Influence of Sowing Method and Potassium Fertilization on Yield and Technological Traits of Some Sugar Beet Varieties

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ABSTRACT

A field experiment was carried out in the two successive seasons *i.e.*, 2022/23 and 2023/24 in Sinnuris, El-Fayoum Governorate (latitude 29° 27′ 34″N and longitude 30° 50′ 00.6″E) to find out the optimal sowing method and potassium fertilizer level to get the highest yield and quality traits of sugar beet. This work included eighteen treatments represent the combinations of two sowing methods (traditionally, in rows of 0.5 m apart and a manual double-row plantar sowing machine, with 0.35 m between rows) in addition to three potassium fertilizer levels (24, 36 and 48 kg K_2O/fed) for planting three monogerm sugar beet varieties, namely Joko, Narmar and Wombat Smart. A randomized complete block design in a split-split plot arrangement was used.

The results indicated that sowing sugar beet mechanically using hand planter scored higher values of root and sugar yields/fed and improved the values of sucrose and the extracted sugar % compared to traditional manual sowing method. Increasing potassium levels from 24 to 36 and 48 kg K_2O/fed significantly increased in root and sugar yields, as well as harvest index without significant difference between the two higher K^+ levels in all measured yield traits in both seasons, except for harvest index in the 1st season. There was a general tendency toward increasing the studied growth characters of sugar beet due to the gradual increase in potassium fertilizer levels. Increasing K levels decreased α-amino N in roots. Insignificant variance was detected between the tested sugar beet varieties and/or sowing methods in their effect on root impurities in terms of Na^+, K^+, α-amino N and alkalinity coefficient.

Under conditions of the present work, sowing sugar beet "Wombat Smart" variety using manual double-row planter for sowing and fertilized it with 36 or 48 kg K_2O/fed can be recommended to increase root and sugar yields/fed.

Key words: Growth, impurities, potassium, sowing method, sugar beet, varieties, quality, yields.

INTRODUCTION

Unlike wheat or alfalfa, sugar beet is grown as single plants per hills. Therefore, its root yield and technological characteristics are the final output of the harvested number of beets per unit area. Plant density has been recognized as a major factor in determining the degree of competition between plants (Sadre *et al.*, 2012). Increasing beets/fed to an optimal number assured an efficient utilization of the overall solar radiation, irrigation and nutrients by plants to produce more root and sugar yields/fed. Nowadays, the most common population density for sugar beet is around 90,000 and 110,000 plants ha^{-1} (Varga *et al*., 2020). Undoubtedly, sowing seeds mechanically is more efficient for having higher planting density compared to manual sowing due to avoiding the worker's error in increasing the distance between hills, placing seeds to a great depth in the soil or placing more than one seed per hill. In this context, Taieb (1997) found that the mechanical sowing of sugar beet saved 33 % of seeds compared with the manual sowing. On the other hand, Kanany *et al*. (2005) revealed that the manual seeding gave higher root yield than that of mechanical seeding but the differences were insignificant. In addition, El-Geddawy *et al.* (2008) showed that sowing sugar beet mechanically attained additional increment amounted to 8.52 % and 25.08 % in root yield over those under the traditional methods (sowing manually), in the 1st and 2nd season, respectively. Attia *et al.* (2011) cleared that mechanical sowing of sugar beet significantly surpassed the traditional sowing (manual) in all studied growth traits (root fresh and dry weights, foliage fresh and dry weights, leaf area index, crop growth rate and relative growth rate. Nassar *et al*. (2022) found that mechanical sowing method in rows increased root length and diameter, root and biological yields, as well as increased sugar yield, sucrose, recoverable sugar, extracted sugar and total soluble solids compared to hand sowing.

As for the variance between sugar beet varieties, Salem (2019) cleared that Gloria variety significantly surpassed MK 4016 and Samba varieties in root length, root diameter, root fresh weight, root yield and recoverable sugar and sugar yields. Abou-Ellail *et al.* (2020) showed that sugar beet varieties significantly differed, where Sirona surpassed Santolhne, Pepite, Amina, Beta 401, Dina, Grinta, and Bts 302 and attained the highest root diameter, root fresh weight/plant and root yield. Also, Bts 302 variety

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registered the values of root length, sucrose percentage and sugar yield.

Potassium is a major plant nutrient, which play an essential role in various physiological processes *i.e.,* photosynthesis, sugar translocation from leaves to be stored in roots. Potassium also has a role in protein synthesis, control of ionic balances, regulation of plant stomata and water use, enzyme activation and osmoregulation (Mengel, 2006; Marschner, 2012 and Nemeat-Alla *et al.,* 2021). Ismail *et al.* (2002) reported that potassium significantly affected root fresh weight, sucrose, purity %, root and sugar yields. Ismail and Allam (2007) showed that potassium levels significantly affected root length, diameter, fresh weight, root and sugar yields and sucrose % as well as root K^+ content and purity. Nafei *et al.* (2010) showed that applying K fertilizer at 36 kg K_2O/fed gave significant increases in root length, diameter and fresh weight/plant and root and sugar yields ton/fed. Salem (2019) found that fertilizing sugar beet with 48 kg K_2O/fed recorded the highest values of root dimensions, sucrose %, root K content, sugar lost to molasses %, root fresh weight and root yield, recoverable sugar and sugar yield/fed. Abd El-Mageed *et al*. (2022) stated that supplying beets with 144 kg K_2O ha^{-1} caused the maximum improvements in white sugar content with a decrease of 42.0% in root sodium content and an increase of 35.9% in root yield ha^{-1}.

Therefore, the present investigation was done to find out the best combination among the studied sowing methods and K^+ levels to obtain the highest root and sugar yields and technological characteristics of the tested sugar beet varieties.

MATERIAL AND METHODS

A field trial was conducted in the two successive seasons of 2022/23 and 2023/24 in Sinnuris, El-Fayoum Governorate (latitude 29° 27′ 34″ N and longitude 30° 50′ 00.6″ E), to find out the best combination of the following factors giving the highest yield and quality of sugar beet:

- Two sowing methods:

1. Manually, in rows of 0.5 m apart (42000 plants/fed) and 2. Using a manual double-row planter, with 0.35 m between rows (60000 plants/fed).

- Three monogerm sugar beet varieties namely Joko, Narmar and Wombat Smart.
- Three potassium fertilizer levels of 24, 36 and 48 kg K_2O/fed.

The soil of the experimental site was leveled precisely using LASER leveling technique before sowing. Sowing seeds using the hand double-row planter took place, in rows of 0.35 m, on a flat soil surface, while ridges of 0.50 m were set-up manually (traditional) sowing. Hill spacing was 0.2 m in both sowing methods.

