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EFFECT OF SOIL AND FOLIAR POTASSIUM FERTILIZATION ON YIELD OF CANTALOUPE PLANT IN SANDY SOIL

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ABSTRACT

This study was carried out on cantaloupe plants (*Cucumis melo* L. *cv* 'Gal152') during the winter growing seasons of 2019-2020 and 2020-2021 at a private vegetable farm located on Abo El-Dahab region, Abo-Khalifa vallage, Ismailia Governorate, Egypt. The seedlings at age of 17 days were transplanted on 25^{th} December in mulched low plastic tunnels under sandy soil conditions to study the treatments which were combinations among three soil applications of 80 units of K_2SO_4 doses rates (100%, 75%, and 50%of recommended potassium requirements) and spraying four foliar potassium sources (Potassium Silicate, K-Sili; Potassium Citrate, K-Citr.; Potassium Acetate, K-Acet.; Potassium Thiosulphate, K-Thio.; and water spray as control) on cantaloupe. So, this study included fifteen treatments. The highest-grade A yield value was recorded by each of $T_{100\%}$× k-Citr treatment without significant differences followed by $T_{75\%}$× k-Citr, $T_{100\%}$× K-Sili, $T_{100\%}$×without spray, and $T_{75\%}$× without spraying treatments in the second season. The highest marketable yield value was recorded by each of $T_{50\%}$× k-Acet treatment, without significant differences than $T_{50\%}$ × K-Sili and $T_{100\%}$ × without K-spray in first season and $T_{100\%}$ × without K-spray, T_{75} × k-Acet, $T_{50\%}$ × k-Thio, and $T_{50\%}$ × k-Citr treatments in second season. The highest total yield was recorded by the treatment of $T_{100\%}$ × without k- spray (2.48kg/m^2, 10.42 ton. /fed.) and $T_{50\%}$ × K-Sil without significant differences between them in first season, while in second season, the highest total yield was recorded by the treatment of $T_{100\%}$ × without k- spray (2.80 kg/m^2,11.76 ton./fed.) $T_{50\%}$ × k-Acetate; $T_{50\%}$ × K-Sili; and $T_{75\%}$ × k-Acet without significant between them..

INTRODUCTION

Cantaloupe (*Cucumis melo* L.) is one of the most important and popular fruity vegetables grown in many countries including Egypt. It considered as excellent source of vitamins) as well as carbohydrates and minerals (especially potassium). Also, it is rich in antioxidant compounds which have the ability to protect body cells against cancer **(Lester *et al*., 2005).** It is cultivated largely for its fruits pulp which serves as a desert or be used in fruit salad. It is also an important crop that is rich in water which help in preventing dehydration during drought period and contains fibers which has a role aid in digestion of food **(Sabo *et al*., 2013)**.

Potassium (K) is an essential plant nutrient involved in numerous physiological processes of plant growth, yield and quality parameters such as taste, texture and nutritional/health properties **(Marschner, 1995).** It is one of the essential plant nutrients that plays a crucial role in the quality improvement of fruits and vegetables. It has also a great requirement and impact on the fruit quality. Soil application of mineral nutrients requires repeated irrigation and causes low fruit quality, since melons

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are sensitive for frequent irrigations that decrease fruit firmness. Generally various sources of K salts were used for plants nutrition such as potassium chloride, potassium sulfate, mono potassium phosphate (KH_2PO_4), and potassium nitrate **(Magen, 2004)**. Potassium (K) exerts greater influence on the characteristics that determine the consumer's preferences, the quality of the fruits and the concentration of phytonutrients of vital importance to human health **(Lester *et al*., 2010b; Salama, 2015)**. Plant growth, fruit weight, fruit diameter, total yield, flesh firmness and the number of marketable fruits significantly increased with increasing K_2O doses **(Demiral and Koseoglu, 2005; Frizzone *et al.,* 2005; Kaya *et al.,* 2007).**

During reproductive development, the soil potassium supply must be adequate to support crucial processes such as sugar transport from leaves to fruit, enzyme activation, protein synthesis, and cell extension that ultimately determine fruit yield and quality **(Lester *et al*., 2005).** Insufficient or excessive potassium level adversely affects fruit quality, while adequate K nutrition is associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit color, increased shelf life, and shipping quality of many horticultural crops **(Lester *et al*., 2006 and 2010a).** Even in normal condition, an intensive K application should be supplied during flowering and fruit setting to ensure uniform fruits with high TSS content **(Lester *et al.,* 2005; Jifon and Lester, 2009).**

Lester *et al.* (2005) indicated that the beneficial effects of supplemental foliar K application on fruit quality were greater when an organic form of K (Metalosate-K) was used compared to an inorganic (*e.g.* potassium chloride, KCl) source. Also, studies of **Lester *et al.* (2005, 2006 as well as lester and jifon (2008)** indicated that supplementing soil K supply with foliar K applications during fruit development and maturation can improve muskmelon fruit quality parameters such as fruit firmness, sugar content, ascorbic acid and beta-carotene levels. **Jifon and Lester (2011)** evaluted the impact of foliar K on cantaloupe yield and quality in calcareous soils and found that foliar K treatments resulted in higher plant tissue K concentrations, higher soluble solids contents, total sugars, and bioactive compounds (ascorbic acid and β-carotene).

Tang *et al.* (2012) evaluated effects of potassium levels on fruit quality in two Hami melon cultivars, in soilless medium culture under a plastic greenhouse. They reported that with, potassium level of 234-351 mg/L, the concentrations of total soluble solids, sucrose, K content, and volatile acetate components significantly increased in fruit flesh thickness, which should good fruit favorable quality. Moreover, **Asao *et al.* (2013)** found that it had not any significant effect on fruit yield. In addition soluble solid content of melon fruits was not decreased in plants grown with reduced KNO_3 concentration compared with standard nutrient solute.

