Journal of Sohag Agriscience (JSAS) 2025, 10(2): 182-200

ISSN 2735-5578
https://jsasj.journals.ekb.eg
JSAS 2025; 10(2): 182-200

Received: 23-10-2025
Accepted: 02 -11-2025

Mohamed H. M. Koriem
Wael A. A. Hamd-Alla

Crop Intensification Research Department
Field Crops Research Institute
Agricultural Research Center
Giza
Egypt

Corresponding author:
Wael A. A. Hamd-Alla
bwael20@gmail.com

Impact of Preceding Crops and Various Fertilizer Applications on Sugar Beet Productivity, Quality, and Economic Return

Mohamed H. M. Koriem and Wael Hamd-Alla

Abstract

A field experiment was conducted during the two seasons (2023-24 and 2024-25) under field conditions at Sakha Agricultural Research Station, at Kafr El-Sheikh Governorate, Egypt, to evaluate the effects of preceding summer crops and different fertilizer applications (soil and foliar applications) on sugar beet productivity, quality, and economic return. A strip plot design with three replications was used. The four preceding crops: sesame, maize, soybean and cowpea, were allocated in horizontal plots, while the four fertilizer applications in sugar beet: control, microelements (Fe + Zn + Mn + B), humic acid + molasses and mixed (humic acid + molasses and microelements) were in vertical plots. The results indicated that planting legume crops such as cowpea and soybean before planting sugar beet led to striking improvement in soil N, P, K, OM, and maintained a stable soil pH. In contrast, maize and sesame had little effect on these fertility attributes. Sugar yield after cowpea was 5.74 ton/fed, and root yield was 30.90 ton/fed. In contrast, sesame resulted in the lowest values (e.g., sugar yield: 4.29 ton/fed and root yield: 25.78 ton/fed) over the two seasons, while maize was intermediate between the two legumes and sesame. The highest total income (105331 L.E./fed) and net return (66338 L.E./fed) were obtained with the combination of cowpea with the mixed fertilizer treatment. Therefore, this study recommends that planting sugar beet after cowpea or soybean with mixed fertilizer treatment (humic acid + molasses and microelements) increases sugar beet productivity and economic return.

Keywords: Humic acid, microelements, molasses, maize, cowpea

INTRODUCTION

In Egypt, increasing the production of sugar crops is important to decrease the sugar production disparity brought on by the ongoing population growth. In Egypt and many other nations throughout the world, sugar beet (*Beta vulgaris* L.) comes in ranks 2nd to sugarcane. For the purpose of increasing sugar production and closing the gap between production and consumption, the Egyptian government promotes sugar beet growers to expand their cultivated area (Ali *et al.,* 2023). Egyptian sugar production now heavily relies on the sugar beet. Growing on recently reclaimed land and producing a high sugar recovery make this crop significant. Sugar beet is frequently the most significant cash crop as well. (Abu-Ellail *et al.,* 2020). Compared to sugarcane, which has a growth season of about 12 months, the growth season of sugar beet is shorter at 5-6 months. Sugar beet may be a viable crop to tolerate alkalinity of the soil or for recently recovered soils that are unsuitable for cane or another crop (Abou-Elwafa *et al.,* 2020). The selection of preceding crops is a critical factor because crop rotation can diversify soil microbiota, disrupt pest and disease cycles, and enhance soil structure and fertility. The legume crop, like faba bean or soybean or cowpea as preceding crops, significantly enhances soil nitrogen availability through biological nitrogen fixation, which in turn positively influences the chlorophyll content and vegetative vigor of subsequent sugar beet crops. These improvements ultimately result in increased root yield and a higher amount of sugar compared to beet planted after cereals or other non-leguminous crops (Grunwald *et al.,* 2025). The preceding crop itself, with variations in yield performance and agronomic input requirements, was the primary factor influencing the agronomic efficiency of sugar beet successions that occurred two years prior. Therefore, while choosing crop successions in the future, we advise taking into account either low-input (like legumes) or high-yielding (like silage maize) crops that come before crops. Modern agriculture frequently uses continuous cropping because of land constraints and financial advantage (Wang *et al.,* 2022). Crop rotation is becoming more and more popular among farmers as a secure and effective method of growing crops. Enhancing soil fertility, improving agricultural resource efficiency, enriching soil, and allowing crops to utilize soil nutrients that complement each other in time and space by crop rotation (Jing *et al.,* 2022). Ahmed and Hassan (2019) revealed that planting sugar beet in place of soybean roots produced the highest root yield (37.98 tons/fed), followed by planting sugar beet in place of all sesame crop residues (36.89 tons/fed). However, the least amount of sugar beet roots (25.07 tons/fed) was observed when sugar beet was planted in place of maize crop roots either entirely or in part. Crop rotation is one of the most extremely important agronomic strategies in sustainable agriculture design. after the soybean crop, to maximize the beet crop yield and quality, in addition to the highest total income. Since legume crops can preserve mineral nitrogen and increase soil fertility, they are a better resource than cereals (Ibrahim 2018). The quantity of OM, available NPK, and B elements in was soil were higher after preceding crop, such as legume crops like soybeans and fahl berseem, than after maize. Vegetative and sugar yield, as well as sucrose%, purity%, and root yield, were all significantly impacted by the previous harvest in both seasons. Furthermore, when compared to maize, the previous crops, such as legume crops, significantly enhanced vegetative growth and yield attributes, with the exception of sugar beet quality traits. According to the average of both seasons, the maximum root and sugar yields/fed were achieved when sugar beet was planted after soybean/fahl berseem (32.74 and 5.00 tons/fed), followed by soybean (31.60 and 4.88 tons/fed) (Attia *et al.,* 2018). Continuous cropping cycles are a major problem in the cultivation of sugar beets. Applying the preceding crop cultivation has been a successful method for reducing the issues related to continuous cropping systems (Li *et al.,* 2025). The humic acid (HA) can be used to repair micronutrient deficiencies in alkaline soils; it significantly contributes to improving plant growth (Hamada and Hamd-Alla 2019). The highest root and sugar yields/fed were obtained from sugar beet plants fertilized with a combination of humic acid at a rate of 15 L/fed as a soil application with sprayed 2 L/potassium/fed. In contrast to the control, the administration of humic acid resulted in a notable rise in sucrose percentage, root yield, and sugar yield (Enan *et al.,* 2016). The amount of humic acid (6 kg/fed) produced the highest sugar beet values. Conversely, the control treatment yielded the lowest values. However, there was a significant decrease in the percentages of extraction, α-amino nitrogen, and sodium (Rassam *et al.* 2015). The results of the interaction between humic acid and boron fertilization included the following: sugar yield ton/fed in the first season, total soluble solids percentage, sucrose percentage, purity percentage, α-amino nitrogen percentage, sodium percentage, and top yield ton/fed, as well as biological yield ton/fed (Ibrahim *et al.,* 2019). Phosphate, potassium, and sugar yield were all increased when humic acid (10 kg ha^{-1}) was applied to the soil (Deshmukh *et al.,* 2024). The yield of sugar (4.41 tons/fed) and root (30.41 tons/fed) was significantly impacted by the application of humic acid to beets. The application of 5 kg/fed humic acid to beets produced the maximum root and top yields. Other than that, there was no significant difference in the sugar quality percentage values across treatments; the control treatment had the highest values (Ghazy *et al.,* 2024). Wilczewski *et al.,* (2018) demonstrated that the biological yield of sugar from storage roots and the yield of sugar beets can both be increased by applying foliar potassium fertilizer and humic fertilizer to the soil. Sugar beet yields the maximum quality and production when the micronutrient mixture (Fe + Zn + Mn + B) is sprayed twice (Gobarah *et al.,* 2014). Foliar spraying (Fe + Zn + Mn + B) at a concentration of 1.5 L/fed and potassium application at a rate of 48 kg K_2O/fed had a significant impact on sucrose percentage, root sugar yields/fed, and root diameter and fresh weight (Abdelaal *et al.,* 2015). Compared to the control treatment, applying 150 L/fed of molasses increased the amount of organic matter, calcium, magnesium, available N, P, and K, and organic matter in the soil following sugar beet harvest. Additionally, the use of sugar beet molasses enhanced the quality of the juice by lowering the content of contaminants that impede the extraction of sugar (Abofard *et al.,* 2021). Thus, the purpose of this study is to assess the effects of preceding summer crops and different fertilizer applications (soil and foliar applications) on sugar beet productivity, quality, and economic return in Kafr El-Sheikh Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt (31° 07' N Latitude, 30° 05' E Longitude), during the 2023-24 and 2024-25 seasons. As shown in Table 1, the soil used in this experiment was clay.