A randomized complete block design in split split-plot arrangement using four replicates, where the two sowing methods were allocated in the main plots, sugar beet varieties were sown in the sub plots, while K-fertilizer levels were randomly applied in the sub-sub plots. Sub sub-plot area was 24.5 m^2, including 7 or 10 rows of 0.50 m or 0.35 m in width, respectively and 7 m in length.

Potassium treatments were applied once with the 1st dose of nitrogen fertilization.

Overall application of 100 kg P_2O_5/fed was given at land preparation. Moreover, 100 kg N/fed was added in two equal doses; at 30 and 60 days after sowing.

Physical and chemical characteristics of the experimental soil were determined according to the method of Black (1965) (Table 1).

The recorded data:

At harvest (190 days after sowing), ten plants were randomly collected from the guarded rows of each sub sub-plot to determine the following traits:

1. Growth traits:

- Root length (cm).
- Root diameter (cm).
- Root fresh weight (kg).
- Foliage fresh weight (kg).

Table 1. Some physical and chemical properties of the soil of the experimental site

Physical properties particle size						Soil chemical properties										
Sand %	Silt %	Clay %	pH (1:2.5)	E.C. ds/m	Organic Matter %	Soluble cations (meq/l)				Soluble anions (meq/l)				Available contents mg.kg^{-1}		
Texture: clayey						Ca^{++}	^{++}Mg	Na^+	K^+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	N	P_2O_5	K_2O
2022/2023																
23.2	33.6	43.2	8.4	3.45	0.92	8.2	5.2	14.3	1.2	--	4.4	18.6	8.2	25.4	7.35	106.4
2023/24																
22.8	34.1	43.1	8.0	3.52	0.87	9.4	5.5	14.9	1.3	--	4.7	19.4	7.8	24.8	7.23	103.8

2. Yield traits:

- Root yield/fed (ton), which was estimated in kg/ plot and converted into tons/fed.
- Sugar yield/fed (ton) = root yield/fed (ton) × extracted sugar %.
- Harvest index was calculated according to the following equation:
- Harvest index% = [root yield (ton)/biological yield (ton)] × 100

3. Qualitative characters:

Quality analysis was done on fresh samples of sugar beet roots at the Laboratory of El-Fayoum Sugar Factory, Egypt at harvest time.

- Sucrose percentage (Pol %) was determined according to the method of Le-Docte (1927).
- Impurities: sodium, potassium and α-amino-nitrogen contents in roots were estimated as meq/100 g beet, where sodium and potassium were determined in the digested solution using "Flame-photometer". Alfa-amino N was determined using Hydrogenation according to the method described by Cooke and Scott (1993).
- Sugar lost to molasses percentage (SLM %) was calculated according to the equation of Devillers (1988):

SLM % = 0.14 (Na + K) + 0.25 (α–amino N) + 0.5

- Extracted sugar percentage (ES %) was calculated using the following equation of Dexter *et al*. (1967):

ES % = sucrose % - SLM % - 0.6

- Quality index (QI) was calculated using the equation of Cooke and Scott (1993) as follows:

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

- Alkalinity coefficient (AC) was calculated according to the following equation:

$$AC = (Na^+ + K^+) / \alpha\text{–amino N}$$

The obtained data were statistically analyzed according to the technique (Co-STATC) computer software package, using analysis of variance (ANOVA) as published by Gomez and Gomez (1984). The least significant difference (LSD) method was used to test the differences between treatment means at the 5% level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Growth traits:

The results in Table 2 pointed out that sowing sugar beet manually caused significant increases in root length, root fresh weight/plant and foliage fresh weight /plant in the 2nd season, and root diameter, in the 1st one, compared with using hand sowing machine. These results may be due to the fact that the studied manual sowing provides more land area per plant (1000 cm^2) compared with mechanical planting method (700 cm^2), which resulted in lower competition among plants for solar radiation, water and soil nutrients. These results were in line with those reported by El-Ghareib *et al.* (2012), who stated that the highest plant density of 56000 plant/fed gave the lowest root fresh weight**.** Furthermore, Varga *et al.* (2020) found that beets plants sown at wider intra-row spacing produced higher root weight compared to average root weight of beets grown in narrower intra–row spacing. Also, Xu *et al*. (2023) reported that growth of sugar beet root is affected by planting spacing. Reducing plant spacing or increasing planting density will lead to competition among plants for growth elements such as individual growth space, soil nutrition or water in the population.

Data in Table (2) cleared that Wombat Smart sugar beet variety markedly surpassed the other two varieties in root length and root fresh weight/plant (in the 1st season) and foliage fresh weight/plant (in the 2nd one), while the evaluated varieties insignificantly varied in root diameter in both seasons. The difference in growth characters of sugar beet varieties may be referred to their gene make-up. Salem (2019); Abazied & Al-Maracy (2023) and Grzanka *et al.* (2023), also recorded varietal difference among beet varieties in growth trait.

The results in Table (2) exhibited a gradual and appreciable increases in the values of sugar beet growth traits accompanying the increase in K-fertilizer levels from 24 up to 48 kg K_2O/fed in both seasons, except for root diameter (in the 2nd season) and foliage fresh weight (in the 1st one). The positive influence of potassium is probably attributed to its role in growth and development of plants. It activates enzymes, maintains cell turgor, enhances photosynthesis, reduces respiration and helps in transport of sugars and starches as well as nitrogen. In addition to plant metabolism, potassium improves crop quality (Abdel-Mawly and Zanouny, 2004).

Effect of the interactions on growth traits:

The results in Table (3) revealed that the interaction between sowing method and sugar beet varieties had significant influence of root length (in both seasons), root fresh weight/plant (in the 1st season) and foliage fresh weight/plant (in the 2nd one). Insignificant difference was detected between Joko and Wombat Smart varieties in root length, when they were sown using hand planter. Nevertheless, Wombat Smart variety markedly produced longer roots in case of sowing it traditionally (manually), compared with Joko, in both

seasons. Concerning root fresh weight, the same results were found in the 1st season. In respect to foliage fresh weight/plant, a significant difference was recorded between Joko and Wombat Smart varieties when they were sown mechanically, while the variance between them in this character was insignificant in case of sowing them manually, in the 2nd season.

Data in Table (4) showed that the interaction between sowing method and K-fertilizer level substantially affected root length (in both seasons), root and foliage fresh weight/plant (in the 2nd one). The results cleared that fertilizing sugar beet with 36 kg K_2O/fed significantly resulted in higher and appreciable value of root length, compared with those fertilized with 24 kg K_2O/fed, when beets were sown mechanically. However, insignificant variance was found between these two K-fertilizer levels, in their effect on root length, when beets were sown manually, in the 1stseason. In the 2nd one, the significant variance in root length was more distinguished (4.00 cm) due to increasing K-fertilizer rate from 24 to 36 kg K_2O/fed under manual sowing than that under mechanical planting (1.66 cm).