A study on contacted by **El-Sayed *et al.* (2017)** in cantaloupe showed that Galia or Gal 152 variety with potassium thiosulphate KTS or potassium glysrophosphate KGP gave total acidity and vitamin C in fruits. Foliar spray of C8 hybrid variety with KTS increased yield/plant, marketable yield and total yield/fed., followed by spray of Galia variety with KTS in both seasons with respect to marketable yield and total yield. **Sindhuja *et al.* (2017)** reported that foliar spray of 2-chloro-4-pyridyl-N-phenylurea (CPPU) 5 ppm and potassium nitrate at 3 % at fruit set and fruit maturation stage of muskmelone improved the quality attributes but titratable acidity (0.59%), physiological loss in weight recorded maximum in untreated fruit.

Preciado-Rangel *et al*. (2018) found that, high values of total yield and fruit quality of cantaloupe were obtained with K concentrations increased, showing a lineal, positive and significant trend, which evidences that the optimal dose of K in muskmelon is higher than 11 mM, being suggested for future research, to evaluate concentrations above this value.

Fertilization program must pay a high intention for time and quantity of application specially potassium application under sandy loam soil conditions reported by **Ahmed *et al.* (2020)** since total yield and fruit quality were positively affected by increasing potassium fertilizer rates from 100 to 180 kg/fed., the highest value for each of total fruit yield/plant and fed., was recorded with commercial cultivar (Primal) and Egyptian 'Galia F1' "GH0913 (GW× Hira4). **El-Drany (2021)** reported that application of potassium silicate at 10 or 20 cm^3/l resulted in higher total soluble sugar, number of fruits/plant, average fruits weight (g), fruits yield/plant (kg) and fruits yield/feddan (ton).

Keeping in view the above facts, the present investigation was undertaken with the following objectives to study effect of soil potassium rates and foliar application of various potassium sources on cantaloupe yield and the shelf-life storage.

MATERIALS AND METHODS

This study was carried out on cantaloupe plants (*Cucumis melo* L. *cv* 'Gal152') during the winter growing seasons of 2019-20 and 2020-21 at a private vegetable farm located at Abo El-Dahab region, Abo-Khalifa vallage, Ismailia Governorate, Egypt. The seedlings at age of 17 days were transplanted on 25th December in mulched rows under low plastic tunnels conditions. The experiment was conducted under sandy soil conditions to study the combinations among fifteen treatments including three soil applications of 80 unit K_2SO_4 rates 100% ($T_{100\%}$); 75%, ($T_{75\%}$); 50%, ($T_{50\%}$) and spraying four foliar potassium sources (Potassium Silicate, K-Sili; Potassium Citrate, K-Citr.; Potassium Acetate, K-Acet.; Potassium Thiosulphate, K-Thio.; and tap water spray as control) on cantaloupe. So, this study included fifteen treatments.

The statistical layout of this experiment was split-plot experiment in completely randomized block design with three replicates, main plots were randomly occupied by soil application rates of K_2SO_4 and the sub plots were randomly entitled to potassium foliar applications. Chemical analyses of irrigation water and initial physical and chemical properties of investigated soil of cultivated area were determined in The Central Laboratory, Faculty of Agriculture, Ismailia University (Tables 1 and 2). Drip irrigation system (GR drippers with 50 cm spaces among drippers) and soil surface mulch (black plastic) were used.

The seedlings of 17 days age were transplanted in one side of dripper lines on 25th December in winter seasons of 2019-20 and 2020-21. Plot area was 30 m^2 (2 rows, each with 10 m length and 1.5 m width), planting density was two plants/m^2. Experimental units included two drip irrigation lines one was used for samples of vegetative growth and the other line was used for determination of yield.

Soil potassium rates were added as fertigation treatment (supply with water irrigation water) during plant growth as recommended, while foliar potassium applications were sprayed at 30 days from transplanting, where plots received units of different potassium sources by spraying several times according to their composition. All experimental units received equal amounts of commercial fertilizers, *i.e.*, ammonium sulfate (20.6%N), and ortho-phosphoric acid (85%) as recommended fertilizers for cantaloupe from nitrogen and phosphorus. Other agriculture practices (irrigation and pest control…*etc.*) were applied as recommended for cantaloupe cultivations.

Table 1. Chemical analyses of irrigation water

pH	EC (ppm)	Soluble ions (meq. l^{-1})							
		Cations				Anions			
		K+	Na^+	Mg++	Ca++	Cl^-	HCO_3^-	CO_3^{--}	SO_4^-
First season (2019-20)									
7.12	561	0.21	18.18	17.00	20.71	46.06	2.70	-	7.34
Second season (2020-21)									
7.32	600	0.23	18.96	19.34	21.47	48.75	2.97	-	8.28

Table 2. Initial physical and chemical properties of investigated soil of cultivated area

Physical property	Particles size distribution (%)	
Coarse sand (%)	62.0	61.0
Fine sand (%)	20	21.0
Silt (%)	10.5	10.0
Clay (%)	7.5	8.0
Soil texture	Loamy sand	Loamy sand
Bulk density (Mgm^{-1})	1665	1670
Chemical property	**(Soluble ions (in 1:5 soil water extract)**	
Ca^{++} (meq l^{-1})	3.10	3.89
Mg^{++} (meq l^{-1})	3.90	4.13
Na^+ (meq l^{-1})	2.44	2.89
K^+ (meq l^{-1})	0.24	0.29
CO_3^{--} (meq l^{-1})	-	-
HCO_3^- (meq l^{-1})	4.08	4.40
Cl^- (meq l^{-1})	4.20	5.35
SO_4^{--} (meq l^{-1})	1.40	1.45
EC (dS m^{-1}) in 1:5 water extract)	0.97	1.12
pH (in 1:2.5 Soil water suspension extract)	8.10	8.13
Organic matter (%)	0.153	0.171
$CaCO_3$ (%)	22.43	22.48

