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EFFECT OF FERTILIZATION AND IRRIGATION ON YIELD AND QUALITY OF SWEET POTATO

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ABSTRACT

Three field experiments were carried out in the two successive summer seasons of 2003 and 2004 at the Agricultural Experimental Station, Faculty of Agriculture, Cairo University at Giza. These experiments aimed to study the effect of soil fertilization with: I) Ammonium sulphate (20 % N) at rate of 0, 15, 30 and 45 Kg N /fed. and foliar spray with micro-elements at of rate of 1.5 g /L. II) Cultivars (Mabrouka, local cultivar, and Beauregard) and potassium sulphate (49.5% K_2O) at rate of 0, 50, 100 and 150 Kg K_2O/fed. III) Cultivars (Mabrouka and Beauregard) and time of last irrigation at 15, 30 and 45 days before harvest on the vegetative growth, yield and root quality of sweet potatoes .The results indicated that:

Increasing N level resulted in increasing the vegetative growth characters, i.e., plant length, plant fresh weight and number of branches per plant. Significant increases were obtained also in the total yield and the root quality, i.e., root length and weight, due to increasing N level up to 30 Kg N/fed. Increasing N level resulted in higher dry matter and lower T.S.S., but did not have any influence on ascorbic acid or carotene contents. Total yield, in first season only at a rate of 0 and 15 Kg N/fed., was significantly increased by foliar application with microelements. The root quality parameters and chemical content of roots were not affected by microelements fertilization.

Increasing potassium applications by 0 to 150 Kg K_2O/fed significantly increased plant fresh weight and number of branches per plant, but had no effect on plant length. Total and marketable yield per fed. were increased by increasing K rate. The potassium rate did not affect either the root length or its diameter, but increased the root weight. Increasing K rate reduced the dry matter and increased T.S.S. ascorbic acid, carotene and chlorophyll content.

The short period between last irrigation and harvest resulted in increasing all characters of plant growth, total yield, root length, root weight, T.S.S., dry matter and carotene content but had no effect on root diameter and ascorbic acid in the sweet potato roots.

Key word: sweet potato-*Ipomea batatas*- cultivars- vegetative growth- yield- roots quality- microelements- foliar fertilization- potassium- nitrogen-irrigation.

INTRODUCTION

Sweet potato is among the world's most important, versatile, and underexploited food crops. With more than 133 million tons in annual production, sweet potato currently ranks as the fifth most important food crop on a fresh weight basis in developing countries.

Nitrogen fertilizers have been used to increase the yield and improve its quality. Johnson and Ware (1949) reported that vine weight was significantly increased with each increase in nitrogen application. Weight and growth of vines have been correlated with high N levels (Johnson and Ware, 1949, Stino and Lashin, 1952). Abdel Razik (1996) in work with carrots cv. Chantenay found that chlorophyll content of the leaves was increased with increasing N application (0, 80, 160 and 240 kg/ha).

Harper and Walker (1985) observed significant increase in yield of sweet potato occurred at applying 30 Kg N /ha compared with high level (60 Kg N /ha). Bautista *et al.*(1989) in work with sweet potato reported that maximum tuber yield was attained at 90 Kg N /ha compared with other N rates(45, 135 and 180 Kg N /ha). Significant increases were obtained in total yield and plant productivity by either weight or number of tubers/plant, due to increasing N level up to 80 Kg N/fed. (Abdel-Razik and Gabr, 1999). According to root quality, Knavel (1971) studied the effect of three levels of NH_4 NO_3 on the quality of sweet potato roots. It was found that increasing N without K lead to an increase in the weight of roots and length to diameter ratio (L/D). Abdel-Razik and Gabr (1999) found increases in the fresh weight of tuber, tuber length and diameter of sweet potato roots by additions of N were only effective of low N levels. On the other hand, Guertal and Kemble (1997) reported that no influence for using N fertilizers on the root quality of sweet potatoes. Constantin *et al.* (1984) found that dry matter content of sweet potato was increased linearly with the increase in N rate. Hammett and Miller (1982) reported no effects from the use of 3 N sources (NH_4 NO_3, $Ca(NO_3)2$ and Na NO_3) and 2 N rates (101 and 202 Kg N /ha) on carotene and ascorbic acid content of sweet potato roots.