Data in Table (5) illustrated that the interaction between beets varieties and potassium fertilizer markedly influenced root length and fresh weight in the 2nd season. The results showed that the application of 48 kg K_2O/fed to Joko variety produced considerably taller roots compared to 36 kg K_2O/fed, while there was insignificant difference in root length of Narmar or Wombat Smart plants treated with 36 or 48 kg K_2O/fed. However, fertilizing beets varieties with 48 kg K_2O/fed markedly enhanced root fresh weight by different values compared to the addition of 36 kg K_2O/fed. These enhancements were 0.12, 0.22 and 0.36 kg in Joko, Narmar and Wombat Smart varieties, respectively.

Table 2. Main effect of sowing method and potassium level on root length (cm), root diameter (cm), root fresh weight (kg) and foliage fresh weight (kg) of tested sugar beet varieties

Treatments	Root length (cm)		Root diameter (cm)		Root fresh weight (kg/plant)		Foliage fresh weight (kg/plant)	
	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing method (S)								
Mechanical sowing	38.52	35.70	13.00	13.67	1.47	1.27	1.07	0.95
Manual sowing	39.07	39.07	15.00	14.74	1.60	1.72	1.09	1.09
L.S.D at 0.05 for (S)	**NS**	**1.12**	**1.81**	**NS**	**NS**	**0.04**	**NS**	**0.05**
Sugar beet variety (V)								
Joko	37.31	37.63	14.00	13.56	1.52	1.53	1.06	1.05
Narmar	39.22	37.33	14.11	14.78	1.50	1.49	1.03	1.03
Wombat Smart	40.22	37.61	13.94	14.28	1.61	1.49	1.18	0.99
LSD at 0.05 for (V)	**0.67**	**NS**	**NS**	**NS**	**0.07**	**NS**	**NS**	**0.02**
K-fertilizer level (kg K_2O/fed), K								
24	37.67	35.50	13.08	13.25	1.43	1.31	1.00	0.90
36	37.58	37.17	13.33	13.50	1.49	1.40	1.05	1.01
48	40.07	38.27	14.73	14.60	1.64	1.65	1.15	1.12
LSD at 0.05 for (K)	**0.76**	**0.62**	**0.51**	**NS**	**0.04**	**0.04**	**NS**	**0.04**

Table 3. Interaction between sowing method × variety effect on root length, root diameter, root fresh weight and foliage fresh weight of sugar beet

Treatments		Root length (cm)		Root diameter (cm)		Root fresh weight (kg)		Foliage fresh weight (kg)	
Sowing method	Variety	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing method (S) × Variety (V)									
Mechanical	Joko	38.11	35.78	13.22	12.78	1.51	1.31	1.47	0.98
	Narmar	38.67	36.00	12.89	14.67	1.41	1.26	1.59	0.96
	Wombat	38.78	35.33	12.89	13.56	1.50	1.25	1.73	0.91
Manual	Joko	35.78	38.67	14.67	14.33	1.48	1.71	0.98	1.08
	Narmar	39.78	38.67	15.33	14.89	1.60	1.72	1.03	1.10
	Wombat	41.67	39.89	15.00	15.00	1.74	1.73	1.25	1.08
LSD at 0.05 for (S×V)		**0.76**	**0.61**	**NS**	**NS**	**0.02**	**NS**	**NS**	**0.03**

Table 4. Interaction between sowing method × K- level effect on root length, root diameter, root fresh weight and foliage fresh weight of sugar beet

Treatments		Root length (cm)		Root diameter (cm)		Root fresh weight (kg)		Foliage fresh weight (kg)	
Sowing method	K-level	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing method (S) × K-fertilizer level (kg K_2O/fed), K									
Mechanical	24	36.78	34.78	12.00	13.67	1.37	1.12	0.98	0.82
	36	38.67	36.44	12.89	13.11	1. 90	1.28	1.06	0.97
	48	40.11	35.89	14.11	14.22	1.56	1.41	1.16	1.05
Manual	24	38.67	35.78	14.11	14.11	1.47	1.48	1.08	0.98
	36	38.67	39.78	15.00	15.00	1.59	1.67	1.10	1.03
	48	39.89	41.67	15.89	15.11	1.73	2.01	1.08	1.25
LSD at 0.05 for (S×K)		**0.89**	**0.73**	**NS**	**NS**	**NS**	**0.05**	**NS**	**0.05**

Table 5. Interaction between variety × K- level effect on root length, root diameter, root fresh weight and foliage fresh weight of sugar beet

Treatments		Root length (cm)		Root diameter (cm)		Root fresh weight (kg)		Foliage fresh weight (kg)	
Variety	K-level	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Variety (V) × K-fertilizer level (kg K_2O/fed), K									
Joko	24	36.00	34.83	13.00	12.67	1.39	1.32	0.95	0.91
	36	36.17	37.67	13.83	13.50	1.51	1.54	1.02	1.06
	48	38.67	39.17	15.00	14.50	1.58	1.66	1.13	1.13
Narmar	24	37.83	34.83	13.00	15.17	1.40	1.28	1.08	0.92
	36	39.67	38.33	14.33	14.50	1.53	1.48	1.01	0.98
	48	40.17	38.83	15.00	14.67	1.58	1.70	0.98	1.19
Wombat Smart	24	39.33	36.17	13.17	13.83	1.47	1.30	1.06	0.88
	36	40.17	38.33	13.67	14.17	1.58	1.41	1.22	0.97
	48	41.17	38.33	15.00	14.83	1.78	1.77	1.25	1.13
LSD at 0.05 for (V×K)		**NS**	**0.89**	**NS**	**NS**	**NS**	**0.06**	**NS**	**NS**

Data in Table (6) disclosed that both root length and diameter of sugar beet were insignificantly affected by the 2nd order interaction among the three studied factors, in the 1st and 2nd seasons. On the contrary, root fresh weight/plant was markedly influenced by the 2nd order interaction, in both seasons. The results cleared that raising K-fertilizer rate from 36 to 48 kg K_2O/fed attained a significant and distinguished increase amounted to (0.30 and 0.47 kg, in the 1st and 2nd season, respectively) in root fresh weight of Wombat Smart variety, when it was manually sown in rows of 0.5 m apart. However, applying 48 as compared with 36 kg K_2O/fed, resulted in (0.06 and 0.25 kg only, in the 1st and 2nd season, respectively) in root fresh weight of the same variety, in case of sowing it mechanically using hand planter in rows of 0.35 m distance. Similar results were obtained in the 2nd season, for Narmar variety fertilized with 36 and/or 48 kg K_2O/fed and sowing with both methods.