Table 3. Potassium fertilizer source

Commercial name	Composition	Company and Address
Solo K Potassium sulphate	K_2O 50% And S 18%	Egypt Ferkem for Chemicals and Fertilizers. El-Saddat City, Industrial Zone 4, Al-Monofia, Egypt.
Potassium thiosulphate (KTS)	K_2O 36% and S 25%	Egypt Ferkem for Chemicals & Fertilizers. El-Saddat City, Industrial Zone 4, Al-Monofia, Egypt
Pepsil (Potassium silicate)	K_2O 32% and Sil_2 60%	Mac for Agriculture Development, Al-Nozha, Cairo
Global Pota planet (Potassium citrate)	K_2O 38% and Citric acid15%	Global Green Plant for Agriculture Development - Cairo
Target potassium 47 (Potassium acetate)	K_2O 47.9% and Acetic acid 52.1%	Rawkit for Fertilizers amd chemicals Industrial Zone no.78, El-Salhia El-Ggadida, Egypt

Table 4. Quantity of potassium sources/fed., and per m^2

Soil Potassium Fertilizer Level	K_2O unit	Fertilizer dose/fad. (Kg.)	Fertilizer dose/m^2 (g)	Foliar Spraying fertilizer level and source	K_2O unit	Fertilizer dose/fad. (Kg.)	Fertilizer dose/m^2 (g)
50% of K_2SO_4 (Potassium sulphate 48% K_2O)	40	83.3	18.83	50% K_2SO_4 Pepsil (Potassium silicate)	40	125	29.76
				50% K_2SO_4 Global Pota planet (Potassium citrate)		105.26	25.06
				50% K_2SO_4 Target potassium 47 (Potassium acetate)		83.50	19.88
				50% K_2SO_4 Potassium thiosulphate		111.11	26.45
75% of K_2SO_4 (Potassium sulphate 48% K_2O)	60	124.95	29.75	25% K_2SO_4 Pepsil (Potassium silicate)	20	62.5	14.88
				25% K_2SO_4 Global Pota planet (Potassium citrate)		52.63	12.53
				25 % K_2SO_4 Target potassium 47 (Potassium acetate)		41.75	9.94
				25% K_2SO_4 Potassium thiosulphate		55.55	13.22
100% of K_2SO_4 (Potassium sulphate 48% K_2O)	80	166.6	39.66	Tap water spray			

Data Recorded

Fruit yield

Cantaloupe fruits were harvested at proper marketable stage complete and the following data were recorded:

a. Grade A yield: it was calculated from fruits weighed more than 400g,

b. Marketable yield

c. Total Yield.

Fruit shelf-life storage ability

Cantaloupe fruits at the beginning of storage period as well as at the end of storage period were subjected to the following:

1. Fruit Firmness: manual penetrometer was used to determine fruit firmness
2. Fruit Weight loss: The weight loss of cantaloupe fruit samples was calculated by considering the differences between basic initial weight and final weight of storage periods of (8days), (16days), and (24days) currently tested cantaloupe fruits divided by their basic initial weight for each period.

Statistical Analysis

The obtained data were subjected to statistical analysis of variance according to **Snedecor and Cochran (1980)**, and means separation was done according to **Duncan (1955).**

RESULTS AND DISCUSSION

Fruit Yield

Effect of soil fertilizer application

Grade A yield

Data in Table 5 show significant effects for soil potassium application rates on grade A yield traits; *i.e.*, number of fruits and fruit yield per m^2 and per fed., in both seasons. Soil potassium rate of 100% had the highest values at (1.00 kg./m^2 and 1.03 A kg./m^2; 4.20 ton./fed., and 5.46 ton./fad., in the first and second seasons, respectively) without significant differences with soil potassium rate of 75%. While using 50% of soil potassium rate recorded the lowest value in both seasons. This result may be due to that potassium involved in numerous physiological processes of plant growth, yield and quality as reported by **Marschner (1995)**. Also, **Demiral and Koseoglu (2005), Frizzone *et al.* (2005) and Kaya *et al.* (2007)** found that increasing K_2O doses increased fruit weight, fruit diameter, total yield, flesh firmness and the number of marketable fruits significantly. In addition, **Ahmed *et al*. (2020)** found that fruit yield and its components (Early fruit yield/plant, total fruit No./plant, total fruit yield/plant and total fruit yield/fed.) were positively affected by increasing potassium fertilizer rates from 100 to 180 kg/fed., the highest values of total fruit yield/plant or fed.

Marketable yield

Resuts in Table 5 show that significant effects for soil potassium application rates were recorded on marketable yield of cantaloupe plants in both seasons. Soil potassium rate of 100% had the highest values of yield (8.65 ton./fed., in first season and 8.74 ton./ fed., in second season) without significant differences than soil potassium rate of 75%, while soil potassium rate of 50% recorded the lowest value in both seasons. These results are in agreement with those of **El-Sayed *et al.* (2017) and Ahmed *et al.* (2020)**.