Table 1. Some physical properties and chemical analysis of the experimental soil before cultivation of the preceding summer crops in the 2023-24 and 2024-25 seasons.

Properties		2023 season	2024 season
A: Particle size distribution:			
Sand%		9.02	8.93
Silt%		29.94	30.49
Clay%		61.04	60.58
Texture		Clay	Clay
B: Chemical analysis:			
pH		7.09	7.02
EC ds/m²		1.95	1.43
Organic matter (g kg^{-1})		11.40	11.50
Total N%		0.14	0.13
Total carbonate%		4.20	4.21
CEC meq/100 g soil		41.38	41.60
SP%		78.40	78.52
SAR		4.58	4.67
Available (mg/kg)	**N**	23.10	24.25
	P	8.20	8.05
	K	240.30	255.40
Soluble cations (meq/L)	**Zn**	6.15	6.00
	Mn	14.10	13.75
	Ca^{++}	4.49	3.29
	Mg^{++}	1.17	1.86
	Na^{+}	14.04	9.30
	K^{+}	0.59	0.61
Soluble anions (meq/L)	**CO_3^{--}**	0.00	0.00
	HCO_3^{-}	2.51	2.59
	CL^{-}	8.42	6.18
	SO_4^{--}	9.36	6.29

Treatments and Experimental Design

The experiment consisted of three replications and was designed as a randomized complete block using a strip plot layout. The four preceding crops: sesame, maize, soybean and cowpea, were allocated in horizontal plots, while the four fertilizer applications in sugar beet: control, microelements (Fe + Zn + Mn + B), humic acid + molasses and mixed (humic acid + molasses and microelements) were in vertical plots.

Crop Establishment and Management

Before planting, a sufficient quantity of a biofertilizer containing N_2-fixing bacteria (*Bradyrhizobium japonicum* for soybean seeds and *Rhizobium leguminosarum* for cowpea seeds) was applied. Thirty days after planting, the modulation's effectiveness was evaluated by more than ten nodules that are active in each root. Sugar beet (*Beta vulgaris* L.) seeds cv. Karam multi-germ variety. The plot area was 14.4 m^2 containing 6 ridges were sown on one side of 4 m length (60 cm between ridges and 20 cm between plants). Sugar beets varieties in the first and second seasons were sown on November 20th and 16th, respectively. The plants were thinned into one plant per hill after 35 days from sowing. Superphosphate (15.5% P_2O_5) at a rate of 150 Kg/fed and potassium sulfate (48% K_2O) at a rate of 50 kg/fed were applied during seed preparation. Nitrogen was applied as urea (46.5% N) at a rate of 80 kg N/fed. in two equal doses, at before the first irrigation (after 35 days from sowing) and the second after month later (at 65 days after planting). Solid humic acid potassium humate (95%) contains are (PH 7%, humic acid (dry basis)70%, potassium (K_2O dry basis) 12% min, fulvic acid 4%, and Fe 2%), also it is a soluble content (water solubility 95% min). The humic acid 5 Kg/fed + molasses 5 kg/fed treatment is soil application applied once time at the first irrigation (35 days after sowing) by spraying the ground around the sugar beet plants. Microelements (Fe + Zn + Mn + B) were applied as foliar application at three times (35, 50 and 65 days after sowing) of sugar beet as per the treatments Fe 6% (1.5 cm/L), Zn 10% (1.5 cm/L), Mn 9% (1 cm/L) and B 1% (1 cm/L). Sugar beet was harvested on May 8th and 5th 2024 and 2025 seasons, respectively. Chemical and quality traits were assayed in the Quality Control Laboratory at Delta Sugar Factory, Kafr El-Sheikh, Egypt. We followed the recommendations of Sugar Crops Research Institute, Field Crops Research Institute, Agricultural Research Center, and the Ministry of Agriculture and Land Reclamation for irrigation, fertilization, and other practices applicable to all crops in this study.

Table 2. Chemical of molasses produced from beet sugar processing

Parameters	Percentage%
Sucrose (disaccharide)	25-35
Water	15-25
Ash%	8-10
P%	3-5
Na%	0.5-1
Ca%	0.5-1
Mg%	0.2-0.5
N%	1-3
Microelements (Fe – Zn – Mn – B)	0.01
Organic acids	2-4
Other non-sugar substances	5-10

The studied traits of sugar beet

1- **Chlorophyll content:** At the heading stage was determined in ten flag leaves by using a chlorophyll meter (Model–SPAD502) from Minolta Camera Co. Ltd., Japan, using the Spectrophotometric method according to Moran (1982). Chlorophyll was expressed as µg/ml using the following formula:

Chlorophyll a =12.64 A664 - 2.99 A647
Chlorophyll b =5.60 A647 - 23.26 A664
Where A664 and A647 are absorbances at A647 and A664 nm.

At harvest time, a sample of 10 guarded plants was randomly taken from each plot to determine the following characteristics:

2- **Vegetative traits:** Top fresh weight/plant (g), top dry weight/plant (g), root diameter (cm), root length (cm), and root weight/plant (g).

3- **Yield traits:** Top fresh weight (ton/fed), top dry weight/fed (ton/fed), root yield (ton/fed) and sugar yield (ton/fed) was calculated as follows:

Sugar yield/ (ton/fed) = root yield x sugar recovery%

4- **Impurities traits:** Alpha amino nitrogen%, potassium% and sodium%

5- **Quality traits:** Sucrose%, sugar loss in molasses%, extractable sugar% and quality%.

Sugar lost to molasses % = 0.14 (Na + K) + 0.25 (α–amino N) + 0.5

Extractable sugar % = (sucrose% – sugar lost to molasses %) – 0.6

Quality = (extracted sugar% x 100) / sucrose%

Statistical analysis and interpretation of data.

The Analysis of Variance (ANOVA) was carried out using statistical packages and procedures using the SAS program version 9.2 (2009). Means comparison were carried out using the Least Significant Difference (L. S. D.) test at a 5% probability level (Gomez and Gomez 1984).

