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EFFECT OF VINE CUTTINGS AGE AND SOME POTASSIUM FERTILIZER SOURCES ON GROWTH AND YIELD COMPONENTS OF SWEET POTATO

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ABSTRACT

Two field experiments were carried out during the growth seasons of 2017 and 2018 at the Experimental Farms of Mallawy Agriculture Research Station, Hort. Res. Institute, Giza, Egypt to evaluate the effect of vine cutting ages and potassium fertilizer sources on the growth of the sweet potato cv "Mabrouka". The treatments comprised three apical vine cuttings ages (3, 5 and 7-days) as well as fresh cutting (control treatment) and four sources of potassium fertilizer (K-sulphate, K-silicate, K-citrate and K-humate). The obtained data revealed that: the highest survival rate of vine cuttings was achieved with the 3-days age and fresh cutting planting. The greatest sweet potato studied parameters [vine fresh weight (ton.fed$^{-1)}$, storage root yield (ton.fed^{-1}), biomass yield (ton.fed^{-1}) storage roots length, cm), and K %] were produced with the treatment of immediate planting and 3-days old cuttings. Also, 5-days old cuttings showed the highest total number of storage roots. Contrariwise, storage root diameter, (cm) storage root dry matter (%) and marketable yield (%) were not affected by vine cuttings age in both seasons.

All potassium sources which were used as foliar application affected the growth and yield parameters of sweet potato cv. "Mabrouka”. The treatments of K- silicate and K-sulphate gave the best results of biomass yield (storage roots + forage weight, ton.fed^{-1}), marketable yield%, and root diameter. The combined treatments of fresh cuttings and K-silicate foliar fertilizer showed the greatest values for number of storage roots, root yield, root diameter and biomass yield (ton.fed^{-1}). Also, the 3-days- vine cuttings and K-humate treatment recorded the best results for vine fresh weight (ton.fed^{-1}).

Keywords: *Sweet potato, vine cutting age, potassium sources, Growth and Yield components*

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a herbaceous perennial vine, which produces storage roots and edible leaves in marginal lands (Drapal *et al*., 2019). It is a dicotyledonous plant that belongs to the family *Convolvulaceae* (Tortoe, 2010) and can be considered very important in promoting nutritional security particularly in poor soils (Srinivas, 2009). It is a major crop in most eastern and southern African countries (Shonga *et al.* 2013) and worldwide. More than 110 countries produced sweet potato. China followed by Uganda and Nigeria on the top (FAO, 2004). Sweet potato is commonly vegetatively propagated by small tubers and vine cutting (Lencha. *et al.* 2016). The most common method of sweet potato propagation is by the use of vine cuttings (Edmond, 1971). The plant is traditionally cultivated for food (Ruiz *et al*., 1981), livestock (Giang *et al*, 2004 and goats (Tesfaye *et al*., 2008) It is an excellent source of carbohydrate, protein, iron, fiber and vitamins in both storage roots and leaves (Smart and Simonds, 1995). Etela *et al*., (2008) showed that feeding the sweet potato vines to cows increased milk yield in the tropical and sub-tropical climate zones, (ICAR, 2007).

In many places, farmers use various lengths and ages of cutting which are available. Some farmers use short cuttings for planting just because they are easy for handling or in order to economize the planting materials.

Information regarding the effect of vine cuttings age for the establishment and successful sweet potato production in Egypt is not known.

Potassium (K) is the most important nutrient in sweet potato production **(**Uwah *et al*., 2013). It is essential for the synthesis and translocation of carbohydrates from the tops to the roots (Byju. and Nedunchezhiyan 2004 and Pushpalatha, *et al.* 2017). Potassium activates over 60 enzymes, promotes photosynthesis, controls stomata opening, improves the utilization of nitrogen, promotes the transport of assimilates, and consequently increases crop yields. It plays a critical role in reducing the loss of water from leaf stomata,and it increases the ability of root cells to take up water from the soil (Havlin et al., 1999). Also, potassium plays an important role in improving vegetable quality characteristics like size, shape, color, taste, shelf life, etc. (Pushpalatha, *et al.* 2017).

Information about potassium sources which are used as foliar fertilizers is rare and poorly documented. However, using potassium fertilizers, increases production costs. Selecting the proper form and amount of fertilizers that are suitable for the soil type and plant species should be done to minimize the production cost. Therefore, it was, necessary to identify the best of apical vine cutting age and source of potassium fertilizer to optimizing the growth, yield and yield component of sweet potato cultivar "Mabrouka".

MATERIALS AND METHODS

The field experiment was carried out during the growing seasons 2017 and 2018 at the Experimental Farm of Mallawy Agric. Research Station, Hort. Res. Inst., to evaluate the effect of apical vine cuttings age and potassium fertilizer sources on the growth and yield of sweet potato cv. "Mabrouka". The site of the farm is located at an altitude of 52.0 m above sea level, latitude 27°04' N and longitude 80°12' E.

Annual average maximum and minimum temperatures during the growing seasons were 34.45°C and 19.26°C, 35.94°C and 18.60°C., in 2017 and 2018 respectively. But the annual average maximum and minimum relative humidity were 86.83%, 24.22% and 87.63%, 23.45% respectively.

The field trial was laid out as a 3 × 3.5m factorial experiment. Treatment combinations were arranged in split-plot, in a Randomized Complete Block design (RCBD) with three replicates. The studied factors were for apical ages (Fresh cutting (FC), 3, 5 and 7-days) and potassium fertilizer sources (No-k, K-Sulphate, K-Citrate, K-Silicate and K-humate) were sprayed on foliage three times after 90, 105 and 120 days from planting.