The foliar application of micronutrients by means of sprays offers a method of supplying nutrients to higher plants more rapidly than methods involving root application. As for the effects of microelements on sweet potato plants, Vendilo *et al.* (1991) in work with table beet roots noted that spraying with 0.01% of the trace elements at the start of root formation generally increased yields. Hatwar *et al.* (2003) in work with chilli (*Capsicum annuum var. Jayanti*) found that combined application of Zn, Fe and B at 0.1% was the most effective on plant height, number of branches per plant and diameter of stem. El-Gawad *et al.* (2004) reported that B application at 0.5 kg/fed reduced TSS% at harvest, whereas Zn, Mn and the mixture showed no significant effect on TSS% of sugar beet (*Beta vulgaris* L.).

The highest tuber yield of sweet potato was produced with application of 100 Kg K_2O/ha (Patil *et al.*, 1992) or 75 Kg K_2O/ha (Mukhopadhyay *et al.*,

1992). Abdel-Razik and Gabr (1999) noted that increasing the applied K rate resulted in corresponding increase in shoot fresh and dry weight, leaf area/plant and plant length, with the exception of number of branches/plants. On the other hand, Quinn (1925) working with sweet potato reported no influence for K rates on vine growth. The same results were obtained by Stino and Lashin (1952). Many studies have shown that potassium application increases yield (Leonard *et al.*, 1949; Stino and Lashin,1952; Duncan *et al.*, 1958). Knavel (1971) found that the highest level of K2 SO4 increased mean weight of sweet potato roots with high levels of N. Samuels and Landrau (1952) and Djazuli and Ismunaji (1987) reported no results from the use of potassium fertilizers on the carotene content of sweet potatoes. Hammett and miller (1982) found that the high rates of potassium fertilizer decreased root dry matter.

Somyot (1996) studied the effects of water deficient on growth of sweet potato. It was found that average of vine length from non-water deficit treatment was larger than those of treatment with water deficit. Escalante and Gonzel (1988) reported that the level of available moisture significantly affected the number of marketable tubers and total tuber yield. Somyot (1996) found that root weight and length from non-water deficit treatment were larger than those of treatment with water deficit. Constantin *et al.*(1974) studied the dry matter content and total carotene pigments of sweet potato with variations in the irrigation levels. They noted significant decrease in dry matter content and total carotene pigments were found due to increasing the soil moisture levels.

MATERIALS AND METHODS

This study was conducted at the Experimental Station, Faculty of Agriculture, Cairo University, Giza, to study the effect of soil application with nitrogen, foliar application with microelements, potassium, and time of last irrigation before harvest on vegetative growth, yield and quality of sweet potatoes roots cvs. Mabrouka (local cultivar) and Beauregard during the two successive summer seasons of 2003 and 2004. The soil of the experimental area was loamy clay in texture with pH 8.03 and 7.89, EC 1.61 and 1.65 (mmohs/cm) and contained 42 and 35 ppm N, 22 and 20 ppm P, 187 and 180 ppm K in the first and second seasons, respectivly . Three experiments were performed:

The first experiment was conducted to study the effect of nitrogen fertilization with or without microelements on cv. Mabrouka (local cultivar). The experiment included eight treatments as follows:

a- Ammonium sulphate (20 % N) at rates of 0,15, 30 and 45 Kg N/feddan without application microelements.

b- Ammonium sulphate (20 % N) at rates of 0,15, 30 and 45 Kg N/feddan. + 1.5 g per liter from the liquied fertilizer Agrochem which contains 16.52% microelements: chelated Iron 3%, Mn 5%, chelated Zinc 7%, Cu 0.5%, B 0.5%, Mo .02 % and Mg 0.5 %.).

The treatments were arranged in a randomized block design with three replications.

