis of AOAC International, vol. I. 16th ed. AOAC: Arlington, USA.

Arora, S. (2008). Balanced nutrition for sustainable crop production. Krishi World (Pulse of Indian Agriculture) pp. 1-5.

Black, C. A. (1965). Methods of soil analysis. Amer. Soc. Agron. Madison, Wis., USA.

Boke, S. (2014). Effect of organic and inorganic fertilizer application and seedbed preparation on potato yield and soil properties on alisols of Chencha. International Journal of Natural Sciences Research, 2(8),123-132.

Carrillo, C., D. Wilches-Perez, E. Hallmann, R. Kazimierczak and E. Rembiałkowska (2019). Organic versus conventional beetroot. Bioactive compounds and antioxidant Properties. LWT - Food Science and Technology 116: 108552.

Dawuda, M. M., P. Y. Boateng, O. B. Hemeng and G. Nyarko (2011). Growth and yield response of carrot (*Daucus carota* L.) to different rates of soil amendments and spacing. Journal of Science and Technology, 31(2), 11-20.

Deuter, P. and T. Grundy (2004). Beetroot commercial production and processing. Agency for Food and Fibre Sciences. Holland Horticultural Limited Partnership. P. 1 – 4.

Domagala-Swiatkiewicz, I., and M. Gastol (2012). Comparative study on mineral content of organic and conventional carrot, celery and red beet juices. Acta Sci. Pol., Hortorum Cultus, 11(2), 173-183.

Dubois, M. K. A., J. K. Hamilton, P. A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances, Anal. Chem., 28: 350-356.

Faller, A. L. K. and E. Fialho (2010). Polyphenol content and antioxidant capacity in organic and conventional plant foods. Journal of Food Composition and Analysis, 23: 561–568.

Hailu, S., T. Seyoum and N. Dechassa (2008). Effect of combined application of organic and inorganic nutrient sources with their sole application on postharvest quality of carrot. African J. Biotech., 7: 2187-96.

Heimler, D., A. Romani and F. Ieri (2016). Plant polyphenol content, soil fertilization and agricultural management: a review. Eur. Food Res. Technol. DOI 10.1007/s00217-016-2826-6.

Jackson, M. L. (1973). Soil chemical analysis. Prentice-Hall of India Private Limited New Delhi, 141 p.

Jagadeesh, C, M. Madhavi M. Siva Prasad and V. V. Padmaja (2018). Effect of organic manures on growth and yield attributes of beet root Cv. Crimson Globe. Int. J. Curr. Microbiol. App. Sci., 7(11):3538-3553. doi: https://doi.org/10.20546/ijcmas.2018.711.403

Kiran, M., M. S.Jilani, K. Waseem and S. K. Marwat (2016). Response of carrot (Daucus carota L.) growth and yields to organic manure and inorganic fertilizers. American-Eurasian J. Agric. & Environ. Sci., 16 (6): 1211-1218. DOI: 10.5829/idosi.aejaes.2016.16.6.12990

Krey, K. L., P. D. Nabity, C. K. Blubaugh, Z. Fu, J. T. Van Leuven, J.P. Reganold, A. Berim, D. R. Gang, A. S. Jensenand W. E. Snyder (2020). Organic Farming Sharpens Plant Defenses in the Field. Front. Sustain. Food Syst., 4:97. doi: 10.3389/fsufs.2020.00097

Kujala T. S., M. S. Vienola, K. D. Klika, J. M. Loponenand K. Pihlaja (2002). Betalain and phenolic compositions of four beetroot (*Beta vulgaris*) cultivars. Eur. Food Res. Technol., 214:505–510. DOI 10.1007/s00217-001-0478-6

Kumar, P., P. R. Meghwal and D. K. Painuli (2014). Effect of organic and inorganic nutrient sources on soil health and quality of carrot. Indian J. Hort., 71(2):222-226.

Lampkin, N. (1990). In: Organic farming, Ipswich, W.K., Farming Press Book, pp. 801-910.

Ling, E. R. (1963). Determination of total nitrogen by semi-microkjeldahl method. Dairy Chem., 11: 23-84.