2. Yield traits

Data in Table (7) indicated that sowing sugar beet seeds mechanically, markedly enhanced sugar yield by 75.26 and 44.59% in the 1st and 2nd season, respectively. On the other hand, it reduced the harvest index in the 1st season. There were insignificant influences in root yield due to sowing sugar beet seeds mechanically or manually. Similar result was found by Nassar *et al*. (2022). These results clearly showed the superiority of hand planter in the above traits. That could be due to uniform in seed placement in hills, which positively reflected in decreasing the number of un emerged plants in the field compared to the manual sowing.

There were insignificant differences among the examined varieties in root and sugar yields in both seasons as well as harvest index in the 1st one. However, Narmer variety surpassed the other tested varieties in Harvest index percentage the 2nd season. The differences between varieties in these traits were also found by Salem (2019); Abazied & Al-Maracy (2023) and Grzanka *et al.* (2023).

Table 6. Effect of the 2nd order interaction among sowing method × variety × K- level on root length; root diameter, root and foliage fresh weight of sugar beet

Treatments			Root length (cm)		Root diameter (cm)		Root fresh weight (kg)		Foliage fresh weight (kg)	
Sowing method	Variety	K-level	2021/22	2022/23	2021/22	2022/23	2021/22	2022/23	2021/22	2022/23
Mechanical	Joko	24	36.67	34.33	12.33	11.67	1.37	1.22	0.97	0.88
		36	38.00	36.00	13.00	12.33	1.53	1.33	1.03	1.00
		48	39.67	37.00	14.33	14.33	1.63	1.37	1.25	1.05
	Narmar	24	36.33	35.33	11.67	16.00	1.33	1.08	1.05	0.83
		36	39.00	36.33	13.33	13.67	1.42	1.30	1.03	0.97
		48	40.67	36.33	13.67	14.33	1.47	1.38	0.97	1.07
	Wombat Smart	24	37.33	34.67	12.00	13.33	1.40	1.07	0.92	0.75
		36	39.00	37.00	12.33	13.33	1.52	1.22	1.12	0.93
		48	40.00	34.33	14.33	14.00	1.58	1.47	1.27	1.03
Manual	Joko	24	35.33	35.33	13.67	13.67	1.42	1.42	0.93	0.93
		36	34.33	39.33	14.67	14.67	1.48	1.75	1.00	1.12
		48	37.67	41.33	15.67	14.67	1.53	1.95	1.02	1.20
	Narmar	24	39.33	34.33	14.33	14.33	1.47	1.48	1.12	1.00
		36	40.33	40.33	15.33	15.33	1.63	1.67	0.98	0.98
		48	39.67	41.33	16.33	15.00	1.68	2.02	1.00	1.32
	Wombat Smart	24	41.33	37.67	14.33	14.33	1.53	1.53	1.20	1.02
		36	41.33	39.67	15.00	15.00	1.68	1.60	1.32	1.00
		48	42.33	42.33	15.67	15.67	1.98	2.07	1.23	1.23
LSD 0.05 for (S×V×K)			**NS**	**NS**	**NS**	**NS**	**0.01**	**0.09**	**NS**	**0.08**

Fertilizing sugar beet plants with 36 or 48 kg K_2O/fed produced higher root and sugar yields/fed compared with 24 kg K_2O/fed with insignificant differences between them in both seasons. The application of 48 kg K_2O/fed recorded noticeable higher values of harvest index compared with adding 24 or 36 kg K_2O/fed with insignificant difference with the middle K- level in the 2nd season (Table 7). The positive effect of potassium on sugar yield could be mainly attributed to its important role in the physiological processes and sugar storage, which reflected on root yield (Marschner, 2012).

Table 7. Main effect of sowing method and potassium level on root yield, sugar yield and harvest index of sugar beet varieties

Treatments	Root yield (ton/fed)		Sugar yield (ton/fed)		Harvest index (%)	
	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing Method (S)						
Mechanical sowing	47.96	50.78	6.73	6.81	67.39	63.58
Manual sowing	28.02	35.81	3.84	4.71	68.53	61.97
LSD at 0.05 for (S)	**NS**	**NS**	**1.30**	**0.89**	**0.32**	**0.47**
Variety (V)						
Joko	39.31	44.69	5.44	5.89	68.08	62.47
Narmar	37.06	43.22	5.23	5.73	67.48	63.22
Wombat Smart	38.81	43.39	5.36	5.87	68.12	62.84
LSD at 0.05 for (V)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.30**
K-fertilizer level (kg K_2O/fed), K						
24	35.21	40.17	4.62	4.84	67.82	61.49
36	43.33	47.50	6.01	6.40	67.76	63.45
48	43.27	47.73	6.31	6.81	68.28	63.74
LSD at 0.05 for (K)	**1.25**	**1.23**	**0.40**	**0.63**	**0. 33**	**0.35**

Effect of the interactions on yield traits:

Data in Table (8) cleared that root yield was significantly affected by the interaction between beets variety and sowing method, in the 1st season, where Wombat Smart variety out-yielded Joko when they were planted using hand planter. However, these two varieties were insignificantly varied, when they were manually sown. Similar results were detected concerning the performance of Narmer and Joko, in respect to their harvest index values, in the 2nd season. Sugar yield was insignificantly affected by the interaction of sowing method x beet variety, in both seasons.

The results in Table (9) revealed that raising K- level from 24 to 36 K_2O/fed resulted in a distinguished and appreciable increase in root yield of 4.78 tons/fed, when sugar beet was sown mechanically. However, the variance between these two K-rate**s** was 1.17 ton of beets only, when they were sown manually, in the 1st season. The results indicated that the difference between the application of 24 and 36 K_2O/fed, in their influence on sugar yield was significant, when beets were sown mechanically. Nevertheless, the variance between these two K-rate**s** in the produced sugar yield was insignificant, in case of planting beets traditionally, in the 1st season. Concerning sugar yield the 2nd season, similar trend to that of root yield (in the 1st season) was observed.

Data in Table (10) showed that there were marked interaction between varieties × K- level on root yield in the 1st season and harvest index in both seasons. There was insignificant variance between Narmar and Wombat Smart varieties in root yield/fed, when they were supplied by 24 kg K_2O/fed. Meanwhile, Wombat Smart markedly produced higher root yield than that given by Narmar, in case of raising K-rate to 48 kg K_2O/fed. Likewise, Wombat Smart significantly recorded higher harvest index than that of Narmar, when they were supplied by 48 kg K_2O/fed, without significant difference between the two varieties, when they were fertilized with 36 kg K_2O/fed, in the 1st season. Similar findings were detected between Jako and Wombat Smart, in the 2nd season.