Soil Sampling and Analysis

Sampling dates were 15 days before planting. Three soil samples at depth 0 -30 cm were randomly collected from each plot, homogenized to make up one sample, air dried, crushed, and sieved through a 2mm sieve.

The characteristics of that soil under the experimental plot were analyzed at the Service Laboratory for Soil, Water and Plant Analysis, Faculty of Agriculture, EL-Minia University. Physical and chemical properties of the experimental soil were estimated according to described procedures by Jackson (1973). The data exhibited that the texture grade of the soil was silt/clay, E.C = 1.12, O.M= 1.07 and available nutrients of N.P.K were 50.0, 11.5 and 83.0 ppm respectively.

LAND PREPARATION

The soil was prepared 15 days before planting. During the soil preparation, 200kg/fed. (15.5% P_2O_5) were applied. In addition, 100 kg/fed. ammonium sulphate (20.6% N), 100kg/fed. potassium sulphate (48% K_2O) were added at two equal doses after one and two months from planting.

EXPERIMENTAL DESIGN:

Apical vine cuttings (25-30 cm length were taken; at 55 days from the sweet potato cv. "Mabrouka" nursery and used in this trial). The experiment was arranged in a split-plot design with three replicates contained the four vine cuttings ages (fresh cutting (FC), 3, 5 and 7- days old) in the main plots, while the K-sources occupied the sub plots. The experimental sub plot area was 10.50 square meters (1/400 fed.) consisting of 3 ridges five meters in length and 70 cm in width whereas; one row was left without planting between sub plots. The rows direction was nourth–south. Thus, the total numbers were 60 experimental units.

PLANTING TECHNIQUE:

Planting was immediately carried out after irrigation where apical vine cuttings of 25-30 cm in length with at least 4 nodes were used as planting materials. The apical cutting with intact leaves was obtained from the apical portion of the selected vine. The apical cuttings were stored under shade for 3, 5 and 7 days before planting as well as the control treatment (fresh cutting). The cuttings were planted at the distances of 25-30 cm apart on May 7th and 10th for the two growing seasons, respectively. All other cultural practices were followed according to the recommendations of the Ministry of Agriculture, Egypt.

TREATMENTS:

a. Main plots: Four apical vine cutting ages;

Fresh cutting (Zero) - 3, 5 and 7-days from cutting.

b. Sub-plots: Potassium-sources:

1-Control (without foliar K)

2- Potassium sulphate K_2SO_4 (48% K_2O) (KSu)

3-Potassium citrate $C_6H_5K_3O_7\text{-}H_2O$ (38.28% K) (KCi)

4- Potassium silicate $K_2Si_2O_3$ (32% K2O) (KSi)

5-Potassium humate $C_9H_8K_2O_4$ (10% K2O) (KH)

These treatments were prepared and used as 2g / l K_2O from each source. The foliar treatments were applied 3 times after 90, 105, and 120 days from planting.

DATA COLLECTION:

1. After 15 days from planting:

The number of survival plants was counted in each plot and the percentages was calculated by the following formula:

$$\text{Survival rate (percentage)} = \frac{\text{Number of survived plants/plot}}{\text{Total number of transplanted plants/plot}} \times 100$$

2. After 150 days from planting:

2.1. Vegetative growth parameters

2.1.1. Vine fresh weight (ton fed^{-1}.)

3. Yield component

A random sample of storage roots of ten plants from each experimental sub plot was taken and the following parameters were recorded:

3. 1. Number of storage roots $plant^{-1}$,

3. 2. Storage root length.

3. 3. Storage root diameter., 3. 4. Storage root fresh weight (ton fed^{-1}.)

3. 5. Percentage of marketable yield.,

3. 6. Biomass yield (ton fed^{-1}.).

4. Dry matter percentage (DM %): 100 grams of random sample of tuber roots was oven dried at 70°C till constant weight.

4.1. Root dry matter %

4.2. Potassium %

Statistical analysis: Data were compared using the analysis of variance (ANOVA) procedures according to Gomez and Gomez (1984) and mean differences were performed using multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

3.1. Survival % of sweet potato vines after 15 days from planting:

Data presented in Table 1 showed that survival % of sweet potato apical stem cuttings was significantly affected by the life time of vine cuttings. In the two seasons, the treatments of fresh cutting (control) and 3- days old from cutting showed significant increase in survival % (99.00 and 98.13%) respectively. These results are in harmony with Beyene *et al.* (2015) who showed that storing of vines under ambient conditions for a long time caused failure of establishment in the field due to drying. Alcoy *et al.* (1993) and Hammett, (1983) showed that vine cuttings held under shade before planting for 3 days produced plants with the highest marketable root yield followed by 4 days old cuttings. Cut vines with intact leaves when stored under shade conditions for two days prior to planting in the field had better root good establishment of vines and higher root yield (Ravindran and Mohankumar, 1989 and Biswal, 2008). Storing of vines for a long time under any circumstances caused failure of establishment in the field. However, storing vine cuttings for 1 - 3 days does not affect the final yield. (SASHA, 2009) Apical portion of the stem is site of hormone synthesis like auxins which promote root formation and resulting in higher survival %.

Table 1: Survival rate (%) of sweet potato stems cuttings as affected by vine cutting ages treatments under shade conditions after 15 days from planting during 2017 and 2018 season.