Malshe, K. and B. G. Desai (2020). Response of cabbage to organic manures. Journal of Eco-friendly Agriculture, 11(1): 10-11.

Page, A. L. (1982). Methods of soil analysis. 2nd Ed. Part 1, Soil Sci. Soc. Amer. Madison Wisc. USA.

Petek, M., N. Toth, M. Pecina, T. Karazija, B. Lazarevic, I. Palcic, S. Veres and M. H. Custic (2019). Beetroot mineral composition affected by mineral and organic fertilization. PLoS ONE, 14(9), e0221767. https://doi.org/10.1371/journal.pone.0221767

Reyes, L. F., E. Villarealand, L. Cisneros-Zevallos (2007). The increase in antioxidant capacity alter wounding depends on the type of fruit or vegetable tissue. Food Chemistry, 101(3): 1254–1262.

Rutkowska, B., W. Szulc, T. Sosulski and W. Stepien (2014). Soil micronutrient availability to crops affected by long-term inorganic and organic fertilizer applications. Plant Soil Environ., 60(5): 198–203

Sadasivam, S., and A. Manickam (1991). Biochemical methods for agricultural sciences. Wiley.

Samandasingh, V. and Y. Singh (1988). Organic manures the only curve for better crop and soil health. Farmer and Parliament. 23-29-30.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th Edition, The Iowa State University Press, Ames.

Somanath, B. S., and C. A. Sreenivasmurthy (2005). Influence of FYM and inorganic fertilizer (NPK) and sources of potassium on the yield of *Coleus forskohlii*. Journal of Medicinal and Aromatic Plant Sciences, 27(1): 16-19.

Szopinska, A. A., and M. Gaweda (2013). Comparison of yield and quality of red beet roots cultivated using conventional, integrated and organic method. Journal of Horticultural Research, 21(1), 107-114. DOI: 10.2478/johr-2013-0015

von Elbe, J. H. (2001). Betalains. spectorophotometric determination of betacyanins and betaxanthins. Current Protocols in Food Analytical Chemistry F3.1.1-F3.1.7, New York: Wiley.

Yusuf, E., K. Karolina Tkacz, I. P. Turkiewicz, A. Wojdyło, and P. Nowicka (2021). Analysis of chemical compounds' content in different varieties of carrots, including qualification and quantification of sugars, organic acids, minerals, and bioactive compounds by UPLC. European Food Research and Technology, 247:3053–3062.

استجابة نباتات بنجر المائدة لنظم مختلفة من التسميد العضوي

سمير كامل الصيفي، رواء صلاح الشطوري، خالد السيد عبدالحميد، إبراهيم ناصف ناصف، علي محمد عبدالعزيز محمد عياد
قسم البساتين ، كلية الزراعة، جامعة قناة السويس، الإسماعيلية، مصر

المستخلص: أجريت هذه الدراسة فى مزرعة عضوية خاصة بجمعية العاشر من رمضان بمحافظة الإسماعيلية، وفى معمل قسم البساتين كلية الزراعة جامعة قناة السويس خلال موسمين متتاليين 2019-2020م و2020-2021م؛ وذلك لبحث تأثيرات التسميد العضوي على النمو والمحصول والمكونات الكيماوية الحيوية، مثل: السكريات والفينولات وصبغات البيتالينات، ومحتوى العناصر المعدنية لنبات بنجرالمائدة. اشتملت التجربة على أربع معاملات، هى: 100% من الكمية الموصى بها تسميد عضوي (سماد الكتكوت)+ 0%NPK و75 % من الكمية الموصى بها تسميد عضوى +25% NPK و50 % من الكمية الموصى بها تسميد عضوي+50% NPK، و 0% من الكمية الموصى بها تسميد عضوي + 100% NPK. أوضحت النتائج أن نظام التسميد العضوي 75% + 25% NPK أعطى أعلى قيم نمو خضري ومحصول جذور ومحتوى سكريات وصبغات بيتالينات وفوسفور وبوتاسيوم وعناصر معدنية صغرى تحت ظروف التربة الرملية.

الكلمات المفتاحية: بنجر المائدة، سماد الكتكوت، صبغات البيتالينات، الفينولات، السكريات.