Table 8. Interaction between sowing method × varieties effect on root yield, sugar yield and harvest index of sugar beet

Treatments		Root yield (ton/fed)		Sugar yield (ton/fed)		Harvest index (%)	
Sowing method	**Variety**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**
Sowing method (S) × Variety (V)							
Mechanical	Joko	47.78	50.33	6.64	6.59	67.61	62.64
	Narmar	46.89	51.00	6.74	6.79	66.62	64.28
	Wombat Smart	49.22	51.00	6.81	7.05	67.93	63.83
Manual	Joko	28.44	36.22	3.89	4.76	68.94	61.90
	Narmar	27.22	35.44	3.72	4.68	68.35	62.16
	Wombat Smart	28.39	35.78	3.92	4.69	68.30	61.85
LSD at 0.05 for (S×V)		**0.76**	**NS**	**NS**	**NS**	**NS**	**1.08**

Table 9. Interaction between sowing methods × K- levels effect on root yield, sugar yield and harvest index of sugar beet

Treatments		Root yield (ton/fed)		Sugar yield (ton/fed)		Harvest index (%)	
Sowing method	**K-level**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**
Sowing method (S) × K-fertilizer level (kg K_2O/fed), K							
Mechanical	24	43.89	47.78	5.82	5.79	66.91	62.73
	36	48.67	51.00	6.76	6.96	67.48	63.78
	48	51.33	53.56	7.59	7.69	67.77	64.23
Manual	24	26.22	31.89	3.48	3.86	68.57	60.58
	36	27.39	36.44	3.76	4.72	68.61	62.07
	48	30.44	39.11	4.28	5.55	68.40	63.26
LSD at 0.05 for (S×K)		**0.46**	**NS**	**0.29**	**0.27**	**NS**	**NS**

Table 10. Interaction between varieties× K- levels effect on root yield, sugar yield and harvest index of sugar beet

Treatments		Root yield (ton/fed)		Sugar yield (ton/fed)		Harvest index (%)	
Variety	**K-level**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**
Variety (V) × K-fertilizer level (K)							
Joko	24	36.17	40.33	4.73	4.79	68.22	61.34
	36	37.33	43.83	5.14	5.84	67.96	62.77
	48	40.83	45.67	5.92	6.39	68.65	62.70
Narmar	24	34.75	39.17	4.71	4.78	67.59	61.99
	36	37.42	43.83	5.22	5.80	68.03	63.54
	48	39.00	46.67	5.75	6.62	66.83	64.11
Wombat Smart	24	34.25	40.00	4.51	4.89	67.42	61.64
	36	39.33	43.50	5.45	5.88	68.16	62.46
	48	42.83	46.67	6.13	6.84	68.78	64.42
LSD at 0.05 for (V×K)		**0.57**	**NS**	**NS**	**NS**	**1.51**	**1.60**

Table 11. Effect of the 2nd order interaction among sowing method × beet variety × K- level on root yield, sugar yield and harvest index of sugar beet

Treatments			Root yield (ton/fed)		Sugar yield (ton/fed)		Harvest index (%)	
Sowing method	**Variety**	**K-level**	**2021/22**	**2022/23**	**2021/22**	**2022/23**	**2021/22**	**2022/23**
Mechanical	Joko	24	44.67	47.67	5.76	5.54	67.68	61.59
		36	47.33	50.67	6.57	6.96	67.31	63.08
		48	51.33	52.67	7.59	7.28	67.84	63.25
	Narmar	24	44.00	48.00	6.07	5.91	66.67	63.77
		36	47.67	51.00	6.73	6.85	66.67	64.61
		48	49.00	54.00	7.42	7.61	66.52	64.44
	Wombat Smart	24	43.00	47.67	5.63	5.91	66.38	62.83
		36	51.00	51.33	7.04	7.06	68.46	63.64
		48	53.67	54.00	7.77	8.19	68.96	65.01
Manual	Joko	24	27.67	33.00	3.70	4.04	68.76	61.09
		36	27.33	37.00	3.71	4.73	68.60	62.47
		48	30.33	38.67	4.26	5.50	69.46	62.16
	Narmar	24	25.50	30.33	3.35	3.65	68.50	60.20
		36	27.17	36.67	3.72	4.75	69.39	62.48
		48	29.00	39.33	4.09	5.63	67.15	63.79
	Wombat Smart	24	25.50	32.33	3.40	3.87	68.46	60.45
		36	27.67	35.67	3.85	4.69	67.85	61.27
		48	32.00	39.33	4.50	5.50	68.60	63.83
LSD at 0.05 for (S×V×K)			**2.67**	**2.89**	**0.80**	**0.84**	**NS**	**NS**

Data in Table (11) cleared that root and sugar yields/fed were significantly affected by the 2nd order interaction among the three studied factors in both seasons, while harvest index was not influenced. The results indicated that Wombat Smart produced higher root yield/fed (3.67 tons) than that given by Joko under the mechanical planting, while the variance between the two varieties was only 0.34 ton, under traditional sowing, in case of fertilizing them with 36 kg K_2O/fed, in the 1st season. Similar trend was observed with Joko and Narmer varieties, when they were fertilized with 48 kg K_2O/fed, in the 2nd season. It was found that Wombat Smart produced higher sugar yield/fed than that of Narmar, when they were supplied by 36 kg K_2O/fed, under mechanical sowing, compared with manual planting, in the 1st and 2nd seasons.

3. Technological traits:

Data in Table (12) illustrated that sowing sugar beet seed mechanically using hand planter considerably enhanced sucrose percentage in 1st and 2nd seasons as

well as extracted sugar percentage in the 1st one. However, there were insignificant differences between beets sown mechanically or manually in sugar lost to molasses and quality index, in both seasons and extracted sugar percentage in the 2nd one. These findings are in harmony with those claimed by Nassar *et al.* (2022), who revealed that planting sugar beet seeds mechanically by a planter improved growth similarity of roots, which reflected on better root growth, and hence their sucrose, recoverable sugar, extracted sugar.

The tested sugar beet varieties significantly varied in sucrose percentage, in the two seasons as well as extracted sugar and sugar lost to molasses in the 1st one. Data cleared that Narmar variety surpassed the other two varieties in sucrose, extracted sugar and sugar lost to molasses in the 1st season, while Wombat Smart scored the best sucrose percentage in the 2nd one. Similar findings were reported by Salem (2019); Abazied & Al-Maracy (2023) and Grzanka *et al.* (2023).

Increasing K- level from 24 to 36 or 48 kg K_2O/fed increased sucrose and extracted sugar percentages in both seasons. However, the application of the two higher K-rates recorded insignificant changes in sugar lost to molasses in the 1st season. These results were in accordance with those reported by Salem (2019), who mentioned that growing sugar beet plants under the application of potassium fertilizer at the rate of 48 kg K_2O/fed caused significant increases in sucrose and sugar lost to molasses.