Treatments	Survival %	
	2017	2018
Fresh cutting (FC)	99.00 a	98.13 a
3- days	97.70 ab	97.5 ab
5-days	96.43 bc	96.20 bc
7 –days	95.53 c	94.80 c

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test

3.2. Vegetative growth parameters:

3.2.1. Vine fresh weight (ton fed^{-1})

Data illustrated in Table (2) showed that vine fresh weight (forage) yield (ton/fed.) was affected by the studied treatments. The highest significant increase in forage yield (ton/fed.) was recorded with the treatments of 3-days old (22.02 and 20.76 ton/fed.) followed by using fresh cuttings (21.39 and 20.90 ton/fed.), respectively with insignificant differences among them in both seasons. The lowest significant decrease in forage yield (20.94 and 20.17 ton/fed.) was obtained with increasing storage period up to (7-days).

Concerning to the effects of treatments of K sources, the obtained results revealed a statistically significant effect (Table 3).The values of the treatments of K-Si (22.27 and 21.28 ton/fed.) followed by K-H

(22.19 and 21.05 ton/fed) showed significant increase compared to zero K (20.0 and 18.64 ton/fed.) in the first and second seasons respectively.

The interaction between vine cuttings ages and K-sources had significant effects on vine fresh weight (ton/fed.) as shown in Fig (1). The 3-days old of vine cuttings and K-H fertilizer gave significantly higher values than the other treatments (23.03 and 21.58 ton/fed.) followed by K-Su treatment (22.90 and 21.37 ton/fed.) in the first and second season, respectively.

As reported by Uwah *et al*., (2013), the positive response of forage yield to the applied K is attributable to its role in cell multiplication and photosynthesis in conjunction with N, which positively led to increase vine length, and leaves branches numbers, K-Si source effect was existed. However, Shi *et al.* (2016) found that the improving effect of silicon seemed to be due to increasing root hydraulic conductance of the plants. Also, Silicon can enhance antioxidant defense and then decrease oxidative stress in plants under drought, and it can increase the photosynthesis and relevant carboxylase activities, as found in wheat by Gong and Chen, (2012). Also, Pilon *et al.* (2013) found that silicon application increased leaf area and chlorophyll concentration of well-watered potato plants, improved plant growth parameters and pigment concentration of wheat, (Maghsoudi *et al.* (2015) and rice Oliveira *et al.* (2016).

3.**3. Yield and its component**

3.3.1. Total number of storage roots plant^{-1}.

Data in Table (2) showed that the total number of sweet potato storage roots was affected by the studied treatments. The highest number of sweet potato storage roots was found with the fresh cuttings' treatment in both seasons (8.013 and 7.033) followed by 5-day and 7-day ages but only in the first season (7.00 and 6.88), respectively. All K-sources (Table 3) affected total number of storage roots plant^{-1} and gave significant increase compared to the control treatment. Potassium applications as K-H produce the highest number of roots plant^{-1} (7.40 and 6.30) followed by K-Si (7.45 and 6.25) in the first and second season, respectively without significant differences.

Regarding to the interaction effect, immediate planting of vine cuttings and foliar spray by K-Si showed significant increase in storage roots number in the two seasons (10.0 and 7.33 roots plant^{-1}) (Fig. 2). Similar results were reported by Li *et al.* (2002) and Rodrigues *et al.* (2003) about the roles of Si on growth and development of strawberry and rice which that number of productive tillers and total number of tillers per square meter were enhanced by foliar silicon application. Many authors suggested that Si had structural and metabolic functions in the physiology of plants, generating benefits that may result in increased productivity of various plant species like wheat **(**Basha *et al.* 2013), tomato (Marodin, *et al.* 2014), and rice (Emam, *et al.* 2014).

Table (2): Vine fresh weight (ton/fed-1), no. storage roots per plant), root yield(ton/fed-1), biomass yield(ton/fed-1) of sweet potato plants cv "Mabrouka". as affected by vine cutting ages (0.0, 3-days, 5-days and 7-days) during 2017 and 2018 season.

Treatments	Vine fresh weight (ton/fed)		No. storage roots(plant)		Root yield(ton/fed)		Biomass yield(ton/fed)	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Fresh cutting (FC)	21.39 ab	20.90 a	8.013 a	7.033 a	25.05 a	23.16 a	46.45 a	46.45 a
3-days old	22.02 a	20.76 a	6.480 b	5.887 b	23.52 ab	22.35 bc	45.54 ab	43.11 b
5-days old	21.86 a	20.37 b	7.00 ab	5.540 b	21.51 b	22.87 ab	43.37 bc	43.24 ab
7-days old	20.17 b	20.94 b	6.880 ab	5.620 b	21.17 b	21.81 c	42.11 c	41.98 c

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan’s test

Table (3): Vine fresh weight (ton/fed-1), no. storage roots (per plant-1), root yield(ton/fed-1), biomass yield(ton/fed-1) of sweet potato plants cv "Mabrouka". as affected by K- sources treatments during 2017 and 2018 seasons.