RESULT AND DISCUSSION

1. Effect of preceding summer crops on soil content of available NPK, OM, and pH after harvesting preceding crops (before sugar beet planting)

The results highlight that the type of preceding crop had a marked influence on the soil's content of nitrogen (N), phosphorus (P), potassium (K), organic matter, and pH after harvest, compared to the levels before cultivation. Before cultivation of the preceding crops, available N levels were (23.10 and 24.25 mg/kg); available P levels were (8.20 and 8.05 mg/kg); and available K levels were (240.30 and 255.40 mg/kg); organic matter content was (11.40 and 11.50 g/kg) and pH levels were (7.09 and 7.02) in the first and second seasons, respectively (Table 1). After the cultivation of different preceding crops, the differences became pronounced. Cowpea and soybean (legumes) increased the soil's available nitrogen, with values reaching 58.30 and 56.90 mg/kg after cowpea and 48.70 and 47.20 mg/kg after soybean, respectively. In contrast, maize and sesame had much lower N content (23.00 and 23.80 mg/kg) and (22.90-22.30 mg/kg) in the first and second seasons, respectively (Fig. 1). The trend for phosphorus and organic matter was similar to that for nitrogen (Figs. 2 and 4). For potassium, cowpea once again led to the highest residual K (330.50 and 325.70 mg/kg), followed by soybean (300.20–305.70 mg/kg), while maize and sesame had lower K values, around (260.30 and 270.10 mg/kg) and 275.10 and 280.20 mg/kg) in the first and second seasons, respectively (Fig. 3). Soil pH remained relatively stable but increased slightly after the planting of non-legumes such as sesame and maize (Fig. 5). These results are due to legume crops increasing soil carbon and available soil nitrogen through symbiotic N_2 fixation and nitrogen-rich residue return, thereby improving soil fertility and Increased biomass and root residues from legumes help retain more potassium in the soil for the following sugar beet crop. In contrast, maize and sesame had little effect on these fertility attributes and tend to be soil nutrient depleters rather than contributors. The same trend was shown by (Fageria and Moreira 2011; Abdou *et al.,* 2020).

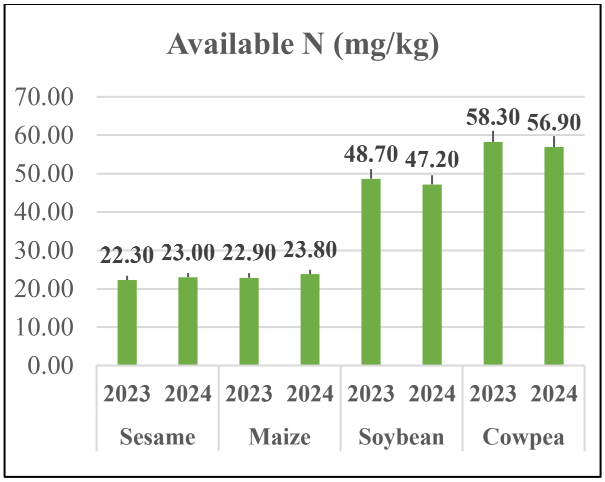

Fig. 1. Available N (mg/kg) after harvesting preceding crops

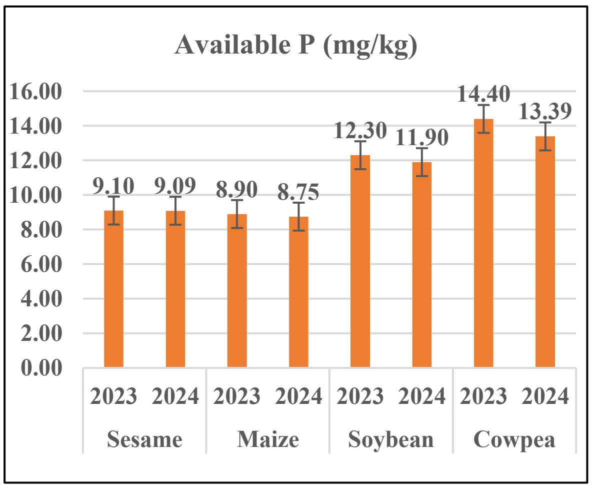

Fig. 2. Available P (mg/kg) after harvesting preceding crops

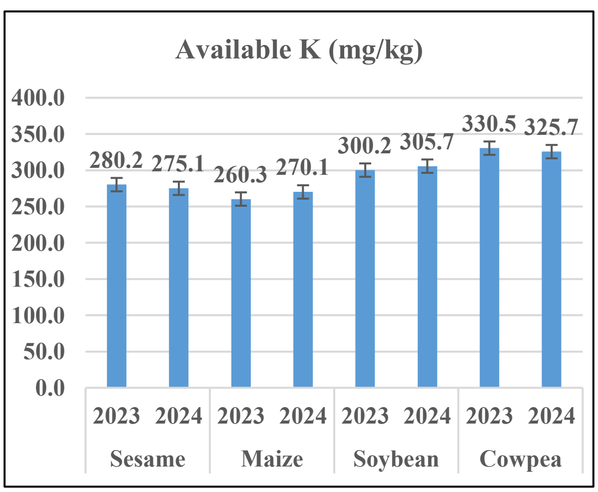

Fig. 3. Available K (mg/kg) after harvesting preceding crops

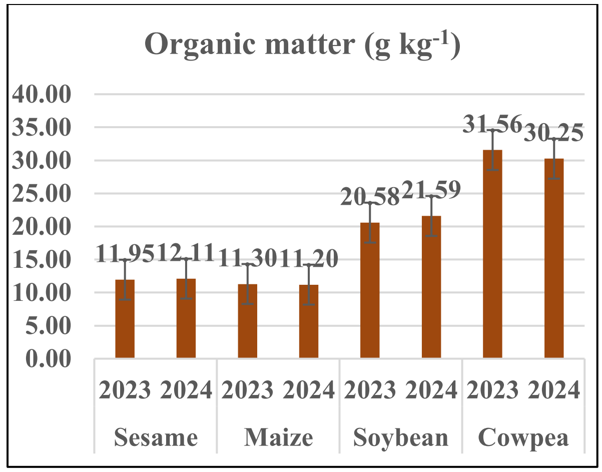

Fig. 4. Organic matter (g kg^{-1}) after harvesting preceding crops

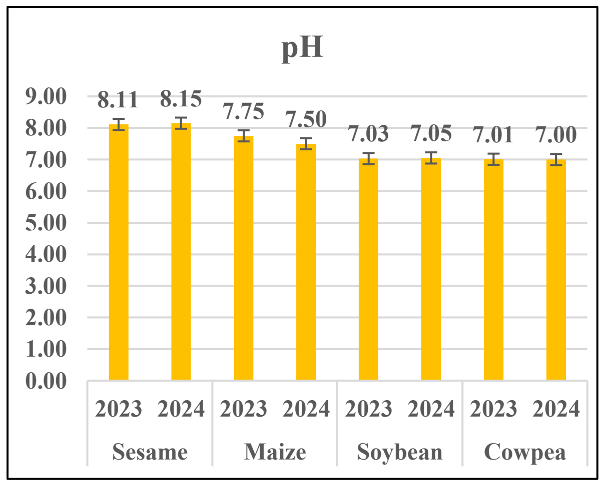

Fig. 5. pH after harvesting preceding crops

2. Chlorophyll content

2.1. Effect of preceding crops

Data in Table 3 show the type of preceding crop had a highly significant effect on chlorophyll parameters (a, b, and a+b) in leaves of sugar beet in the combined data across the two seasons. Sugar beet grown after cowpea consistently exhibited the highest chlorophyll a, b, and total chlorophyll (a+b) contents. The chlorophyll a content for cowpea as the preceding crop was 3.38 µg/ml, followed closely by soybean at 3.17 µg/ml, while the lowest values were observed for maize and sesame at 1.93 µg/ml and 1.72 µg/ml. On the other hand, the content of chlorophyll b, in sesame shows the highest levels (2.64 µg/ml), and cowpea the lowest (1.59 µg/ml). Cowpea has the greatest total chlorophyll content (4.96 µg/ml) compared to sesame crop, which was lower (4.35 µg/ml). This is attributed to the rotation with legume crops, such as cowpea and soybean, which is known to enhance soil nitrogen availability and soil microbial activity, contributing to improved physiological performance in subsequent crops. The results are in general agreement with those obtained by (Hamd-Alla, 2015; El-Bassiony *et al.,* 2016; Khalil *et al.,* 2021). This beneficial effect is evident in our study, where the legumes, especially cowpea, provided both the highest chlorophyll fractions and improved overall plant vigor compared to maize and sesame. Similar findings were reported by Abd El-Ghany *et al.,* (2020), who showed that sugar beet grown after legumes had increased leaf chlorophyll content and photosynthetic rates.