Total yield

Results in Table 5 show significant effects for soil potassium application rates on total yield traits; *i.e.*, number of fruits, fruit yield per m^2 and per fed. in both seasons. Soil potassium rate of 100% had the highest values (2.13 kg. /m^2 in and 2.14 kg./m^2 8.95 ton./fed., and 8.95 ton./fad., in first and second seasons, respectively) without significant differences than soil

Table 5. Effect of soil potassium application and foliar potassium sources on cantaloupe fruit yield in 2019-20 and 2020-21 seasons

Parameter	Grade A yield			Marketable yield			Total yield		
	(m^2)		(ton/fad.)	(m^2)		(ton/ fad.)	(m^2)		(ton/ fad.)
Treatment	No. fruits	Fruits weight (kg)		No. fruits	Fruits weight (kg)		No. fruits	Fruits weight (kg)	
First Season (2019/2020)									
Soil–K application									
$T_{100\%}$	1.89a	1.00a	4.20a	6.70a	2.06a	8.65 a	6.99a	2.13a	8.95a
$T_{75\%}$	1.78a	0.92a	3.86a	5.61b	1.86a	7.81 a	5.84b	1.91ab	8.02ab
$T_{50\%}$	1.33b	0.67b	2.81b	5.17b	1.54b	6.47 b	5.56b	1.66b	6.97b
Foliar-K sources									
Without	1.89b	0.99ab	4.16ab	4.72b	1.48c	6.22 c	5.14b	1.61c	6.76c
k-Sili	1.74b	0.91b	3.82 b	6.26a	1.99ab	8.36 ab	6.79a	2.1ab	8.82ab
k-Citr	2.16a	1.07a	4.49a	6.40a	1.86b	7.81 b	6.66a	1.94b	8.15b
k-Acet	1.38c	0.74c	3.11c	6.47a	2.18a	9.16 a	6.61a	2.22a	9.32a
k-Thio	1.17d	0.61d	2.56d	5.27b	1.60c	6.72 c	5.44b	1.65c	6.93c
Second Season (2020/2021)									
Soil–K application									
$T_{100\%}$	1.93a	1.03a	5.46a	6.67a	2.08a	8.74 a	6.82a	2.14a	8.99a
$T_{75\%}$	1.82 a	0.93a	3.91a	5.69ab	1.82ab	7.64 ab	5.83ab	1.86a	7.81a
$T_{50\%}$	1.28 b	0.65c	2.35c	5.05b	1.61b	6.76 b	5.37b	1.72a	7.22a
Foliar-K sources									
Without	1.84ab	0.97ab	4.07ab	5.24b	1.63c	6.85 c	5.52b	1.73c	7.266c
k-Sili	1.78ab	0.92ab	3.86ab	6.04ab	1.95ab	8.19 ab	6.34ab	2.6a	10.92a
k-Citr	2.16a	1.07a	4.49a	5.80ab	1.73bc	7.27 bc	5.97ab	1.79bc	7.52bc
k-Acet	1.41bc	0.78bc	3.28c	6.57a	2.08a	8.74 a	6.67a	2.12ab	8.90ab
k-Thio	1.20c	0.62c	1.48c	5.36 b	1.78abc	7.48 abc	5.52b	1.83abc	7.69abc

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test

$T_{100\%}$	Soil application (100% K_2SO4)	k-Sili	Foliar Potassium Silicate
$T_{75\%}$	Soil application (75% K_2SO4)	k-Citr	Foliar Potassium Citrate
$T_{50\%}$	Soil application (50% K_2SO4)	k-Acet	Foliar Potassium Acetate
		k-Thio	Foliar Potassium Thiosulphate

potassium rate of 75%, in second season. This result may be due to that adequate K nutrition is associated with increased yields as reported by **Frizzone *et al.* (2005) and Kaya *et al.*, (2007).**

Effect of Foliar spray with potassium sources

Grade A yield

Resuts in Table 5 show that significant effects for foliar potassium treatments on cantaloupe grade A yield. Concerning number of fruits and fruits weight per m^2 the highest yield value was recorded by k-Citr spraying treatment (2.16 kg and 1.07 kg /m^2 and 4.49 ton /fed. in first and second seasons, respectively) without significant difference than k-Sili. or without k spray in the second season. Similar results were obtained by **El-Sayed *et al.* (2017)** who found yield and fruit quality of some cantaloupe hybrids affected by K spraying.

Marketable yield

Results in Table 5 show that significant effects for foliar potassium treatments on cantaloupe marketable yield. Concerning number of fruits and fruits weight per m^2 the highest values was recorded by k-Acet spraying treatment, where the highest marketable yield per m^2 was 2.18 kg in first season and 2.08 kg. /m^2 in second seasons and 9.16 ton/fed. and 8.74 ton/fed. in first and second seasons, respectively without significant difference than k-Sili treatment in both seasons. This result is in harmony with that of **Ahmed *et al*. (2020)**.

Total yield

Results in Table 5 show that significant effects of foliar potassium spray treatment on cantaloupe total yield. In the first season the values were recorded by $T_{50\%}$ × k-Acet treatment that recorded total yield of 9.32 ton. /fed in first season while in the second season was recorded by K-silicate (10.92 ton/fad.) followed by K-acetate (8.90 ton/fad). Similar results were obtained by **Ahmed *et al.* (2020)** who obtained highest values of total fruit yield / plant or fed. with increasing potassium fertilizer rates from 100 to 180 kg/fed.

Effect soil potassium application and foliar potassium sources interaction

Grade A yield

Results in Tables 6 and 7 show that significant effects for soil potassium application and foliar potassium sources interaction treatments on cantaloupe grade A yield. The highest values were recorded by $T_{100\%}$ × k-Citr treatment without significant differences than $T_{75\%}$ × k-Citr, in both seasons. These results are expected because K plays a vital role in increasing fruit size, where an increase in demand for K during the plant's production process; so, when the melon plants of this experiment received enough K, the efficiency of water was improved by increasing osmotic pressure of cells, making them more expansion and increasing the weight and size of fruits. These results are in agreement with that of **Asao *et al*. (2013**) on melon, who found that the highest values of number of fruits per plant and number of fruits per feddan were obtained with the highest potassium application levels. Also, **El-Sayed *et al.* (2017),** on cantaloupe and **El-Drany *et al.* (2021),** on muskmelon found similar results.