Effect of the interactions on qualitative traits:

Data in Table (13) illustrated an appreciate influence of the interaction between sowing method and beet variety on extracted sugar, sugar lost to molasses and quality index percentages in the in the 1st season as well as sucrose percentage in the 2nd one.

Table 12. Main effect of sowing method and potassium level on sucrose, extracted sugar, sugar lost to molasses and quality index percentages of sugar beet varieties

Treatments	Sucrose (%)		Extracted sugar (%)		Sugar lost to molasses (%)		Quality index (%)	
	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing Methods (S)								
Mechanical sowing	17.71	16.91	14.00	13.36	3.71	3.54	79.01	78.96
Manual sowing	17.22	16.60	13.69	13.07	3.53	3.53	79.55	78.68
L.S.D at 0.05 (S)	**0.18**	**0.11**	**0.30**	**NS**	**NS**	**NS**	**NS**	**NS**
Sugar beet varieties (V)								
Joko	17.37	16.63	13.79	13.17	3.58	3.46	79.39	79.12
Narmar	17.76	16.78	14.00	13.18	3.76	3.60	78.81	78.50
Wombat Smart	17.37	16.97	13.78	13.40	3.59	3.57	79.34	78.91
LSD at 0.05 for (V)	**0.17**	**0.17**	**0.10**	**NS**	**0.11**	**NS**	**NS**	**NS**
K-fertilizer levels (kg K_2O/fed), K								
24	16.60	15.58	13.17	12.06	3.43	3.52	79.36	77.37
36	17.46	16.88	13.84	13.42	3.62	3.46	79.30	79.52
48	18.19	17.81	14.49	14.25	3.69	3.55	79.69	80.02
LSD at 0.05 for (K)	**0.25**	**0.20**	**0.21**	**0.26**	**0.10**	**NS**	**NS**	**NS**

Table 13. Interaction between sowing methods × varieties effect on sucrose; extracted sugar, sugar lost to molasses and quality index of sugar beet

Treatments		Sucrose (%)		Extracted sugar (%)		Sugar lost to molasses (%)		Quality index (%)	
Sowing method	Variety	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing methods (S) × Varieties (V)									
Mechanical	Joko	17.52	16.46	13.85	13.05	3.67	3.41	79.00	79.19
	Narmar	18.10	16.86	14.36	13.27	3.74	3.59	79.27	78.68
	Wombat smart	17.50	17.40	13.78	13.77	3.72	3.63	78.77	79.01
Manual	Joko	16.99	16.56	13.65	13.08	3.33	3.48	80.39	78.92
	Narmar	17.42	16.70	13.64	13.09	3.78	3.61	78.35	78.31
	Wombat smart	17.24	16.53	13.77	13.03	3.47	3.50	79.92	78.81
LSD at 0.05 for (S×V)		**NS**	**0.20**	**0.11**	**NS**	**0.13**	**NS**	**0.98**	**NS**

It was found that Narmer variety markedly recorded higher sucrose% than that of Joko, when they were sown mechanically, while the variance between the two varieties were insignificant under manual planting, in the 2nd season. The same trend was observed for extracted sugar %, in the 1st one. The results showed insignificant difference between Narmar and Wombat Smart varieties in sugar lost to molasses, under mechanical sowing. Meanwhile, the variance between the two varieties reached the level of significance under manual planting, in the 1st season. Similar tendency was detected for Joko and Narmar, concerning quality index %, in the same season.

Data in Table (14) pointed out exhibited significant influence on sucrose and extracted sugar percentages in the 1st season, sugar lost to molasses in both seasons and quality index in the 2nd one due to the interaction between sowing method and K- level. The results cleared that raising K- rate from 36 and 48 K_2O/fed resulted in a pronounced increase in sucrose %, under mechanical planting, higher than that resulted under manual sowing, in the 1st season. Similar finding was observed for extracted sugar %, in the 2nd one. The results showed insignificant difference in sugar lost to molasses as affected by the application of 24 or 36 K_2O/fed. Nevertheless, the variance of these two K-level was significant, when beets were sown manually, in the 1st season. In the 2nd one, significant difference in this trait between 36 and 48 K_2O/fed was detected, under mechanical planting, without any appreciable variance between the two K- rates, in their effect on sugar lost to molasses, in case of sowing beet seeds manually. Opposite results were obtained, regarding quality index %, in the 2nd season.

Data in Table (15) revealed that except for sugar lost to molasses in the 1st season, all of sucrose, extracted sugar and quality index were insignificantly influenced by the interaction between beet varieties and K-levels, in both seasons, as well as sugar lost to molasses in the 2nd one. The results pointed to a significant variance between 24 and 36 K_2O/fed, in their effect on sugar lost to molasses % of Narmar and/or Wombat Smart varieties, while the variance between these two K- rates in this trait was insignificant in Joko variety.

Table 14. Interaction between sowing method × K- level effect on sucrose; extracted sugar, sugar lost to molasses and quality index of sugar beet

Treatments		Sucrose (%)		Extracted sugar (%)		Sugar lost to molasses (%)		Quality index (%)	
Sowing method	**K- level**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**
Sowing method (S) × K-fertilizer level (kg K_2O/fed), K									
Mechanical	24	17.04	15.76	13.27	12.11	3.78	3.65	77.82	76.79
	36	17.62	17.02	13.93	13.64	3.69	3.38	79.05	80.14
	48	18.46	17.94	14.80	14.35	3.66	3.59	80.17	79.94
Manual	24	16.47	15.61	13.28	12.09	3.18	3.53	80.67	77.42
	36	17.27	16.55	13.73	12.95	3.54	3.60	79.53	78.22
	48	17.92	17.63	14.06	14.17	3.86	3.45	78.46	80.40
LSD at 0.05 for (S×K)		**0.21**	**NS**	**0.25**	**NS**	**0.12**	**0.17**	**NS**	**0.79**

Table 15. Interaction between variety × K- level effect on sucrose; extracted sugar, sugar lost to molasses and quality index of sugar beet

Treatments		Sucrose (%)		Extracted sugar (%)		Sugar lost to molasses (%)		Quality index (%)	
Variety	**K- level**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**	**2022/23**	**2023/24**
Variety (V) × K-fertilizer level (kg K_2O/fed), K									
Joko	24	16.62	15.44	13.12	11.93	3.49	3.50	79.01	77.30
	36	17.23	16.59	13.73	13.25	3.50	3.34	79.69	79.86
	48	17.92	17.52	14.41	14.02	3.51	3.50	80.40	80.01
Narmar	24	17.07	15.90	13.49	12.17	3.58	3.72	79.01	76.57
	36	17.68	16.73	13.90	13.18	3.79	3.55	78.58	78.76
	48	18.53	17.71	14.62	14.20	3.92	3.51	78.84	80.16
Wombat Smart	24	16.58	15.73	13.22	12.18	3.37	3.55	79.72	77.45
	36	17.42	17.04	13.86	13.45	3.55	3.59	79.60	78.92
	48	18.12	18.13	14.26	14.57	3.86	3.56	78.71	80.34
LSD at 0.05 for (V×K)		**NS**	**NS**	**NS**	**NS**	**0.15**	**NS**	**NS**	**NS**