Second experiment was conducted to study the effect of potassium fertilization on two sweet potato cultivars, namely Mabrouka (local cultivar) and Beauregard. The experiment included 8 treatments which were the combination of the two cultivars and four potassium sulphate (49.5% K_2O) at rate of 0, 50, 100 and 150 Kg /fedd. The treatments were arranged in a split-plot design with three replications. The cultivar in main plot and treatments arranged in sub-plot.

The third experiment was conducted to study the effect of the time of last irrigation before harvest on two sweet potato cultivars, Mabrouka (local cultivar) and Beauregard.. The experiment included 6 treatments which were the combination of the two cultivars and three irrigation treatments: stopping irrigation at 15, 30 and 45 days before harvest. The treatments were arranged in a split-plot design with three erplication.

The sweet potato cultivars were assigned in the main plots and the level of potassium rates or irrigation in sub-plots were randamly distributed in the sub-plots. The experimental area was 24.5 m^2 and consisted of 7 ridges, each 5 m long and 0.7 m wide for all experiments. Stem cuttings were set 15 cm apart on one side of the ridge on 15 th of April each year. The fertilizer treatments were started 30 days after planting for 3 times and at one month intervals. All the other agricultural practices required for sweet potato production were done as commonly followed in the district.

Data recorded:

1-Plant Growth Measurements:

Five plants were taken randomly from each experimental plot as a representative sample after 150 days from planting for measuring the plant length, number of branches per plant, fresh weight per plant and chlorohpell content using SPAD reading apparatus.

2-Yield and its quality: -

About mid-October of each year, roots were harvested from inner five rows and total and marketable yields were recorded:

a- Total yield: Weight of all roots were taken from each plot and the average weight of roots/feddan was calculated.

b- Marketable yield: Weight of straight and free defect roots (above size, misshapen or damaged) were calculated.

3-Roots characteristics:

Ten roots were taken randomly from each experimental plot for measuring the: Average root weight, length, and diameter.

4-Chemical constituents of root:

Samples were taken at the harvest time to measure the chemical constituents as follows:

Ascorbic acid according to A.O.A.C. (1990), carotene content according to Nornai (1982), T.S.S (hand rafractometer) and dry matter percentage. Data were treated by analysis of variance with using SPSS 11.0 for windows software and using Tukey test between treatments means determined at the 5% level.

RESULTS AND DISCUSSION

First experiments:

Effect of Nitrogen fertilizer:

A. Vegetative growth characters:

Increasing rates of N fertilization from 0 to 45 Kg N/fed. had a significant influence on all of the vegetative growth traits of sweet potato(Table 1). As N rate increased there were an increase in plant length, plant fresh weight and number of branches per plant in 2003 and 2004 seasons. The highest rates (30 and 45 Kg/fed.) reflected the highest increments in the average of plant length, plant fresh weight and number of branches per plant compared to the lowest rat (15 Kg/ fed.) and the control treatments in the 2003 and 2004 seasons(except plant fresh weight in 2004 season). Obtained results are in agreement with those reported by Johnson and Ware (1949) and Stino and Lashin (1952). The increasing effect of N on the vegetative growth of sweet potato plants can be explained on the fact that N plays an important role for synthesis amino acids and proteins, also, the N required for optimal growth and improve the cell elongation (Marschner, 1999).

The same data in Table (1) show that application of foliar fertilizer with microelements increased plant length and number of branches in both seasons of study. On the other hand, plant fresh weight was not affected by micronutrients. These results are in agreement with Hatwar *et al.* (2003) in work with chilli (*Capsicum annuum var. Jayanti*) reported that the most effective and the highest values of the following values: plant height; number of branches per plant and diameter of stem were obtained with combined application of Zn, Fe and B at 0.1%. In this respect, the highest values of all studied growth parameters were recorded in case of the combination of 30 and or 45 Kg N/fed. with the application of micro-elements in both seasons of study.