Marketable yield

Results in Tables 6 and 7 show that significant effects for soil potassium application and foliar potassium sources interaction treatments on cantaloupe marketable yield. The highest values were recorded by $T_{50\%}$ × k-Acet treatment that recorded marketable yield of 10.84 ton./fed., in first and second season, followed by $T_{50\%}$× K-Sili, $T_{100\%}$ × without K-spray in T_{75} × k-Acet, in both seasons. **Demiral and Koseoglu (2005), Frizzone *et al.* (2005),** and **Kaya *et al.* (2007)** demonstrated that number of marketable fruits significantly increased with increasing K_2O doses.

Table 6. Effect of soil potassium application and foliar potassium sources interaction on canteloupe fruit yield in first season (2019-2020)

Parameter	Grade A yield			Marketable yield			Total yield		
	(m^2)			(m^2)			(m^2)		
Treatment	No. fruits	Fruits weight (kg)	(ton/ fed.)	No. fruits	Fruits weight (kg)	(ton/ fed.)	No. fruits	Fruits weight (kg)	(ton/ fed.)
$T_{100\%}$×without	2.23b	1.20b	5.04 b	6.23cd	2.22abc	9.32 abc	6.96cde	2.48ab	10.42ab
$T_{100\%}$× K-Sili	2.17bc	1.18b	4.96 b	5.33de	1.55efg	6.51 efg	5.93ef	1.70def	7.14def
$T_{100\%}$× k-Citr	2.70a	1.38a	5.80 a	5.73d	1.67efg	7.01 efg	6.06def	1.81cde	7.60cde
$T_{100\%}$× k-Acet	1.67ef	0.91de	3.82 de	4.26ef	1.53fg	6.43 fg	4.32h	1.54ef	6.47ef
$T_{100\%}$× k-Thio	0.70gh	0.33hi	1.39 hi	4.30ef	0.73 i	3.07 i	4.50gh	0.814h	3.399h
$T_{75\%}$× without	2.07bcd	1.11bcd	4.66 bcd	4.10f	1.25gh	5.25 gh	4.33h	1.32fg	5.544fg
$T_{75\%}$× K-Sili	1.67ef	0.83ef	3.49 ef	6.06cd	1.91c-f	8.02 c-f	6.52def	1.95cde	8.19cde
$T_{75\%}$× k-Citr	2.30b	1.14bc	4.79 bc	5.56d	1.74def	7.31 def	5.77f	1.80cde	7.56cde
T_{75}×k-Acet	1.87cde	1.01bcd	4.24 bcd	6.93bc	2.43ab	10.21 ab	7.03bcd	2.47ab	10.37ab
$_{75\%}$× k-Thio	1.00g	0.50gh	2.10 gh	5.40de	1.96cde	8.23 cde	5.57fg	2.02cd	8.48cd
$_{50\%}$×without	1.37f	0.69fg	2.90 fg	3.83f	0.96hi	4.03 hi	4.13h	1.02gh	4.28gh
$_{50\%}$× K-Sili	1.40f	0.71f	2.98 f	7.40ab	2.50ab	10.50 ab	7.93abc	2.65a	11.13a
$_{50\%}$× k-Citr	1.45f	0.68fg	2.86 fg	7.90ab	2.17bcd	9.11 bcd	8.13ab	2.23bc	9.37bc
$_{50\%}$× k-Acet	0.60h	0.30i	1.26 i	8.23a	2.58a	10.84 a	8.49a	2.65a	11.13a
$_{50\%}$× k-Thio	1.80de	0.98cde	4.12 cde	6.13cd	2.10bcd	8.82 bcd	6.26def	2.14bc	8.99bc

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test

Table 7. Effect of soil potassium application and foliar potassium sources interaction on canteloupe fruit yield in second season (2019-2020)

Parameter	Grade A yield			Marketable yield			Total yield		
	(m^2)			(m^2)			(m^2)		
Treatment	No. fruits	(ton/ fed.)	(ton/ fed.)	No. fruits	Fruits weight (kg)	(ton/ fed.)	No. fruits	Fruits weight (kg)	(ton/ fed.)
$T_{100\%}$×without	2.07a-d	1.10abc	4.24 abc	7.73ab	2.60a	10.92 a	8.23ab	2.80a	11.76a
$T_{100\%}$× K-Sili	2.37abc	1.27ab	5.33ab	4.63fgh	1.39c-f	5.84 c-f	5.06efg	1.54efg	6.47efg
$T_{100\%}$× k-Citr	2.67a	1.38a	5.80 a	4.66fgh	1.48c-f	6.22 c-f	4.92efg	1.57efg	6.59efg
$T_{100\%}$× k-Acet	1.87b-e	1.08a-d	4.54 a-d	4.00gh	1.30def	5.46 def	4.10fg	1.34fg	5.65fg
$T_{100\%}$× k-Thio	0.70h	0.30f	1.26 f	4.23gh	1.28def	5.38 def	4.53fg	1.37fg	5.75fg
$T_{75\%}$× without	2.07a-d	1.10abc	4.24 abc	4.30gh	1.23ef	5.17 ef	4.56fg	1.30g	5.46g
$T_{75\%}$× K-Sili	1.77b-f	0.87cde	3.65 cde	6.03c-f	1.97abc	8.27 abc	6.23cde	2.02b-e	8.48b-e
$T_{75\%}$× k-Citr	2.50ab	1.25abc	5.25 abc	5.56d-g	1.74b-e	7.31 b-e	5.66def	1.78 def	7.48def
T_{75}×k-Acet	1.60def	0.87cde	3.65 cde	7.30abc	2.36a	9.91 a	7.40abc	2.39abc	10.04a-c
$T_{75\%}$× k-Thio	1.17fgh	0.59ef	2.48 ef	5.26e-h	1.80bcd	7.56 bcd	5.33d-g	1.81def	7.60def
$T_{50\%}$×without	1.40d-g	0.72def	3.02 def	3.70 h	1.07f	4.49 f	3.80g	1.10g	4.62g
$T_{50\%}$× K-Sili	1.20e-h	0.61ef	2.56 ef	7.46abc	2.49a	10.46 a	7.72abc	2.63ab	11.05ab
$T_{50\%}$× k-Citr	1.30e-h	0.59ef	2.48 ef	7.16a-d	1.97abc	8.27 abc	7.32abc	2.02cde	8.48c-e
$T_{50\%}$× k-Acet	0.77gh	0.39f	1.64 f	8.43a	2.58a	10.84 a	8.53a	2.64ab	11.09ab
$T_{50\%}$× k-Thio	1.73c-f	0.94b-e	3.95 b-e	6.60b-e	2.26ab	9.49 ab	6.73bcd	2.30a-d	9.66a-d