Data in Table (16) cleared that extracted sugar % was markedly influenced by the 2nd order interaction among the three studied factors (in both seasons) and sugar lost to molasses (in the 1st one), while sucrose and quality percentages were not affected. The results showed that the difference between Narmar and Wombat varieties in the extracted sugar % was significant, when they were fertilized with 48 kg K_2O/fed and sown mechanically. However, the difference was insignificant between the two varieties in this trait, in case of supplying them with the same K-rate, under manual seeding, in the 1st season. The same trend was detected with Joko and Wombat Smart, in the 2nd one. Joko and Narmar varieties differed significantly in sugar lost to molasses, when they were given 36 kg K_2O/fed and sown mechanically. Meantime, insignificant variance between the two varieties was recorded, in case of fertilizing them with the same K-level and planting them manually, in the 1st season.

4. Impurities

Data in Table (17) cleared that, except for Na^+ (in the 1st season), sowing method had insignificant influence on all determined impurities. Sowing beet seeds using hand planter markedly resulted in higher root Na^+ content, compared to sowing seeds manually.

The tested sugar beet varieties varied considerably in root contents of K^+ and α-amino N, in the 1st and 2nd season, respectively. Narmer variety recorded the highest values of these two traits, compared to the other varieties. The differences between beets varieties in beet impurities were also registered by Salem (2019); Abazied & Al-Maracy (2023) and Grzanka *et al.* (2023).

The applied K- levels had a significant influence on root Na^+, α-amino N and Alkalinity coefficient, in both seasons, as well as root K^+, in the 1st one. It was found that raising K-rates from 24 to 48 kg K_2O/fed resulted in higher values of Na^+ (in the 2nd season), K^+ (in the 1st season), alkalinity coefficient (in the two seasons), while increasing K-fertilization level from 24 to 36 and 48 kg K_2O/fed caused a gradual reduction in root content of α-amino N, in both seasons. Similar results were recorded by Salem (2019).

The results in Table (18) revealed root Na^+ content was significantly affected by the interaction of sowing method x K-fertilization level, in both seasons. In the 1st one, insignificant variance between 36 and 48 kg K_2O/fed in their effect on Na^+, under mechanical sowing, but when beets were planted manually, the difference in Na^+ reached the level of significance. Opposite results were obtained, in the 2nd season.

Table 16. Effect of the 2nd order interaction among sowing method × beet variety × K- level on sucrose; extracted sugar, sugar lost to molasses and quality index of sugar beet

Treatments			Sucrose (%)		Extracted sugar (%)		SLM (%)		Quality index (%)	
Sowing method	Variety	K-level	2021/22	2022/23	2021/22	2022/23	2021/22	2022/23	2021/22	2022/23
Mechanical	Joko	24	16.83	15.22	12.90	11.62	3.93	3.59	76.65	76.37
		36	17.50	16.73	13.88	13.73	3.62	3.00	79.31	82.04
		48	18.23	17.45	14.78	13.81	3.46	3.63	81.04	79.16
	Narmar	24	17.60	16.02	13.82	12.31	3.78	3.71	78.45	76.85
		36	17.83	16.83	14.11	13.43	3.72	3.40	79.13	79.81
		48	18.87	17.74	15.14	14.08	3.73	3.66	80.24	79.39
	Wombat Smart	24	16.70	16.05	13.08	12.38	3.62	3.66	78.36	77.16
		36	17.53	17.51	13.80	13.75	3.74	3.75	78.70	78.56
		48	18.27	18.65	14.47	15.16	3.80	3.49	79.24	81.29
Manual	Joko	24	16.40	15.65	13.34	12.25	3.06	3.41	81.36	78.23
		36	16.97	16.45	13.58	12.77	3.38	3.68	80.07	77.67
		48	17.60	17.59	14.04	14.22	3.56	3.37	79.75	80.86
	Narmar	24	16.53	15.78	13.15	12.04	3.38	3.74	79.58	76.29
		36	17.53	16.64	13.68	12.93	3.85	3.71	78.04	77.71
		48	18.20	17.67	14.09	14.32	4.11	3.37	77.44	80.93
	Wombat Smart	24	16.47	15.41	13.35	11.98	3.12	3.43	81.07	77.74
		36	17.30	16.57	13.93	13.14	3.37	3.43	80.50	79.28
		48	17.97	17.61	14.05	13.98	3.92	3.63	78.18	79.40
LSD at 0.05 for (S×V×K)			**NS**	**NS**	**0.44**	**0.52**	**NS**	**0.29**	**NS**	**NS**

Table 17. Main effect of sowing method and potassium level on Na^+, K^+ content and α-amino N as well as alkalinity coefficient of sugar beet varieties

Treatments	Na^+ meq/100 g roots		K^+ content meq/100 g roots		α-amino N meq/100 g roots		Alkalinity coefficient	
	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Sowing Method (S)								
Mechanical sowing	2.30	2.12	3.58	3.39	2.24	2.26	4.01	3.84
Manual sowing	1.99	2.24	3.48	3.24	2.26	2.24	3.81	3.83
LSD at 0.05 for (S)	**0.14**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Variety (V)								
Joko	2.15	2.03	3.26	3.37	2.22	2.12	3.83	3.99
Narmar	2.09	2.24	3.85	3.30	2.34	2.41	3.87	3.61
Wombat Smart	2.18	2.23	3.55	3.35	2.19	2.22	4.03	3.93
LSD at 0.05 for (V)	**NS**	**NS**	**0.20**	**NS**	**NS**	**0.16**	**NS**	**NS**
K-fertilizer level (kg K_2O/fed), K								
24 kg K_2O (K1)	2.52	2.11	3.08	3.25	2.48	2.45	3.50	3.41
36 kg K_2O (K2)	2.17	1.92	3.49	3.43	2.18	2.19	3.99	3.85
48 kg K_2O (K3)	1.86	2.36	3.72	3.32	2.06	2.00	4.20	4.37
LSD at 0.05 for (K)	**0.15**	**0.22**	**0.16**	**NS**	**0.13**	**0.12**	**0.25**	**0.23**

Table 18. Interaction between sowing methods × K- levels effect on Na^+, K^+, α-amino N and alkalinity coefficient of sugar beet