2.2. Effect of fertilizer applications

Data presented in Table 3 showed that chlorophyll content of maize was reacted significantly to fertilizer treatments in the combined data across the two seasons. The mixed treatment (combination of microelements and humic acid + molasses) resulted in the highest chlorophyll a (3.62 µg/ml) and total chlorophyll contents (5.06 µg/ml) compared to other treatments. The humic acid plus molasses treatment provided intermediate chlorophyll a value of (2.89 µg/ml) and (4.72 µg/ml) for total chlorophyll, followed by the microelements (Fe + Zn + Mn + B) treatment, which resulted in lower, but still notably improved chlorophyll content values of (2.41 µg/ml) for chlorophyll a and (4.62 µg/ml) for total chlorophyll. The control consistently showed the lowest values in chlorophyll a (1.27 and (4.08 µg/ml) for total chlorophyll. On the other hand, the content of the chlorophyll b in the control treatment showing the highest levels (2.82 µg/ml) compared to the mixed treatment which was lower (1.44 µg/ml.) This in turn may be due to the humic acid and microelements, which are known to enhance plant growth, photosynthetic activity, chlorophyll content, enzymatic activity, and decrease the oxidative damage. Such findings are in general accordance with those obtained by (Ghazy *et al.,* 2024; Xing *et al.,* 2025). El-Desuki *et al.,* (2017) and Farahat *et al.,* (2019) both found that humic acid applications improved nutrient uptake and chlorophyll synthesis in sugar beet. Furthermore, the supplementation with microelements such as iron, zinc, and manganese has been found to positively affect chlorophyll content and photosynthetic efficiency.

2.3. Interaction between preceding crops and fertilizer applications

The interaction between preceding crops and fertilizer application was also statistically significant for all chlorophyll measures. The data showed that in Table 3, the highest values were observed when sugar beet was grown after cowpea and treated with the mixed treatment achieved chlorophyll a and total chlorophyll values of (4.90 and 5.67 µg/ml), respectively. By contrast, the lowest values were observed in the control after sesame, where chlorophyll a and total were 1.25 µg/ml and 3.97 µg/ml. The low chlorophyll a content recorded for non-legume rotations and the control fertilizer treatment highlights the risk of continued monoculture and minimal fertilization, confirming recommendations from Nour El-Din and El-Sheikh (2019) for diversification and improved nutrient management in sugar beet production systems.

Table 3. Effect of preceding crops, fertilizer applications, and their interaction on chlorophyll content in the combined data across the two seasons

Treatments		Chlorophyll a	Chlorophyll b	Total chlorophyll
Preceding crops				
Sesame		1.71	2.64	4.35
Maize		1.93	2.46	4.38
Soybean		3.17	1.62	4.78
Cowpea		3.38	1.59	4.96
LSD at 5%		0.05	0.13	0.10
Fertilizer applications				
Control		1.26	2.82	4.08
Microelements		2.41	2.21	4.62
Humic + Molasses		2.89	1.83	4.72
Mixed		3.62	1.44	5.06
LSD at 5%		0.04	0.17	0.15
Interaction				
Sesame	**Control**	1.25	2.72	3.97
	Microelements	1.32	2.96	4.28
	Humic + Molasses	1.87	2.67	4.55
	Mixed	2.40	2.22	4.62
Maize	**Control**	1.23	2.71	3.94
	Microelements	1.72	2.78	4.49
	Humic + Molasses	1.99	2.34	4.32
	Mixed	2.80	2.00	4.79
Soybean	**Control**	1.28	2.91	4.19
	Microelements	3.28	1.59	4.89
	Humic + Molasses	3.72	1.19	4.91
	Mixed	4.39	0.78	5.17
Cowpea	**Control**	1.30	2.92	4.23
	Microelements	3.33	1.52	4.85
	Humic + Molasses	3.99	1.12	5.11
	Mixed	4.90	0.77	5.67
LSD at 5%		0.1	0.21	0.25

3. Vegetative traits

3.1. Effect of preceding crops

The identity of the preceding crop exerted a highly significant influence on all measured sugar beet vegetative traits in the combined data across the two seasons. Data in Table 4 show that the advantage of cowpea and soybean over sesame and maize. Among the four crops, cowpea as a prior crop resulted in the highest values for top fresh weight, top dry weight, root length, root diameter, and root weight/plant. Cowpea crop produced a top fresh weight of 360.02 g/plant, top dry weight of 55.44 g, root length of 42.56 cm, root diameter of 38.87 cm, and root weight of 1457.93 g/plant. Soybean also substantially improved growth (e.g., root weight/plant: 1434.87 g, while maize and sesame lagged behind (e.g., sesame root weight/plant: 1332.95 and 1316.35 g). confirming that the advantage of cowpea and soybean over sesame and maize is not due to chance. This is attributed to the legumes fixing atmospheric nitrogen and improving soil biological activity (as shown in fig. 1,2,3 and 4). Hence, create a more favorable environment for subsequent sugar beet crop growth and root development. The present results are in general accordance with those obtained by (El-Bassiony *et al.,* 2016; Attia *et al.,* 2018; Ibrahim 2018; Ahmed and Hassan 2019; Khalil *et al.,* 2021;

Ragab *et al.,* 2022; Grunwald *et al.,* 2025). Abd El-Ghany *et al.,* (2020) similarly found increases in root and shoot biomass of sugar beet following legume crops, attributing these gains to increased soil fertility and nutrient cycling.

3.2. Effect of fertilizer applications

Fertilizer applications markedly improved all vegetative traits. The mixed treatment (combination of microelements, humic acid, and molasses) produced the highest results in the combined data across the two seasons. Data in Table 4 reveal that the mixed treatment generated a top fresh weight of 371.04 g/plant, top dry weight of 57.11 g, root length of 44.26 cm, diameter of 41.29 cm and the greatest root weight of 1482.42 g/plant. The humic acid + molasses treatment also showed strong positive effects, remaining superior to the microelements (Fe, Zn, Mn, B) treatment, while the control yielded the lowest values (e.g., 277.17 g top fresh weight/plant and 1258.92 g root weight/plant). This is due to the combination of micronutrients and organic stimulants, such as humic acid, which has been shown to enhance nutrient uptake, root growth, and shoot biomass in root crops. El-Desuki *et al.,* (2017) showed improved sugar beet growth and yield parameters with humic acid and molasses applications, while Farahat *et al.,* (2019) found that the addition of iron, zinc, and manganese improved both root diameter and top growth. Microelements are essential for chlorophyll formation and enzyme activation, while humic acid and molasses stimulate root proliferation and soil microbial populations, further promoting plant development (Rassam *et al.,* 2015; Ali *et al.,* 2018; Abu-Ellail *et al.,* 2020).

3.3. Interaction between preceding crops and fertilizer applications

The interaction between of the preceding crop and fertilizer applications produced further significant differences for all recorded traits (Table 4). For every trait, the combination of cowpea as a preceding crop and mixed fertilizer treatment led to the highest results, while sesame with control fertilizer persistently resulted in the lowest. Root weight/plant after cowpea and the mixed treatment reached 1582.79 g compared to 1256.79 g for sesame with control. Similar trends were observed for other traits: cowpea × mixed produced a root length of 50.09 cm, compared to 28.90 cm for sesame × control. For top fresh weight/plant, cowpea × mixed achieved 411.16 g, against sesame × control by 270.80 g. Differences between these and all intermediate treatment combinations (such as soybean × humic acid + molasses, maize × microelements, etc.) were mostly significant. This is due to more efficient nutrient use and a better root environment. Consistent with research demonstrating the compounding effects of legume rotations and advanced nutrient strategies, El-Hassanin *et al.,* (2015) who found that the positive effect of legumes on subsequent beet yield was magnified when mineral fertilizers were supplemented with organic matter and micronutrients.