As for the effect of nitrogen fertilizer on chlorophyll content the same data in table (1) show that the chlorophyll content increased with increasing N rates up to 30 kg N/fed. No significant increase in the chlorophyll content was observed with further increasing in the N rate, these results are in accordance with those obtained by Abdel Razik (1996) in work with Carrots. Increasing in chlorophyll content with N fertilizer can be explained by the fact of that protein synthesis and chloroplast formation leads to an increase in the lipids content of leaves as well as to an increase in chloroplast constituents such as chlorophyll (Marschner, 1999). In this respect, chlorophyll content was not influenced by microelement application in both years of study

B. Yield:

Illustrated data in Table (2) indicate that fertilizer treatments with low or moderate rate of nitrogen (15 and 30 Kg N/fed.) increased total yield in both seasons compared to high rate (45 Kg N/fed.) and the control. However,

Marketable yield was not significantly influenced by rates of N fertilization. The application of microelements had no effect on total and marketable yield during the two years of study. These results are in agreement with Abdel-Razik and Gabr, 1999 and Bautista *et al.* (1989) in that optimum root yields were obtained with the lower N rate.

Table (1): Effect of nitrogen rate and microelements on vegetative growth and chlorophyll content of sweet potato cv. Mabrouka in the summer seasons of 2003 and 2004.

Treatments	Plant length (cm)		Plant fresh weight (kg)		Number of branches		Chlorophyll reading	
	2003	2004	2003	2004	2003	2004	2003	2004
0 kg N/fed.	263,40a*	253,16a	2,10a	2,06 b	17,53a	21,06ab	45,50a	46,90ab
0 kg N/fed. + microelements	330,53bc	268,46a	1,84a	1,13 a	18,66a	19,50a	43,76a	43,46a
15 kg N/fed.	300,63ab	266,86a	2,51b	2,80 b	18,03a	22,16abc	47,40a	47,90b
15 kg N/fed. + microelements	328,33bc	303,70a	2,89c	2,18 b	21,83b	24,33de	46,00a	48,06b
30 kg N/fed.	348,43cd	271,93a	2,88c	2,68 b	24,16b	23,23cde	47,76a	50,26b
30 kg N/fed. + microelements	356,93cd	331,66b	2,92c	2,85 b	23,43b	24,06de	45,70a	48,70b
45 kg N/fed.	343,40cd	310,41b	2,92c	2,81 b	22,43b	25,36 e	44,76a	48,06b
45 kg N/fed + microelements	378,86d	320,00b	2,66bc	2,86 b	27,16c	24,93 e	42,50a	47,86b

* The same letter within a column are not significantly different at P <0,05 according to Tukey test.

C. physical roots quality:

Concerning the effect of nitrogen on physical root quality, i.e. root length, diameter and weight data in Table (3) show that increases in N levels caused an increase in root length and weight of sweet potato but did not affect root diameter. These increases are more significantly in the first season of study. The highest rates (30 and 45 Kg K/fed.) tended to decrease root length and root weight compared to the lowest rate (15 Kg N /fed.) or control. These results are confirmed by the findings of Abdel-Razik and Gabr (1999), who found that fresh weight of tuber and tuber length of sweet potato roots were only affected by low N levels. In this connection, microelements had no significant effect on root parameters during both seasons of growth.

D. chemical analysis:

Varying rates of N fertilization from 0 to 45 Kg N/fed. had a significant influence on some of the quality variables of sweet potatoes (Table 4). Dry matter percent as an average of all tests treatments was increased by the application of N fertilizer in both years of study. Similar results were detected by Constantin *et al.* (1984).T.S.S. was slightly lowered by increasing N rates from low rates (15 Kg N/fed.) to high rates (30 and 45 Kg N/fed.) especially in second seasons. Rates of N had no effect on ascorbic acid or on carotene content. These results are

confirmed by the findings of Hammett and Miller (1982), who found that, the used two N rates (101 and 202 Kg N /ha) had no effects on carotene content and ascorbic acid of sweet potato roots. Foliar application with microelements had no influence on dry matter, TSS, ascorbic acid or carotene content of sweet potato roots. However, the highest values in most cases were obtained due to use low nitrogen levels (30 Kg N/fed.) combined with the application of microelements at a rate of 1.5 g/L of Agrochem.