Treatments	Forage yield(ton/fed)		No. storage roots(plant)		Root yield(ton/fed)		Biomass yield(ton/fed)	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	20.00 d	18.64 c	6.067 b	5.433 c	21.64 b	21.27 c	41.64 c	39.91 c
K-Su	21.84 bc	21.02 ab	7.450 a	6.267 ab	23.44 a	23.83 a	45.28 ab	44.85 a
K-Ci	21.46 c	20.75 b	7.100a	5.85 ab	22.48 ab	22.50 b	43.93 b	43.25 b
K-Si	22.27 a	21.28 a	7.450 a	6.250 ab	23.73 a	22.39 b	46.00 a	43.67 b
K-H	22.19 ab	21.05 ab	7.400 a	6.300 a	22.79 ab	22.76 b	44.98 ab	43.81 b

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan’s test

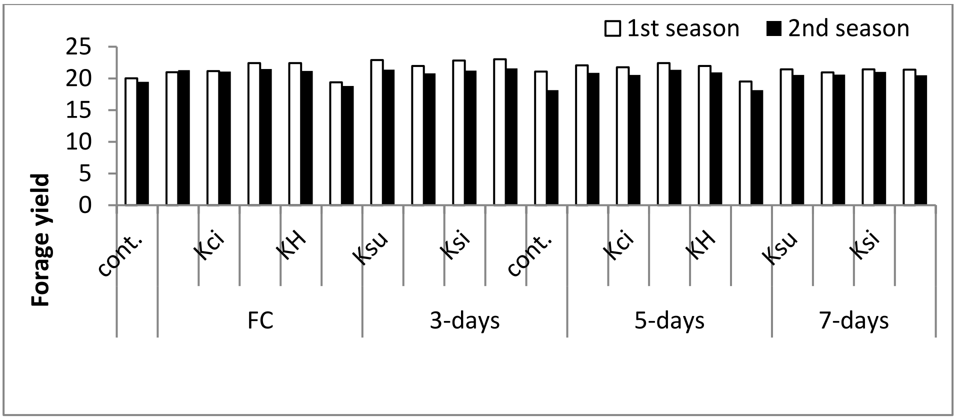

Fig. (1): Interaction effect of vine cuttings age (FC, 3-days, 5- days and 7-days) and K-sources treatments on forage yield (ton/fed.) of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, K-Su = K-sulphate, K-Ci = K-citrate, K-Si = K-silicate, K-H =K- humate, L.S.D. of AB for First season= 0.404, Second season= 0.347

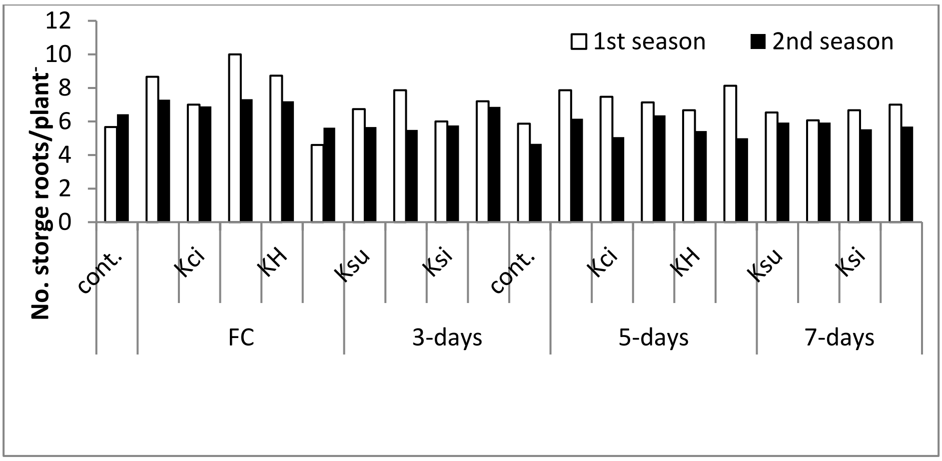

Fig. 2: Interaction effect of vine cuttings age (FC, 3, 5 and 7-days) and potassium sources treatments on total number of storage roots of sweet potato cv."Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, K-Su = K-sulphate, K-Ci = K-citrate, K-Si = K-silicate, K-H =K- humate, L.S.D. of AB for First season=1.770, Second season= 0.9018

3.3.2. Storage root yield (ton fed.$^{-1}$):

The effect of the storage time of apical vine cuttings and K-sources are presented in Table (2). The immediate planting of apical stem cuttings caused a significant increase in root yield in the first and second seasons

(25.05 and 23.16 ton/fed). Also, the treatments of 3-days and 5-days old of vine cuttings exhibited increase in roots yield in the first season (23.52 ton/fed.) and in the second season (22.87 ton/fed.) without significant differences between those two ages.

All potassium fertilizer sources which were used as foliar spray gave significant increases in root yield (ton/fed^{-1}) (Table 3). The treatment of K-Su gave the best significant increase in root yield in the two seasons (23.44 and 23.83 ton/fed^{-1}). The lowest values were recorded for the control treatment. These results explained the importance of potassium fertilizer for enhancing root yield of sweet potato production and these results are in agreement with those reported by Abou zeid and Amal Abd El-Latif (2017) on potato, Georg *et. al.* (2002) on sweet potato and Hassan *et. al*. (2007) on cassava.

The positive effect of potassium sulphate fertilizer on tuber quality characteristics might be attributed to the role of K in assimilation and translocation of carbohydrates, as well as, in their conversion into starch (Nelson, 1970).