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test

Total yield

Results in Tables 6 and 7 show that significant effects for soil potassium application and foliar potassium sources interaction treatments on cantaloupe total yield. In first season, the highest yield was recorded by the treatment of $T_{100\%}$×without k-spray (2.48 kg/m^2, 10.42 ton./fed.) without significant differences than $T_{50\%}$× K-Sili (2.65 kg/m^2, 11.13 ton./fed.). In second season, the highest yield was recorded by the treatment of $T_{100\%}$×without k- spray (2.80 kg/m^2, 11.76 ton./fed.) without significant differences than $T_{50\%}$× k-Acet (2.64 kg/m^2, 11.09 ton./fed.); $T_{50\%}$× K-Sili (2.63 kg/m^2 ,11.05 ton./fed.); and T_{75}×k-Acet (2.39 kg/m^2, 10.04 ton./fed.) treatments.

The increment in total yield may be owe to the increment in number of fruits. The positive effect of potassium fertilizer may be due to that, potassium fertilizer plays an important role in the functions of enzymes needed for the vital process and growth. **Marschner (1995)** reported that potassium is participate in several physiological and biochemical processes which in turn effect on vegetative growth, yield and its quality, as well as under stress conditions.

These results are in accordance with, **Bouzo *et al.* (2018), Ahmed *et al*. (2020), Anouschka *et al* (2021)**, and **Gouda *et al*. (2021)** on cantaloupe; **Preciado-Rangel *et al.* (2018), Al-Kazafy *et al.* (2021)**, and **Matthew (2021)** on Muskmelon

Some fruit characteristics during shelf-life storage

Effect of soil application Fertilizer

Fruit firmness

Results in Table 8 show that decrease in cantaloupe fruit firmness during all storage periods without significant differences among soil potassium application treatments in each storage period. **Lester *et al.* (2005)** indicated the beneficial effects of supplemental foliar K application on fruit quality. **Preciado-Rangel (2018)** obtained higher values of fruit firmness as K concentrations increased, showing a lineal, positive and significant trend, which evidences that the optimal dose of K in muskmelon is higher than 11 mM,

Fruit weight loss during storage

Results in Table 8 show decrease in cantaloupe fruit weight loss during all storage periods without significant differences among soil potassium application treatments in each storage period. This result may be due to that all K treatments had amount of potassium sufficient to fruits growth. Results are in accordance with that obtained by **Preciado-Rangel (2018).**

Effect of Foliar spray with potassium sources

Fruit firmness

Results in Table 8 show decrease in cantaloupe fruit firmness during all storage periods without significant differences among foliar potassium application sources in each storage period. This result may be due to increasing K_2O doses increased flesh firmness as reported by **Demiral and Koseoglu (2005), Frizzone *et al. (*2005),** and **Kaya *et al. (*2007)**.

Fruit weight loss during storage

Results in Table 8 show decrease in cantaloupe fruit firmness during all storage periods without significant differences among foliar potassium application sources in each storage period

Effect soil potassium application and foliar potassium sources interaction

Fruit firmness

Results in Table 9 show decrease in cantaloupe fruit weight loss during all storage periods. Soil potassium application and foliar potassium application sources interaction treatments had significant effects at all storage periods in both seasons, except

Table 8. Effect of soil potassium application and foliar potassium sources on cantaloupe fruit firmness and weight loss during shelf-life storage in 2019-20 and 2020-21 seasons

Parameter / Treatment	Fruit firmness (kg/cm^2)				Fruit Weight loss (%)		
	At Harvest	After 9 days	After 18 days	After 26 days	After 9 days	After 18 days	After 26 days
First Season (2019/2020)							
Soil–K application							
$T_{100\%}$	3.7a	2.1a	1.5a	1.3a	12.5b	32.6a	52.2a
$T_{75\%}$	2.8a	1.9a	1.5a	1.1a	9.8c	28.0a	45.2a
$T_{50\%}$	2.7a	1.8a	1.4a	1.3a	15.4a	35.4a	50.9a
Foliar-K sources							
Without	2.7a	1.75ab	1.53a	1.1a	11.8b	30.6a	47.9a
k-Sili	2.9a	1.7ab	1.57a	1.0a	20.5a	37.7a	51.1a
k-Citr	3.1a	2.6a	1.65a	1.5a	8.0b	32.3a	50.7a
k-Acet	3.0a	1.66b	1.35a	1.3a	11.3b	31.4a	48.7a
k-Thio	3.7a	2.0ab	1.55a	1.4a	11.1b	28.1a	48.8a
Second Season (2020/2021)							
Soil–K application							
$T_{100\%}$	4.1a	2.1a	1.5a	1.2a	13.0a	35.2a	82.2a
$T_{75\%}$	3.7a	1.8a	1.3a	1.1a	11.2a	34.5a	75.2a
$T_{50\%}$	2.8a	2.2a	1.9a	1.2a	12.3a	31.4a	80.8a
Foliar-K sources							
Without	3.7a	2.0a	1.6a	1.2ab	10.2a	33.9a	77.9a
k-Sili	3.4a	2.1a	1.5a	1.1ab	14.4a	35.9a	81.0a
k-Citr	3.6a	1.7a	1.6a	0.98b	11.4a	34.7a	80.7a
k-Acet	3.4a	2.5a	1.9a	1.5a	14.0a	36.0a	78.7a
k-Thio	3.6a	1.8a	1.2a	1.1ab	10.8a	28.0a	78.8a