Table 4. Effect of preceding crops, fertilizer applications, and their interaction on vegetative traits in the combined data across the two seasons

Treatments		Top fresh weight/ plant (g)	Top dry weight/ plant (g)	Root length (cm)	Root diameter (cm)	Root weight/ plant (g)
Preceding crops						
Sesame		302.14	46.08	32.49	25.90	1316.35
Maize		308.13	47.00	34.05	28.35	1332.95
Soybean		356.07	53.87	41.95	37.65	1434.87
Cowpea		360.02	55.44	42.56	38.87	1457.93
LSD at 5%		12.94	0.68	0.86	1.03	6.93
Fertilizer applications						
Control		277.17	41.12	28.94	20.95	1258.92
Microelements		328.14	50.30	36.94	32.20	1370.85
Humic + Molasses		350.01	53.85	40.90	36.33	1429.91
Mixed		371.04	57.11	44.26	41.29	1482.42
LSD at 5%		8.22	1.34	0.86	1.01	6.46
Interaction						
Sesame	**Control**	270.80	40.18	28.90	20.85	1256.79
	Microelements	285.85	43.90	29.39	21.83	1269.49
	Humic + Molasses	316.32	48.63	33.79	27.31	1345.68
	Mixed	335.58	51.61	37.88	33.62	1393.57
Maize	**Control**	266.88	39.50	28.72	20.49	1253.00
	Microelements	304.21	46.75	31.72	24.91	1315.39
	Humic + Molasses	321.94	49.50	35.93	31.11	1359.72
	Mixed	339.52	52.23	39.83	36.89	1403.66
Soybean	**Control**	291.89	41.79	29.01	21.06	1261.39
	Microelements	364.54	55.46	43.45	41.03	1448.72
	Humic + Molasses	369.93	56.94	46.11	42.29	1479.70
	Mixed	397.91	61.27	49.23	46.23	1549.64
Cowpea	**Control**	279.10	43.00	29.15	21.40	1264.62
	Microelements	357.96	55.08	43.21	41.04	1449.78
	Humic + Molasses	391.87	60.33	47.78	44.60	1534.53
	Mixed	411.16	63.33	50.09	48.45	1582.79
LSD at 5%		13.51	1.47	1.42	1.66	10.62

4. Yield traits

4.1. Effect of preceding crops

The data in Table 5 show that the preceding crop significantly affected the yield traits of sugar beet. Cowpea as the preceding crop resulted in the highest values for all yield traits in the combined data across the two seasons. Sugar yield after cowpea reached 5.74 ton/fed, root yield was 30.90 ton/fed, top dry weight was 1.90 ton/fed, and top fresh weight was 12.34 ton/fed. Soybean was also highly beneficial, with sugar yield of 5.49 ton/fed and root yield of 29.92 ton/fed. In contrast, sesame consistently resulted in the lowest values (sugar yield: 4.29 ton/fed and root yield: 25.78 ton/fed), with maize intermediate between the two legumes and sesame. This is due to the benefits of legume crop rotation and agroecosystems, where legumes improve residual nitrogen, soil physical properties (as shown in figs. 1,2,3 and 4) and stimulate soil biota, all of which contribute to enhanced root development and biomass accumulation. The present results are in general accordance with those obtained by (El-Bassiony *et al.,* 2016; Ali *et al.,* 2018; Attia *et al.,* 2018; Ibrahim 2018; Ahmed and Hassan 2019; Abd El-Ghany *et al.,* 2020; Khalil *et al.,* 2021).

4.2. Effect of fertilizer application

Fertilizer application had a strong positive impact on all traits measured in Table 5. The mixed treatment (combining humic acid + molasses and microelements) resulted in the highest yield traits in the combined data across the two seasons. The mixed treatment produced sugar yield of 5.97 ton/fed, root yield of 31.76 ton/fed, top dry weight of 1.95 ton/fed, and top fresh weight of 12.70 ton/fed. The humic acid + molasses treatment also improved yield compared to the control and microelements alone, giving sugar yield 5.43 ton/fed and root yield 29.97 ton/fed. The microelement treatment resulted in moderate improvements (sugar yield: 4.93 ton/fed), while the control produced the lowest yield (sugar yield: 3.62 ton/fed). The superior effect of the mixed treatment is in agreement with studies indicating the necessity of integrated fertilization for maximizing root crop yield (Farahat *et al.,* 2019; Abu-Ellail *et al.,* 2020). El-Sabagh *et al.,* (2021) revealed that sugar beet yield and sugar extraction rates improved significantly with micronutrient supplementation and humic substances, due both to direct nutritional effects and to enhanced root architecture. Likewise, molasses as a carbon source has been found to boost soil microbial activity and improve nutrient availability (El-Desuki *et al.,* 2017). Ali *et al.,* (2018) who showed that sugar beet grown with combined mineral and organic fertilizers yielded significantly more than with either alone.

4.3. Interaction effects (preceding crops × fertilizer applications)

The interaction between the preceding crop and fertilizer application further emphasized the significant advantages of legume rotation and advanced nutrition. The data in Table 5 proved that the highest yield was recorded for sugar beet after cowpea with the mixed fertilizer treatment. This combination produced sugar yield of 6.98 ton/fed, root yield of 35.17 ton/fed, top dry weight of 2.16 ton/fed, and top fresh weight of 14.06 ton/fed higher than any other treatment combination. On the other hand, the lowest values were seen in the control × sesame, where sugar yield was 3.51 ton/fed, root yield was 22.76 ton/fed, top dry weight was 1.46 ton/fed, and top fresh weight was 9.45 ton/fed. This is attributed to integrated crop and soil fertility management, which provides the most benefits to sugar beet, not only yielding heavier and better-quality roots but also improving plant establishment and resilience (Abd El-Ghany *et al.,* 2020; Nour El-Din and El-Sheikh 2019). Conversely, minimal yield from sesame-control plots is consistent with literature showing that continuous non-legume rotations and limited fertilization exacerbate nutrient depletion, poor root growth, and suboptimal yield in root crops (El-Bassiony *et al.,* 2016).

Table 5. Effect of preceding crops, fertilizer applications, and their interaction on yield traits in the combined data across the two seasons

Treatments		Top fresh weight (ton/fed)	Top dry weight (ton/fed)	Root yield (ton/fed)	Sugar yield (ton/fed)
Preceding crops					
Sesame		10.40	1.60	25.78	4.29
Maize		10.62	1.62	26.28	4.43
Soybean		12.03	1.85	29.92	5.49
Cowpea		12.34	1.90	30.90	5.74
LSD at 5%		0.13	0.28	0.26	0.11
Fertilizer applications					
Control		9.50	1.47	23.21	3.62
Microelements		11.20	1.71	27.94	4.93
Humic + Molasses		11.98	1.84	29.97	5.43
Mixed		12.70	1.95	31.76	5.97
LSD at 5%		0.13	0.02	0.62	0.14
Interaction					
Sesame	**Control**	9.45	1.46	22.76	3.51
	Microelements	9.80	1.50	24.51	3.95
	Humic + Molasses	10.84	1.66	27.10	4.59
	Mixed	11.49	1.76	28.74	5.09
Maize	**Control**	9.41	1.45	22.40	3.38
	Microelements	10.43	1.57	26.07	4.37
	Humic + Molasses	11.03	1.69	27.58	4.79
	Mixed	11.63	1.79	29.08	5.19
Soybean	**Control**	9.53	1.47	23.44	3.70
	Microelements	12.32	1.89	30.54	5.69
	Humic + Molasses	12.66	1.94	31.66	5.95
	Mixed	13.61	2.09	34.04	6.63
Cowpea	**Control**	9.63	1.49	24.24	3.89
	Microelements	12.25	1.88	30.64	5.70
	Humic + Molasses	13.40	2.06	33.53	6.39
	Mixed	14.06	2.16	35.17	6.98
LSD at 5%		0.22	0.04	1.03	0.22