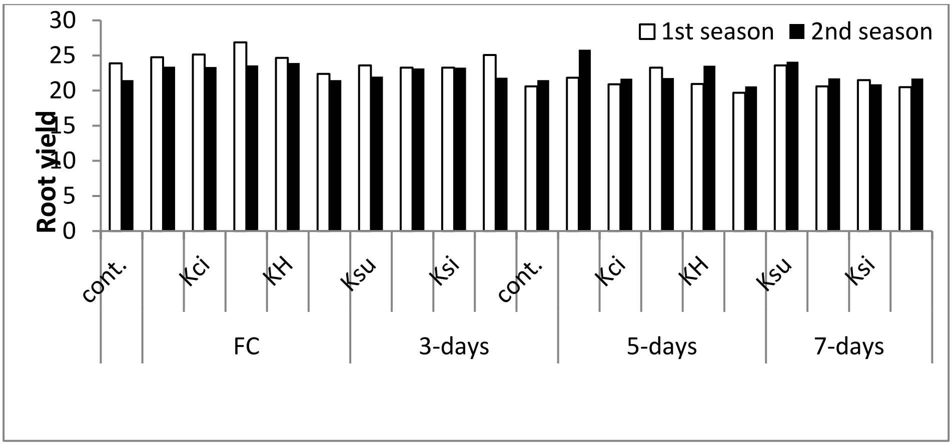

Fig. 3: Interaction effect of storage time of vine cuttings (FC, 3, 5 and 7-days) and potassium sources treatments on storage root yield (ton/fed.) of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.
FC= Fresh cuttings, Cont. = no-K, K-Su = K-sulphate, K-Ci = K-citrate, K-Si = K-silicate, KH = K-humate,
L.S.D. of AB for First season= 3.157, Second season, 1.931

Regarding to the interaction between the treatment of storage duration of vine cuttings and K-sources, The obtained data were differed between the two seasons(Fig.3) The best value was obtained with the combined treatment of FC and K-Si in the first season (26.86 ton/fed.), while the treatment of 5-day old of vine cuttings combined with K-Su gave the best value in the second season (25.83 ton/fed.). Uwah *et al*., (2013) showed that the positive response which was shown by yield characters to K could be directly linked to the well-developed photosynthetic surfaces (vine length, number of leaves and branches) and increased physiological activities leading to more assimilates being produced and subsequently translocated and utilized in rapid tuber development and production. Potassium is known to activate a number of enzymes involved in photosynthesis, carbohydrate and protein metabolism and assists in the translocation of carbohydrates from leaves to tubers and tuberous roots of crops where carbohydrates are the main storage material (Mengel and Kirkby, 2001; Trehan *et al*., 2009.

3.3.3. Biomass yield (ton. Fed $^{-1}$)

Data presented in Table (2) showed that biomass yield (ton.fed^{-1}) (storage root + forage yield) was not affected by vine cuttings ages. The treatment of FC and 3-days old showed the highest values for biomass yield as ton. fed^{-1} in the first season without significant differences. Also, the presented data showed that with increasing the storage time of vine cuttings before planting, the biomass yield was decreased. The lowest values were recorded with the treatment of 7-days old (42.11 and 41.98 ton/fed^{-1}.) in the first and second seasons, respectively.

All potassium sources tested showed highly increase in biomass yield (ton/fed^{-1}.) of sweet potato than control treatment (zero- K). The values of the obtained data reveled that K-Si in the first season (46.0 ton/fed^{-1}) and K-Su in the second season (44.85 ton/fed^{-1}.) showed the highly increase in biomass yield (ton/fed^{-1}).

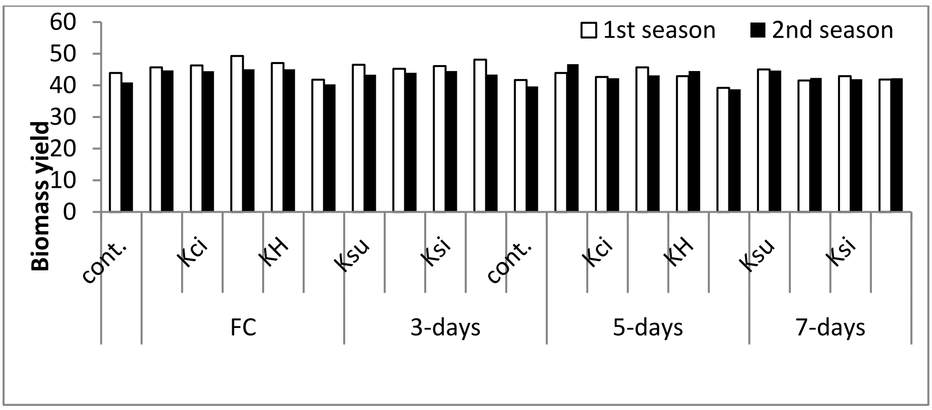

Fig. 4: Biomass yield(ton/fed) of sweet potato cv "Mabrouka". as affected by of vine cuttings ages (FC, 3, 5, and 7-days) and potassium sources treatments during 2017 and2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate,

L.S.D. of AB for First season=3.071, Second season=1.706

The interaction between of storage time of vine cutting and K-sources showed significant effect (Fig.4). The applied treatment of FC x K-Si showed that biomass yield was 49.28in the first season and 45.10-ton fed.$^{-1}$ in the second seasons. Also, the combined treatments of 5-days old of vine cuttings and K-Su gave the highest significant increase in biomass yield in the second season (46.96-ton fed.$^{-1}$). These results might be due to the stimulation of vegetative growth caused by foliar application of potassium humate, similar trends were also achieved by Barakat (1987) and Sherif *et al.* (2003).

3.3.4. Average root length (cm):

The main effect of vine cutting ages was significantly ($p<0.05$) affected the average root length (Table 4). Three-days old vine cuttings showed the longest root length of sweet potato in both seasons (27.73cm).

Average root length (cm) plant^{-1} was statistically higher with the treatments of K-H (28.17 and 28.08cm) and K-Si (27.83and 27.17cm) in both years with insignificant differences (Table5). The lowest values were recorded with the control treatment (22.58cm and 23.58cm). Njoku *et al.* (2001) reported that N and K were critical to sweet potato production.