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test

$T_{100\%}$: Soil application (100% K_2SO4) from recommended it

$T_{75\%}$: Soil application (75% K_2SO4) from recommended it

$T_{50\%}$: Soil application (50% K_2SO4) from recommended it

k-Sili: Foliar Potassium Silicate

k-Citr: Foliar Potassium Citrate

k-Acet: Foliar Potassium Acetate

k-Thio: Foliar Potassium Thiosulphate

Table 9. Effect of soil potassium application and foliar potassium sources interaction on cantaloupe fruit firmness and weight loss during shelf-life storage in 2019-20 and 2020-21 seasons.

Parameter	Fruit firmness (kg/cm^2)				Fruit Weight loss (%)		
Treatment	At Harvest	After 9 days	After 18 days	After 26 days	After 9 days	After 18 days	After 26 days
First Season (2019/2020)							
$T_{100\%}$×without	2.8a	1.78ab	1.3a	1.2a	14.4b	28.7b	34.7b
$T_{100\%}$× K-Sili	3.4a	1.9ab	1.6a	1.0a	12.3bc	31.2b	55.1ab
$T_{100\%}$× k-Citr	4.4a	3.4a	2.0a	1.9a	9.5c	34.7ab	53.4ab
$T_{100\%}$× k-Acet	3.9a	2.7ab	1.2a	1.1a	15.4b	34.4ab	58.4a
$T_{100\%}$× k-Thio	4.3a	1.8ab	1.5a	1.4a	14.1bc	34.1ab	59.7a
$T_{75\%}$× without	2.7a	1.3b	1.2a	0.8a	9.6bc	28.4b	54.8ab
$T_{75\%}$× K-Sili	2.3a	2.1ab	2.0a	1.0a	12.2bc	30.2b	41.8ab
$T_{75\%}$× k-Citr	2.5a	2.5ab	1.5a	1.5a	8.7bc	24.2b	38.5ab
T_{75}×k-Acet	2.7a	1.5ab	1.3a	1.1a	9.3bc	33.1b	43.9ab
$T_{75\%}$× k-Thio	3.6a	1.9ab	1.5a	1.3a	9.4bc	27.2b	37.2ab
$T_{50\%}$×without	2.7a	2.1ab	1.9a	1.2a	11.3bc	37.6ab	54.3ab
$T_{50\%}$×K-Sili	3.1a	1.2b	1.0a	0.9a	37.1a	51.7a	56.2ab
$T_{50\%}$×k-Citr	2.5a	2.0ab	1.4a	1.0a	9.2bc	38.0ab	60.3a
$T_{50\%}$×k-Acet	2.3a	1.6ab	1.4a	1.7a	9.2bc	26.9b	34.0ab
$T_{50\%}$×k-Thio	3.1a	2.2ab	1.5a	1.6a	9.2bc	22.9b	37.6ab
Second Season (2020/2021)							
$T_{100\%}$×without	4.7a	2.0a	1.6ab	1.4ab	8.5b	30.7ab	64.6b
$T_{100\%}$× K-Sili	3.5ab	2.2a	1.3ab	0.86b	12.5ab	35.3ab	85.1ab
$T_{100\%}$× k-Citr	4.5ab	2.3a	2.0ab	1.3ab	14.1ab	33.2ab	83.4ab
$T_{100\%}$× k-Acet	4.1ab	2.1a	1.6ab	1.2a	17.2ab	42.2ab	88.3a
$T_{100\%}$× k-Thio	3.6ab	1.8a	1.1b	1.0ab	12.6ab	34.6ab	89.6a
$T_{75\%}$× without	4.1ab	1.9a	1.0b	0.96ab	14.1ab	44.6a	84.7ab
$T_{75\%}$× K-Sili	3.4ab	1.5a	1.1b	1.0ab	10.9ab	32.8ab	71.8ab
$T_{75\%}$× k-Citr	4.1ab	1.3a	1.3ab	1.0ab	9.3ab	35.9ab	68.4ab
T_{75}×k-Acet	3.6ab	2.6a	1.5ab	1.4ab	12.8ab	36.0ab	73.8ab
$T_{75\%}$× k-Thio	3.5ab	1.5a	1.4ab	1.1ab	8.9b	23.1b	77.2ab
$T_{50\%}$×without	2.3b	2.0a	2.0ab	1.3ab	8.0b	26.3ab	84.3ab
$T_{50\%}$× K-Sili	3.3ab	2.5a	2.3ab	1.3ab	19.9a	39.7ab	86.2ab
$T_{50\%}$× k-Citr	2.3b	1.6a	1.45ab	0.91ab	10.8ab	34.9ab	90.2a
$T_{50\%}$× k-Acet	2.5ab	2.1a	1.6a	1.1ab	10.1ab	29.7ab	70.9ab
$T_{50\%}$× k-Thio	3.8ab	2.0a	1.2b	1.0ab	10.9ab	26.4ab	69.6ab

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of probability according to Duncan's multiple range test.

at harvest, 18 days and 28 days after harvest in the first season and at 9 days after harvest in the second season. The highest fruit firmness during storage was recorded with T100%× k-Citr treatment in both seasons. **Marschner (1995), Demiral and Koseoglu (2005), Frizzone *et al.* (2005) and Kaya *et al.* (2007)** found that increasing K_2O doses significantly increased fruit weight, fruit diameter, total yield, flesh firmness and the number of marketable fruits significantly with

Fruit weight loss during storage

Results in Table 9 show decrease in cantaloupe fruit weight loss during all storage periods without significant differences among soil potassium application and foliar potassium application sources interaction treatments in each storage period.