5. Impurities traits

5.1. Effect of preceding crops

The preceding crop significantly affected α-amino N%, K% and Na% in the combined data across the two seasons. The data in Table 6 show that sugar beet grown after sesame and maize had significantly higher α-amino N%, K% and Na% than those preceded by soybean or cowpea. The highest values for α-amino N% was 0.99% (sesame) followed by 0.97% (maize). For K% values were 4.95% (sesame), 4.82% (maize), 4.32% (soybean), and 4.24% (cowpea). Na% content showed a parallel trend, with sesame and maize (2.00% and 1.92%) higher than soybean and cowpea (1.73% and 1.69%). Thus, preceding crops of legumes (cowpea and soybean) reduce the sodium and potassium content in the beet, suggesting an improved ionic balance under these crop sequences. These results are attributed to legume-based rotations reducing K and Na, thus contributing to better ionic regulation and reduced risk of physiological stress in sugar beet. The same trend was shown by Khalil *et al.,* (2021).

5.2. Effect of fertilizer applications

The fertilizer applications significantly affected α-amino N%, K% and Na% in the combined data across the two seasons (Table 6). The control treatment had the highest of α-amino N% (1.05%), K% (5.19%), and Na% (2.12%). The addition of microelements (Fe + Zn + Mn + B) led to moderate reductions in all impurity's traits, while the humic acid + molasses treatment induced further decreases in α-amino N%, K%, and Na% (0.90%, 4.40%, and 1.75%), respectively. The most substantial decreases occurred under the mixed fertilizer treatment (microelements, humic acid, and molasses): here, α-amino N% dropped (0. 81), K% (4.09%) and Na% (1.63%). The response observed, particularly the reduction in α-amino N%, K% and Na% under mixed fertilizer application (humic acid + molasses and microelements) is strongly supported by El-Desuki *et al.,* (2017) found that humic acid and organic matter additions promote nutrient balance, improve soil cation exchange capacity, and reduce the uptake of excessive mineral ions when crops are stressed or grown continuously without legumes or organic additions.

5.3. Interaction between preceding crops and fertilizer applications

Evaluating the interaction of preceding crop × fertilizer application further reveals significant reductions in α-amino N%, K%, and Na% in Table 6. These results show that cowpea or soybean as preceding crops and applying mixed fertilizer treatment significantly lowers the α-amino N%, K%, and Na%. For α-amino N%, the highest values were recorded under control with sesame (1.06%). This trend persisted for K% (control with sesame, 5.19%), while cowpea with mixed fertilizer achieved the lowest values of α-amino N% (0.71%), K% (3.60%) and Na% (1.42%).

Table 6. Effect of preceding crops, fertilizer applications, and their interaction on impurities traits in the combined data across the two seasons

Treatments		α-amino N%	K%	Na%
Preceding crops				
Sesame		0.99	4.95	2.00
Maize		0.97	4.82	1.92
Soybean		0.88	4.32	1.73
Cowpea		0.85	4.24	1.69
LSD at 5%		0.01	0.03	0.06
Fertilizer applications				
Control		1.05	5.19	2.12
Microelements		0.93	4.64	1.85
Humic + Molasses		0.90	4.40	1.75
Mixed		0.81	4.09	1.63
LSD at 5%		0.01	0.03	0.08
Interaction				
Sesame	**Control**	1.06	5.19	2.21
	Microelements	1.03	5.16	2.05
	Humic + Molasses	0.98	4.92	1.95
	Mixed	0.89	4.51	1.81
Maize	**Control**	1.07	5.21	2.08
	Microelements	0.99	5.00	2.00
	Humic + Molasses	0.92	4.65	1.85
	Mixed	0.88	4.43	1.76
Soybean	**Control**	1.03	5.19	2.12
	Microelements	0.84	4.20	1.67
	Humic + Molasses	0 .80	4.05	1.60
	Mixed	0.76	3.83	1.52
Cowpea	**Control**	1.04	5.17	2.06
	Microelements	0.84	4.21	1.67
	Humic + Molasses	0.79	3.97	1.58
	Mixed	0.71	3.60	1.42
LSD at 5%		0.02	0.05	0.14

6. Quality traits

6.1. Effect of preceding crops

The effect of preceding crops on quality traits in sugar beet was highly significant in the combined data across the two seasons. Data presented in Table 7 show that the sugar beet grown after sesame showed the highest sucrose% with a value of 18.39%. This was closely followed by maize, with sucrose% of 18.17%. Both non-legume preceding crops significantly outperformed legume rotations, cowpea and soybean, which averaged lower sucrose contents 16.77% (soybean) and 16.54% (cowpea). Sugar loss in molasses% echoed this hierarchy with sesame at 1.72% followed by maize at 1.68% and the two crops trailing at about 1.56-1.54% soybean and cowpea, respectively. Extractable sugar% showed the highest value of 16.25% for sesame. The highest among crops, with maize also superior to soybean and cowpea. Quality% similarly reflected this trend, where sesame achieved the highest values (88.22%) with maize close behind (87.96%). Soybean and cowpea had notably lower quality percentages around 86.28% and 85.91%, respectively. These findings could be the result of the reduction in root diameter and weight following sesame and maize, which lowers tissue water content and non-sucrose substances like proteins and alpha amino nitrogen. This, in turn, raises the sucrose percentage content in sugar beet roots. These results are coincidence with those reported by (Ibrahim 2018; Attia *et al.,* 2018).

6.2. Effect of fertilizer applications

Regarding fertilizer, the effects were significant for each trait. Data in Table 7 show the mixed fertilizer treatment (combination of microelements, humic acid, and molasses) delivered the highest sugar quality across all traits in the combined data across the two seasons. Sucrose content peaked under this treatment at 18.73%, surpassing the other fertilizer treatments. The humic acid + molasses treatment followed closely with sucrose values of 18.04%, while the microelement treatment and control were significantly lower, with sucrose% near 17.53% and 15.59%, respectively. Sugar loss in molasses% was marginally increased with control treatment at (1.78%) compared to other treatments. The highest value recorded for extractable sugar% was with the mixed treatment (16.62%). Quality% was highest under the mixed treatment (88.70%), which was significantly greater compared to the control (84.68%). These results highlight that humic substances, in combination with micronutrients, not only enhance sugar beet biochemical composition but also improve processing quality and total recoverable sugar. Molasses as an amendment is also recognized for supporting soil microbial health and facilitating sugar translocation within the plant. The same trend was detected by (El-Desuki *et al.,* 2017; Farahat *et al.,* 2019; Abu-Ellail *et al.,* 2020; El-Sabagh *et al.,* 2021).

6.3. Interaction of preceding crops and fertilizer applications

The data in Table 7 reveal that the combined effect of preceding crops and fertilizer applications further underlined the superior performance of non-legumes combined with advanced fertilization. Sesame with mixed fertilizer treatment exhibited the highest values in nearly all traits: sucrose% reached 19.87%, purity% was 90.02% and extractable sugar was 17.88%. On the other hand, the lowest sugar loss in molasses was 1.38% with cowpea with mixed fertilizer treatment.