Regarded to the interaction effect, the combination between storage time of vine cuttings and K fertilizer sources showed significant difference in the result of root length in both seasons (Fig.5). Three-days old of vine cuttings combined with K-Su treatment had the highest root length in both years (30.0 and 27.67cm).

3.3.5. Average root diameter (cm) of marketable roots:

The main effect of vine cuttings treatments didn't show significant difference in the diameter of marketable roots (cm) in both seasons Table (4). All potassium fertilizer sources application increased the diameter of storage roots except only K-Ci treatment in the first season which gave the lowest value(Table 5).The highest values were observed with treatments of K-H (8.52cm and 8.38cm) followed by K-Si (8.52cm and 8.36cm),and K-Su (8.26cm and 8.18cm) compared to the control treatment (6.01cm and 6.65cm) in the first and second season, respectively.

The interaction between vine cuttings ages and K fertilizer sources did not show significant effect in the second seasons (Fig. 6).But the best value was recorded with the combined treatment of fresh cuttings and (K-Si) treatment (8.86 and 8.53cm) compared to the control treatment (5.40 and 5.36cm), respectively.

Table (4): Root length (cm), root diameter (cm), marketable yield %, dry matter %, K % of sweet potato cultivar cv. "Mabrouka". as affected by of vine cuttings ages (0.0, 3, 5 and 7-days) during 2017 and 2018 season.

Treatments	Root length(cm)		Root diameter (cm)		Marketable yield %		Dry matter %		K %
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season
Fresh cutting (FC)	27.20 ab	25.67 b	7.813 ab	7.733 a	85.35 a	84.05 a	25.22 a	25.01 a	2.006 ab
3-days old	27.73 a	27.73 a	7.707 ab	7.900 a	83.29 a	83.96 a	24.01 a	24.84 a	2.077 a
5-days old	26.00 ab	25.93 b	8.153 a	8.007 a	85.64 a	84.30 a	25.01 a	24.93 a	1.891 b
7-days old	25.73 b	27.00 ab	7.433 b	7.853 a	84.31 a	85.03 a	25.18 a	25.09 a	2.074 a

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test

Table (5): Root length, root diameter(cm), marketable yield %, dry matter %, K % of sweet potato cultivar cv."Mabrouka". as affected by K- sources treatments during2017 and 2018 seasons.

Treatments	Root length		Root diameter (cm)		Marketable yield %		Dry matter %		K %
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season
Control	22.58c	22.58c	6.017 c	6.650 b	82.40 b	82.66 b	24.04 c	24.67 a	1.63 c
K-Su	28.00 b	27.00 a	8.267 a	8.183 a	85.69 a	85.01 a	25.19 ab	24.96 a	2.017 b
K-Ci	26.75 b	27.08 a	7.550 b	7.833 a	84.84 ab	84.75 a	24.50 bc	25.03 a	2.125 ab
K-Si	27.83 a	27.17 a	8.525 a	8.367 a	85.44 a	85.05 a	26.05 a	25.22 a	2.088 ab
K-H	28.17 a	28.08 a	8.525 a	8.383 a	84.86 ab	84.20 ab	24.50 bc	24.94 a	2.205 a

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's test

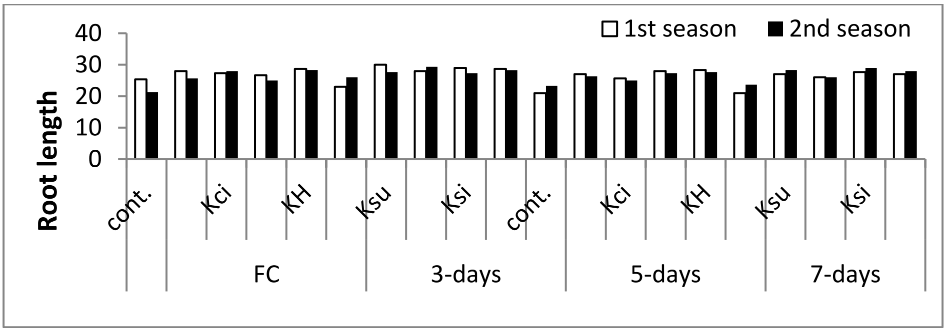

Fig.5: Interaction effect of vine cuttings ages (FC, 3, 5 and 7-days) and K-sources treatments on root length(cm) of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate.

L.S.D. of AB for First season= 2.034, Second season=3.832

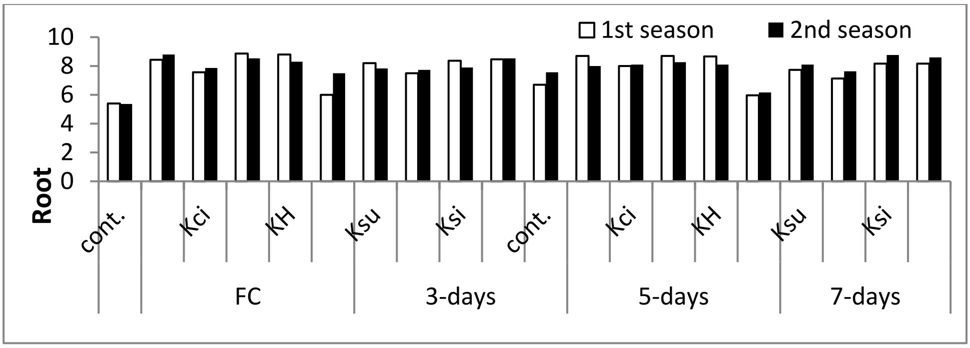

Fig.6: Interaction effect of vine cuttings ages (FC, 3, 5 and 7-days) and K-sources treatments on root diameter(cm) of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate, L.S.D. of AB for First season= 0.520, Second season= 1.195