Treatments		Na^+ meq/100 g roots		K^+ meq/100 g roots		α-amino N meq/100 g roots			
Sowing method	K-level	2022/23	2023/24	2022/23	2023/24	Sowing method	K-level	2022/23	2023/24
Sowing method (S) × K-fertilizer level (kg K_2O/fed), K									
Mechanically	24	2.54	2.10	3.33	3.45	2.55	2.62	3.51	3.25
	36	2.27	1.82	3.59	3.35	2.21	2.24	4.02	3.67
	48	2.11	2.44	3.82	3.36	1.97	1.93	4.51	4.60
Manually	24	2.46	2.29	3.11	3.04	2.50	2.50	3.45	3.35
	36	2.06	2.23	3.51	3.48	2.12	2.13	4.08	4.10
	48	1.47	2.20	3.82	3.21	2.16	2.08	3.88	4.06
LSD at 0.05 for (S×K)		**0.17**	**0.26**	**NS**	**NS**	**NS**	**NS**	**0.29**	**0.27**

Table 19. Interaction between variety× K- level effect on Na^+, K^+, α-amino N and alkalinity coefficient of sugar beet

Treatments		Na^+ meq/100 g roots		K^+ meq/100 g roots		α-amino N meq/100 g		Alkalinity coefficient	
Variety	K- level	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24	2022/23	2023/24
Variety(V) × K-fertilizer level (kg K_2O/fed), K									
Joko	24	2.67	2.19	3.02	3.17	2.47	2.37	3.54	3.51
	36	2.13	1.91	3.29	3.31	2.06	1.97	4.08	4.17
	48	1.72	2.13	3.27	3.41	2.11	2.04	3.84	4.23
Narmar	24	2.45	2.37	3.49	3.24	2.62	2.79	3.43	3.09
	36	2.18	2.01	3.85	3.46	2.30	2.37	3.98	3.60
	48	1.65	2.35	4.22	3.21	2.12	2.06	4.20	4.15
Wombat Smart	24	2.37	2.04	3.15	3.33	2.49	2.52	3.46	3.30
	36	2.19	2.16	3.52	3.48	2.14	2.23	4.09	3.88
	48	1.99	2.49	3.98	3.25	1.95	1.91	4.55	4.61
LSD at 0.05 for (V×K)		**NS**	**NS**	**0.23**	**NS**	**NS**	**0.17**	**NS**	**NS**

As for alkalinity coefficient, it was found that increasing K- level from 36 to 48 kg K_2O/fed caused higher value of this trait, under mechanical planting, than that recorded under traditional sowing, in the 1st season. In the 2nd one, marked increase in alkalinity coefficient was recorded, when K- level was raised from 36 to 48 kg K_2O/fed, in case of sowing beets mechanically, but the variance between the two K- levels was insignificant under manual planting.

Data in Table (19) showed that raising K- level from 36 to 48 kg K_2O/fed given to Jako variety, insignificant difference was detected in root K-content. However, root K-content recorded by Narmar and/or Wombat Smart were significantly increased, in the 1st season. The results pointed to a reduction in root content of α-amino N, of the tested beet varieties, as K-fertilizer level was raised from 24 to 48 kg K_2O/fed, in the 2nd season. Moreover, the reduction in α-amino N was more noticeable in roots of Wombat Smart compared to the other two varieties.

CONCLUSION

Under conditions of the present work, sowing sugar beet Wombat Smart variety using double-row hand machine and fertilizing with 36 or 48 kg K_2O/fed can be recommended to raise the produced root and sugar yields/fed.

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الملخص العربي

تاثير طريقة الزراعة والتسميد البوتاسى علي الحاصل والصفات التكنولوجية لبعض أصناف بنجر السُكَّر

العربى سالم رمضان سالم ، يارا ابراهيم حنفي الجداوى، كرم عبدالصادق جوده عبدالسلام

نفذت تجربتان حقليتان خلال الموسمين ٢٠٢٢-٢٠٢٣ و٢٠٢٣-٢٠٢٤ فى قرية منشأة سنورس والتي تقع علي (دائرة عرض ٣٤" ٢٧′ ٢٩° شمالاً وخط طول ٠،٦" ٥٠′ ٣٠° شرقاً) بمحافظة الفيوم لدراسة تأثير طريقتين للزراعة (آلياً بإستخدام ماكينة زراعة يدوية لزراعة البذور فى سطور المسافة بينها ٣٥ سنتيمتر، وزراعتها يدوياً علي خطوط عرضها ٠،٥ متر) وتسميد البنجر بثلاثة مستويات من السماد البوتاسى (٢٤، ٣٦، ٤٨ كجم بو٢أ للفدان) علي الحاصل وصفات الجودة لثلاثة أصناف وحيدة الجنين من بنجر السُكَّر هي: جوكو Joko ، نارمر Narmar و ومبات سمارت Wombat Smart. تم إستخدام تصميم القطاعات كاملة العشوائية لتوزيع المعاملات فى نظام القطع المنشقة مرتين، فى أربع مكررات، حيث وضعت طرق الزراعة فى القطع الرئيسية، وزعت الأصناف عشوائيا فى القطع المنشقة الأولى، وتم توزيع مستويات السماد البوتاسي عشوائياً فى القطع المنشقة الثانية.

أظهرت النتائج أن زراعة البنجر آليا بإستخدام البلانتر اليدوي أعطت قيماً أعلي معنوياً من حاصلى الجذور والسُكَّر للفدان، وزادت من قيم النسب المئوية للسُكَّروز والسُكَّر المستخلص مقارنة بطريقة الزراعة اليدوية. أدت زيادة مستوي السماد البوتاسي من ٢٤ إلي ٣٦ أو ٤٨ كجم بو٢أ للفدان إلى زيادة حاصلى الجذور والسُكَّر ومُعامِل الحصاد معنوياً بالرغم من عدم وجود فروق معنوية بين المستويين المرتفعين من السماد البوتاسي علي كل الصفات المحصولية فى موسمى الزراعة عدا مُعامِل الحصاد فى الموسم الأول. وجِدَ اتجاه عام لزيادة صفات النمو تحت الدراسة لنباتات بنجر السُكَّر نتيجة الزيادة المتدرجة فى مستويات السماد البوتاسي – فى حين لم يلاحظ إتجاه محدد ما عدا نقص الألفا أمينو نيتروجين بزيادة مستويات السماد البوتاسى المضافة. ومن ناحية أخرى لم يظهر تاثير معنوي لطرق الزراعة أو تباين بين الأصناف في محتوى الجذور من الصوديوم أو البوتاسيوم أو الألفا أمينو نيتروجين أو مُعامِل القلوية.

تحت ظروف هذا البحث يمكن التوصية بزراعة الصنف ومبات سمارت Wombat Smart آلياً بإستخدام البلانتر اليدوى وتسميده بإضافة ٣٦ أو٤٨ كجم بو٢أ للفدان للحصول علي أفضل حاصل جذور وسُكَّر وصفات تكنولوجية.