Table 7. Effect of preceding crop, fertilizer applications, and their interaction on quality traits in the combined data across the two seasons

Treatments		Sucrose%	Sugar loss in molasses%	Extractable sugar%	Quality%
Preceding crops					
Sesame		18.39	1.72	16.25	88.22
Maize		18.17	1.68	16.00	87.96
Soybean		16.77	1.56	14.48	86.28
Cowpea		16.54	1.54	14.22	85.91
LSD at 5%		0.26	0.01	0.27	0.27
Fertilizer applications					
Control		15.59	1.78	13.20	84.68
Microelements		17.53	1.64	15.28	87.12
Humic + Molasses		18.04	1.58	15.86	87.86
Mixed		18.73	1.50	16.62	88.70
LSD at 5%		0.35	0.01	0.36	0.40
Interaction					
Sesame	**Control**	16.04	1.80	13.67	85.21
	Microelements	18.62	1.77	16.48	88.54
	Humic + Molasses	19.06	1.71	16.98	89.11
	Mixed	19.87	1.61	17.88	90.02
Maize	**Control**	15.80	1.79	13.41	84.93
	Microelements	18.61	1.73	16.48	88.53
	Humic + Molasses	18.80	1.64	16.70	88.86
	Mixed	19.48	1.59	17.43	89.53
Soybean	**Control**	15.08	1.78	12.69	84.16
	Microelements	16.76	1.54	14.43	86.10
	Humic + Molasses	17.38	1.49	15.13	87.10
	Mixed	17.86	1.44	15.67	87.75
Cowpea	**Control**	15.43	1.77	13.02	84.42
	Microelements	16.13	1.53	13.76	85.32
	Humic + Molasses	16.93	1.47	14.62	86.37
	Mixed	17.71	1.38	15.50	87.53
LSD at 5%		0.58	0.02	0.59	0.66

Economic evaluation

The economic productivity of the effect of interaction between the preceding crop and fertilizer applications was performed for the total income, total cost, and net return (L.E./fed) in the combined data across the two seasons. The results in Table 8 showed that the combination of cowpea with the mixed fertilizer treatment produced a highest total income (105331 L.E./fed) and net return (66338 L.E./fed) than the other treatments, followed by the combination of soybean with the mixed fertilizer treatment (101948 and 62955 L.E./fed) for total income and net return, respectively, as the combined data across the two seasons. On the other hand, the lowest values of total income and net return were found with the combination of sesame with the control fertilizer treatment (68289 and 32667 L.E./fed), respectively, as the combined data across the two seasons. These results are in accordance with (Ibrahim 2018; Attia *et al.,* 2018).

Table 8. Effect of the interaction between preceding crop, and fertilizer applications on economic evaluation (L.E./fed) in the combined data across the two seasons

Treatments		Actual root yield (L.E./fed)	Actual top yield (L.E./fed)	Total income (L.E./fed)	Total cost (L.E./fed)	Net return (L.E./fed)
Preceding crops	**Fertilizer applications**					
Sesame	**Control**	64934	3355	68289	35622	32667
	Microelements	69927	3479	73406	36128	37278
	Humic + Molasses	77316	3848	81165	37865	43300
	Mixed	81995	4079	86074	38993	47081
Maize	**Control**	63907	3341	67248	35622	31626
	Microelements	74378	3703	78080	36128	41952
	Humic + Molasses	78686	3916	82601	37865	44736
	Mixed	82965	4129	87094	38993	48101
Soybean	**Control**	66874	3383	70257	35622	34635
	Microelements	87131	4374	91504	36128	55376
	Humic + Molasses	90326	4494	94820	37865	56955
	Mixed	97116	4832	101948	38993	62955
Cowpea	**Control**	69157	3419	72575	35622	36953
	Microelements	87416	4349	91765	36128	55637
	Humic + Molasses	95661	4757	100418	37865	62553
	Mixed	100340	4991	105331	38993	66338

*Price L.E. per ton was: root and top of sugar beet 2853 and 355, respectively.

CONCLUSION

From this, we can conclude that planting sugar beet after cowpea or soybean and applying mixed fertilizer treatment (humic acid + molasses and microelements) produced the highest sugar yield, root yield, quality, and economic return as compared to cereal (maize) or oilseed (sesame) as preceding crops, which, in combination with control or single-element fertilization, produced the lowest sugar yield, root yield, quality, and economic return. The highest total income (105331 L.E./fed) and net return (66338 L.E./fed) were obtained with the combination of cowpea with the mixed fertilizer treatment.

REFERENCES

Abd El-Ghany, S. B., El-Sayed, A. A. and Mohamed, S. M. (2020). Effect of preceding summer crops and fertilization on growth and yield of sugar beet under Middle Egypt conditions. *Journal of Plant Production*, 11(3): 223–231. https://doi.org/10.21608/jpp.2020.187510.

Abdelaal, K. 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. *Journal of Plant Production,* 6(1): 123-133.

Abdou, M. A., Moursi, A. A. and El-Khawaga, A. S. (2020). Impact of legume-cereal rotations on soil fertility and crop productivity under Egyptian conditions. *Egyptian Journal of Agronomy*, 42(1): 45-60.

Abofard, M. M., Gaber, A. A. M., Abdel-Mogib, M., Bakr, M. N. and Abou-ElWafa, S. F. (2021). Effect of the application of molasses and vinasses on the yield and quality of sugar beet and soil fertility. *Egyptian Sugar Journal*, 17(17): 23-40.

Abou-Elwafa S.F., Amin AE-EA and Eujayl, I. (2020). Genetic diversity of sugar beet under heat stress and deficit irrigation. *Agronomy Journal* 112:3579-3590.

Abu-Ellail, F. F., Sadek, K. A. and El-Laboudy, E. H. S. (2020). Yield and quality of some sugar beet varieties as affected by humic acid application rates under sandy soil condition. *Journal of Plant Production*, 11(9): 791-796.

Ahmed, N. R. and Hassan, H. M. (2019). Effect of some Preceding Crops on Sugar Beet Productivity and its Relationship with Phyto-Nematodes Infestation. *Journal of Plant Production*, 10(12): 957-965.

Ali, A. M., Ali, A. M. K. and Hamd-Alla, W. (2023). Sugar beet productivity response to intercropping system and nitrogen fertilizer. *Asian Journal of Research in Crop Science*, 8(4): 287-301. DOI: 10.9734/AJRCS/2023/v8i4209

Ali, M. M., El-Ghamry, A. M., and El-Mokadem, M. T. (2018). Effect of crop sequence and organic/inorganic fertilization on sugar beet performance and soil fertility. *Egyptian Journal of Agronomy*, 40(2): 141–154.

Attia, Z. M., El-Mehy, A. A. and Badr, K. S. (2018). Effect of preceding and catch crop with boron foliar application on yield and quality of sugar beet (*Beta vulgaris* L.). *Menoufia Journal of Plant Production*, 3(3): 287-301.

Cooke, D. A and Scott, R. K. (1993). The Sugar Beet Crop. Science Practice. Published by Chapman and Hall, London. 262- 265.

Deshmukh P. S., Naitam R. K., Surwase S. A., Kharade J. P., & Buddhe V. A. (2024). Effect of humic acid on growth, yield and quality of sugarcane. *International Journal of Research in Agronomy* 7(7): 564-567.

El-Bassiony, A. M., Fawzy, Z. F., & Abd El-Monem, A. A. (2016). Influence of legume rotation and organic amendments on sugar beet productivity and soil properties. *Annals of Agricultural Science, Moshtohor*, 54(3): 483–494.

El-Desuki, M., Salman, S. R., El-Greadly, N. H. M., & Ismail, M. M. (2017). Effect of humic acid on growth, yield and quality of sugar beet grown in reclaimed soil. *Mansoura Journal of Plant Production*, 8(3): 201–218.

El-Hassanin, A. S., El-Behairy, U. A., & Abdel-Hady, S. N. (2015). Integrated nutrient management for maximizing sugar beet yield under different preceding crops. *Egyptian Journal of Agricultural Research*, 93(4): 1061–1074.

El-Sabagh, A., Elbalkiny, A. and Samy, F. (2021). Integrated fertilization for maximizing sugar beet productivity under Egyptian environmental conditions. *Egyptian Journal of Agronomy,* 43(1): 77–91.