3.3.6. Marketable yield %:

The main effect of storage period of vine cuttings showed non-significant differences ($P< 0.05$) in marketable yield % of storage roots in the two seasons (Table 4) .On the other hand the potassium treatments showed highly significant increase in marketable yield % without significant differences among all tested sources (Table 5).These increases ranged from 84.84 to 85.69% in the first season and 84.20 to 85.05% in the second season(Fig.7) compared to the control treatments (82.40 and 82.66%) in the first and second season respectively. The rate of increase in marketable yield % represent 3.83% and 2.89% in both seasons. Also, the data revealed that there were in significant differences between storage time of vine cuttings ages and potassium fertilizer sources on marketable yield % in the two seasons.

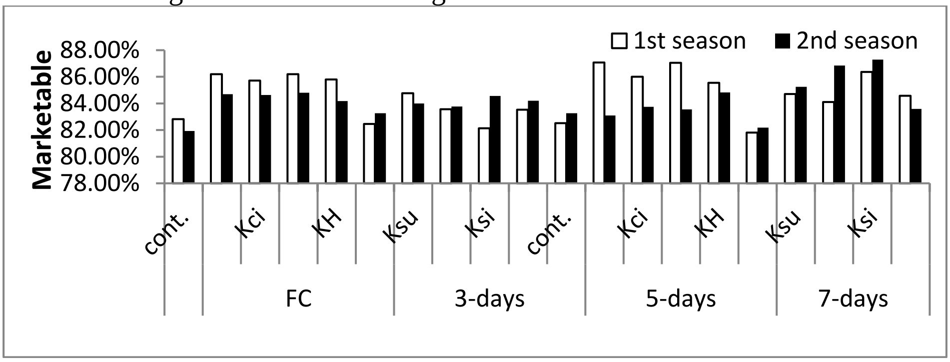

Fig.7: Interaction effect of vine cuttings ages (FC, 3, 5 and 7-days) and K-sources treatments on marketable yield % of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate,

L.S.D. of AB for First season= 5.458, Second season= 1.903

The obtained data revealed that the increasing rate in this character ranged from 18.7% to 29.46% as a result of K application. These results agree with the findings of Trehan and Grewal, (1990), who indicated that potato positively response to K application was well known regarding tuber size

3.3.7. Dry matter% of storage roots:

The illustrated data in Table (4) showed that the storge time of vine cuttings ages on dry matter% of sweet potato storage roots had insignificant effect in the two seasons. Dry matter% of sweet potato storage roots was not affected by K-sources treatments in the second season (Table 5). In both seasons, K-Si treatment exhibited the best values in the two seasons (26.05% and 25.22%), respectively. These results are in accordance with that reported by Uwah *et al.* (2013) who showed that K-application plays role in heavier dry weight of vines and roots because of it is role in cell multiplication and photosynthesis. Also, the obtained data revealed that the best values for the dry matter% of sweet potato storage roots were obtained with the combined treatment fresh cuttings, 7-day old of vine cutting treatments and foliar fertilizer by K-Si (27.83, 25.08% and 26.67, 25.49%) in the first and second season respectively without significant differences between them (Fig. 8).

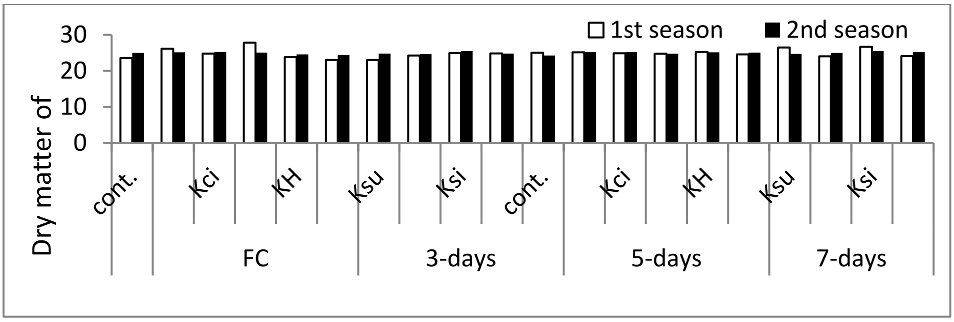

Fig.8: Interaction effect of vine cuttings ages (FC, 3, 5 and 7-days) and K-sources treatments on dry matter% of storage roots of sweet potato cv. "Mabrouka". during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate,

L.S.D. of AB for First season=2.085, Second season=1.066

3.3.8. Potassium %:

As shown inTable (4). K % of sweet potato roots appeared to be significantly affected by the treatments of vine cuttings ages.The treatment of FC, 3 and 7-days of vine cuttings ages showed significant increase in K%without significant differences among them (2.077%). The used K-sources showed highly significant effect on K % of sweet potato roots (Table 5). K-H, K-Ci and K-Si showed highly significant increase in K%without significant differences among them (2.20 %) (2.12 %) and (2.08 %) respectively. The lowest value was recorded with the control treatment (no–K.1.63 %). These results clearly indicate that potassium has an important role in enhancement of photosynthesis, resulting in greater K%. Those responses are in accordance with these obtained by Chen and Aviad, (1990).