In first season, after 9 days of storage $T_{75\%}$ × k-Citr had the lowest percentage of weight loss, without significant difference than $T_{50\%}$ × k-Acet, $T_{50\%}$ × k-Thio, and $T_{75\%}$ × k-Thio treatments; after 18 and 28 days of storage the lowest percentage of weight loss was recorded with $T_{50\%}$ × k-Acet and $T_{50\%}$ × k-Thio treatments followed by $T_{75\%}$ × k-Citr, and $T_{75\%}$ × k-Thio and treatments. In the second season, $T_{50\%}$ × without, $T_{75\%}$ × k-Thio treatments recorded the lowest percentage of weight loss after 9 days of storage and $T_{75\%}$ × k-Thio and $T_{50\%}$ × without after 18 days of storage, while after 28 days of storage, the lowest percentage of weight loss values were recorded by $T_{100\%}$ without followed by $T_{55\%}$ × k-Thio and $T_{50\%}$ × k-Acet.

Results indicated beneficial effects of K supplement on fruit firmness (kg/cm^2) because K increases the accumulation of sugars (solutes) in fruits and fruit firmness is correlated with the pressure potential (ψp) as reported by **Harker *et al.* (1997).** In this direction **Kusvuran *et al*. (2012)** repoeted that **f**ruit firmness is a good indicator of texture and shelf life of horticultural fruits that presumably a result of a combination of an improvement in the assimilation of CO_2 higher photosynthetic activity and greatest translocation of photo-assimilates from leaves to fruits which improve water relations greater enzyme activity and substrate availability for the biosynthesis of bioactive compounds.

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الملخص العربي

تأثير تسميد البوتاسيوم الأرضي وبالرش على محصول نبات الكنتالوب بالأراضي الرملية

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تم إجراء دراسة ميدانية على نباتات الكنتالوب صنف 'Gal152' خلال موسمي النمو الشتويين 20-2019 و 21-2020 في مزرعة خضروات خاصة تقع في منطقة أبو الذهب، بقريه أبو خليفة، محافظة الإسماعيلية، مصر. تم زراعة الشتلات بعمر 17 يوما في 25 ديسمبر تحت أنفاق بلاستيكية منخفضة مع تغطية سطح التربة بالبلاستيك، وذلك تحت ظروف التربة الرملية بهدف دراسة تأثير التوليفات بين ثلاثة مستويات من سلفات البوتاسيوم المضاف للتربة هي 100%، و75%، و50% من متطلبات البوتاسيوم الموصي به مع الرش الورقي بأربعة مصادر للبوتاسيوم هي سيليكات البوتاسيوم (K-Sili)، وسترات البوتاسيوم (K-Citr.)، وخلات البوتاسيوم (K-Acet.)، وثيوسلفات البوتاسيوم (K-Thio.)، كنترول (رش بالماء). وبذلك فإن هذه الدراسة تشتمل على خمسة عشر معاملة. تم تسجيل أعلى قيم للمحصول المبكر عند استخدام معاملة إضافة البوتاسيوم بمعدل 100% + الرش بـk-Citr ، دون اختلافات معنوية عن معاملة الإضافة الأرضية للبوتاسيوم بمعدل 75% +الرش بـ k-Citr، والإضافة الأرضية للبوتاسيوم بمعدل 100% + المعاملة بدون رش للبوتاسيوم، والإضافة الأرضية للبوتاسيوم بمعدل75% + بدون معاملة رش بالبوتاسيوم في الموسم الثاني. كان أعلى محصول قابل للتسويق مع استخدام معاملة التسميد الأرضي للبوتاسيوم بمعدل 50% + معاملة الرش بـ k-Acet. وتحقق أعلى محصول قابل للتسويق عند استخدام معامل الإضافة الأرضية للبوتاسيوم بمعدل 50%+ معاملة الرش K-Sili، ومعاملة الإضافة الأرضية للبوتاسيوم بمعد 100% + معاملة بدون رش بالبوتاسيوم في الموسم الأول، ومعاملة الإضافة الأرضية للبوتاسيوم بمعدل 100%+ معاملة بدون رش بالبوتاسيوم ، ومعاملة الإضافة الأرضية للبوتاسيوم بمعدل 75% + k-Acet، ومعاملة الإضافة الأرضية للبوتاسيوم بمعدل 50% + k-Thio ، ومعاملة الإضافة الأرضية للبوتاسيوم بمعدل 75% + k-Citr, في الموسم الثاني. ونتج عن استخدام الإضافة الأرضية للبوتاسيوم بمعدل 100% + معاملة رش البوتاسيوم أعلى محصول كلي (2.48كجم للمتر المربع، و 10.42طن للفدان)، وبدون اختلافات معنوية عن معاملة الإضافة الأرضية للبوتاسيوم بمعدل 50% +.K-Sili في الموسم الأول. بينما كان أعلى محصول كلي في الموسم الثاني عند استخدام الإضافة الأرضية للبوتاسيوم بمعدل 100% + المعاملة بدون رش للبوتاسيوم (2.80 كجم للمتر المربع، و11.76 طن للفدان)، وبدون اختلافات معنوية عن معاملة الإضافة الأرضية للبوتاسيوم بمعدل 50% + k Acet أو معاملة الإضافة الأرضية للبوتاسيوم بمعدل 50% + K-Sili، ومعاملة الإضافة الأرضية للبوتاسيوم بمعدل 75% +K-Sili.

الكلمات الاسترشادية: الشمام، البوتاسيوم، جودة الثمار، ما بعد الحصاد. انقضاء.

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