Enan, S. A. A. M., Aly, E. F. A. and Badr, A. I. (2016). Effect of humic acid and potassium on yield and quality of some sugar beet varieties in sandy soil. *Journal of Plant Production*, 7(2): 289-297.

Fageria, N. K., & Moreira, A. (2011). The role of mineral nutrition on root growth of crop plants. *Advances in Agronomy*, 110, 251-331. https://doi.org/10.1016/B978-0-12-385531-2.00004-9.

Farahat, E. A., Zaki, M. S., & Abouziena, H. F. (2019). Role of micronutrients and organic fertilizers in improving productivity and quality of sugar beet (*Beta vulgaris* L.). *Zagazig Journal of Agricultural Research,* 46(4): 1637–1650.

Ghazy, N. A., Omar, H. A., Abd-Rabboh, M. S. and Elgamal, I. S. H. (2024). Impact of humic acid and some nanomaterials on Alternaria leaf spot disease and sugar beet productivity. *Middle East J. Agric. Res.,* 13(1): 173-188. DOI: 10.36632/mejar/2024.13.1.10

Gobarah, M. E., Tawfik, M. M., Zaghloul, S. M., and Amin, G. A. (2014). Effect of combined application of different micronutrients on productivity and quality of sugar beet plants (*Beta vulgaris* L.). *International Journal of Plant and Soil Science*, 3(6): 589-598.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research. 2nd Ed. John Wiley Sons. New York. USA.

Grunwald, D., Poeplau, C., Koch, H. J., and Jacobs, A. (2025). Effect of sugar beet (*Beta vulgaris* L.) cultivation on soil organic carbon stocks in Germany. *Soil Use and Management*, 41(1): e70022.

Hamada, A., and Hamd-Alla, W. (2019). Productivity of intercropped wheat with faba bean under crop sequences and foliar application of humic acid. *Egyptian Journal of Agronomy*, 41(3): 225-241.

Hamd-Alla, W. A. A. (2015). Comparative studies on two and three-year crop sequences in newly reclaimed soils (PhD Thesis, Assiut University). https://doi.org/10.1007/s13593-017-0469-z

Ibrahim, M. E. M. (2018). Effect of preceding summer crops on yield and quality of sugar beet intercropped with faba bean. *Journal of Plant Production*, 9(1): 59-65.

Ibrahim, R. El., S. S., Kandil, E. E., and Ibrahim, N. Y. (2019). Productivity and quality of sugar beet in relation to humic acid and boron fertilization under Nubaria conditions. *Alexandria Science Exchange Journal*, 40 (January-March), 115-126.

Jacobs, A., Koch, H. J., and Märländer, B. (2018). Preceding crops influence agronomic efficiency in sugar beet cultivation. *Agronomy for sustainable development*, 38(1): 2-7.

Jing, J., Cong, W.F. and Bezemer, T.M. (2022). Legacies at work: plant-soil-microbiome interactions underpinning agricultural sustainability. *Trends Plant Sci. 27,* 781–792. https://doi.org/10.1016/j.tplants.2022.05.007.

Khalil, R. A., Ibrahim, E. A., and Mohamed, M. S. (2021). Crop rotation and fertilization impacts on chlorophyll status and yield components of sugar beet. *Egyptian Journal of Soil Science*, 61(2), 115–126.

Li Y., Xiaoxia G., and Lu T. (2025). Effects of different preceding crops on soil properties and rhizosphere microbial community of sugar beet. *Front. Plant Sci*.16. doi: 10.3389/fpls.2025.1626870.

Moran, R. (1982). Formulae for determination of chlorophyll pigments with N-N-dimethylformamide. *Plant Physiol.,* 69: 1376-1381.

Nour El-Din, M. S., and El-Sheikh, M. A. (2019). Enhancing sugar beet performance with crop rotation and integrated nutrient management. *Egyptian Journal of Applied Sciences,* 34(8): 1–15.

Ragab, M. E., Ahmed, R. S., and Ismail, K. M. (2022). Effects of previous crop and fertilization regime on sugar beet growth and yield in northern Nile Delta, Egypt. *Journal of Agricultural Sciences*, 67(2): 98–110.

SAS Institute (2009). The SAS System for Windows, release 9.2. Cary NC: SAS Institute.

Wang, L., Chen, M., Lam, P.Y., Dini-Andreote, F., Dai, L. and Wei, Z. (2022). Multifaceted roles of flavonoids mediating plant-microbe interactions. *Microbiome* 10(1): 233. https://doi.org/10.1186/s40168-022-01420-x.

Wilczewski, E., Szczepanek, M., and Wenda-Piesik, A. (2018). Response of sugar beet to humic substances and foliar fertilization with potassium. *Journal of central European agriculture.* 19(1): 153-165. DOI: /10.5513/JCEA01/19.1.2033.

Xing, X., Dong, S., Guo, M., Wei, L., and Shi, S. (2025). Optimizing Nitrogen Application Enhances Sugar Beet (*Beta vulgaris* L.) Productivity by Modulating Carbon and Nitrogen Metabolism. *Agronomy*, 15(5): 1142.

الملخص العربي

تأثير المحاصيل السابقة والأسمدة المختلفة على إنتاجية وجودة بنجر السكر والعائد الاقتصادي

محمد حامد محمد كريم ووائل حمدالله

قسم بحوث التكثيف المحصولي، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، الجيزة، مصر

أجريت تجربة حقلية خلال موسمي 2023–2024 و2024–2025 تحت ظروف محطة بحوث سخا الزراعية، بمحافظة كفر الشيخ، مصر، لتقييم تأثير المحاصيل الصيفية السابقة وتطبيقات الأسمدة المختلفة (التربة والرش الورقي) على إنتاجية وجودة بنجر السكر والعائد الاقتصادي. نفذت التجربة باستخدام تصميم الشرائح المنشقة بثلاث مكررات. حيث وزعت أربعة محاصيل سابقة: السمسم، الذرة الشامية، فول الصويا ولوبيا العلف، في القطع الأفقية بينما اشتملت القطع الرأسية على أربعة أنواع من الأسمدة لبنجر السكر: (الكنترول، العناصر الصغرى (الحديد + الزنك + المنجنيز + البورون)، حمض الهيوميك + دبس السكر وخليط (حمض الهيوميك + دبس السكر والعناصر الصغرى). وأشارت النتائج إلى أن زراعة المحاصيل البقولية مثل لوبيا العلف وفول الصويا قبل زراعة بنجر السكر أدى إلى تحسن ملحوظ في محتوى التربة من النيتروجين والفوسفور والبوتاسيوم والمادة العضوية، وحافظت على درجة حموضة التربة مستقرة. وعلى النقيض من ذلك، كان للذرة الشامية والسمسم تأثير ضئيل على سمات الخصوبة. بلغ إنتاج السكر 5.74 طن/فدان، وإنتاج الجذور 30.90 طن/فدان بعد لوبيا العلف. في المقابل، سجل السمسم أدنى القيم (على سبيل المثال، إنتاج السكر: 4.29 طن/فدان، وإنتاج الجذور: 25.78 طن/فدان) على مدى الموسمين، بينما حلت الذرة في مرتبة متوسطة بين البقوليات والسمسم. وقد تم الحصول على أعلى إجمالي للدخل الكلى (105,331 جنيه/فدان) وصافي العائد (66,338 جنيه/فدان) عند لوبيا العلف مع التسميد المختلط (حمض الهيوميك + دبس السكر والعناصر الصغرى لذلك، توصي هذه الدراسة بزراعة بنجر السكر بعد لوبيا العلف أو فول الصويا مع الأسمدة المخلوطة (حمض الهيوميك + الدبس والعناصر الصغرى) مما يؤدي إلى زيادة إنتاجية بنجر السكر والعائد الاقتصادي.