The interaction between vine cuttings ages and K fertilizer sources showed significant effect (fig .9). 7-days old of vine cuttings and K-Si treatment showed the best result for K% in root storage. Also, the combined treatment of FC, 3-days old of vine cuttings and K-HA showed the highest values in K % (2.46% and 2.31%) without significant differences between them. These increases probably may be due to the supplemental effect of K-humatefor soluble potassium in a readily available form which might aid in the translocation of carbohydrates produced by photosynthesis (Chen and Aviad, 1990).

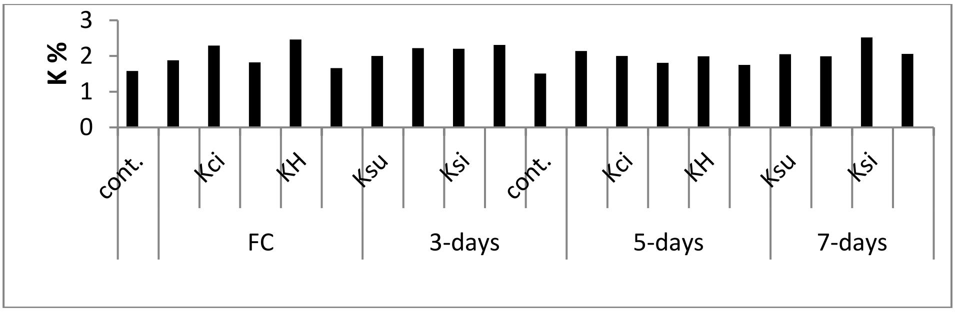

Fig.9: Interaction effect of vine cuttings ages (FC, 3, 5 and 7-days) and K-sources treatments on K% of sweet potato roots cv. "Mabrouka" during 2017 and 2018 seasons.

FC= Fresh cuttings, Cont. = no-K, KSu = K-sulphate, KCi = K-citrate, KSi = K-silicate, KH = K-humate,

L.S.D. of AB for First season=0.2577

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الملخص العربي

تأثير فترة تخزين العقل الساقية وبعض مصادر التسميد البوتاسي على النمو ومكونات محصول البطاطا الحلوة

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تم إجراء تجربة حقلية خلال مواسم النمو في عامي 2017 و2018 بالمزرعة التجريبية لمحطة البحوث الزراعية بملوي – معهد بحوث البساتين – الجيزة – مصر. لدراسة تأثير فترة تخزين قطع العقل الساقية الطرفية ومصادر التسميد البوتاسى على النمو وإنتاجية ومكونات محصول البطاطا الحلوة صنف "مبروكة". حيث تضمنت الدراسة ثلاث فترات تخزين لقطع العقل الساقية القميّة تحت ظروف التظليل (لمدة 3 أيام و5 أيام و7 أيام) بالإضافة إلى معاملة الكنترول (الزراعة الفورية بقص العقل الطرفية وزراعتها مباشرة وكذلك أربعة مصادر تسميد ورقى للاسمدة البوتاسية (كبريتات البوتاسيوم – سليكات البوتاسيوم– سترات البوتاسيوم –هيومات البوتاسيوم) بالاضافة الى معاملة الكنترول (بدون رش للبوتاسيوم). تم توزيع تلك المعاملات فى قطع منشقة مرة واحدة وتكرارها ثلاث مرات.

اوضحت النتائج المتحصل عليها: –

1–اعلى معدل بقاء للعقل الساقية فى صورة حية تم الحصول عليها مع معاملة تخزين العقل لمدة 3 ايام وكذلك معاملة الكنترول

2–اعلى زيادة فى النمو ومكونات المحصول (الوزن الطازج للمجموع الخضرى (طن/فدان)– محصول الجذور (طن/فدان) – المحصول الكلى (محصول المجموع الخضرى +محصول الجذور بالطن/فدان) ومتوسط طول الجذر والنسبة المئوية للبوتاسيوم بالجذور قد تحقق مع زراعة العقل مباشرة بعد التقطيع (الكنترول) وكذلك مع تخزين العقل لمدة 3 ايام تحت ظروف التظليل ومع درجة حرارة الجو العادية وبدون فروق معنوية بينهم

3–تخزين العقل الساقية لمدة 5 ايام اعطى اعلى زيادة فى عدد الجذور المخزنة للنبات وعلى العكس فقد اظهرت الدراسة ان قطر الجذور المخزنة و %للمادة الجافة و % للمحصول المسوق لم تتاثر بفترات تخزين العقل الساقية خلال موسمي الزراعة.

فيما يتعلق بتاثير الرش الورقى ببعض مصادر التسميد البوتاسى اظهرت الدراسة ان التسميد البوتاسى على صورة سليكات البوتاسيوم وعلى صورة سلفات البوتاسيوم اعطا أعلى القيم بالنسبة للمحصول الكلى (طن/فدان) و % للمحصول المسوق وقطر الجذور.

وفيما يتعلق بالتفاعل المشترك اوضحت النتائج ان زراعة العقل الساقية القمية بمجرد القطع مباشرة والرش الورقى بسماد سليكات البوتاسيوم 3 مرات بمعدل 2 جرام/لتر (بو$_2$أ) بعد 130,115,90 يوم من الزراعة ادى الى الحصول على اعلى القيم فيما يتعلق بعدد الجذور المخزنة للنبات والمحصول الكلى (محصول العرش +محصول الجذور بالطن/فدان) واعلى زيادة فى محصول العرش الاخضر (طن/فدان). مع العقل المخزنة لمدة 3 ايام والرش الورقي بهيومات البوتاسيوم.