Table (2): Effect of nitrogen rate and microelements application on total and marketable yield of Mabrouka cultivar on the summer seasons of 2003 and 2004.

Treatments	Total yield (ton/fed.)		Marketable yield (ton/fed.)	
	2003	2004	2003	2004
0 kg N/fed.	4,77 a*	4,90 a	2,39 a	2,81 a
0 kg N/fed + microelements	5,37 ab	6,28 ab	3,29 b	3,22 a
15 kg N/fed	6,87 de	7,49 bc	3,81 b	3,99 a
15 kg N/fed + microelements	7,19 e	7,33 bc	3,84 b	3,86 a
30 kg N/fed	6,76 cde	8,77 c	3,86 b	3,89 a
30 kg N/fed + microelements	6,05 bcd	7,53 bc	3,94 b	4,17 a
45 kg N/fed	5,76 abc	6,64 abc	3,34 b	3,70 a
45 kg N/fed + microelements	5,81 abc	6,51 abc	3,20 ab	3,44 a

Table (3): Effect of nitrogen rate and microelements on root parameters of Mabrouka cultivar on the summer seasons of 2003 and 2004.

Treatments	Root parameters					
	2003			2004		
	Root length (cm)	Root weight (g)	Root diameter (cm)	Root length (cm)	Root weight (g)	Root diameter (cm)
0 kg N/fed.	14,50 a*	339,43bc	6,62 a	13,86 a	209,13 a	5,68 ab
0 kg N/fed + microelements	16,63 c	311,90 b	6,19 a	15,46 a	191,86 a	6,49 ab
15 kg N/fed	14,97ab	374,26 d	6,03 a	15,20 a	272,33 b	6,29 ab
15 kg N/fed + microelements	16,23 bc	315,93 b	5,64 a	14,86 a	236,50ab	6,16 ab
30 kg N/fed	14,93 ab	348,86cd	5,83 a	15,33 a	210,20 a	6,22 ab
30 kg N/fed + microelements	15,20 ab	328,96bc	6,33 a	16,13 a	272,13 b	6,91 b
45 kg N/fed	14,87 ab	352,43cd	6,06 a	15,66 a	205,40 a	5,36 a
45 kg N/fed + microelements	14,99 ab	255,36 a	5,02 a	16,26 a	200,06 a	5,81 ab

* The same letter within a column are not significantly different at P <,05 according to Tukey test.

Table (4): Effect of nitrogen rate and microelements application on chemicals analysis of Mabrouka cultivar during the summer seasons of 2003 and 2004

Treatments	Dry matter (%)		T.S.S.(%)		Ascorbic acid (Mg/ 100g fw)		Carotene (Mg/ 100g fw)	
	2003	2004	2003	2004	2003	2004	2003	2004
0 kg N/fed.	25,55 a*	29,23 ab	8,16 a	11,33 c	7,73 a	7,40 a	1,03 a	0,77 a
0 kg N/fed + microelements	26,06 ab	29,00 a	7,83 a	10,93 bc	7,50 a	6,95 a	1,09 a	0,81 a
15 kg N/fed	27,12 ab	30,77 abc	7,83 a	11,46 c	6,94 a	7,23 a	1,05 a	0,93 a
15 kg N/fed + microelements	27,10 ab	31,02 abc	7,66 a	10,66 abc	6,74 a	7,04 a	0,89 a	0,96 a
30 kg N/fed	26,94 ab	31,16 abc	8,00 a	10,66 abc	6,87 a	6,74 a	0,79 a	0,71 a
30 kg N/fed + microelements	27,46 b	31,22 abc	7,83 a	9,83 ab	6,60 a	6,85 a	0,95 a	0,85 a
45 kg N/fed	27,08 ab	31,44 bc	7,66 a	10,16 abc	7,27 a	6,69 a	0,96 a	0,79 a
45 kg N/fed + microelements	27,34 ab	31,79 c	7,66 a	9,50 a	6,19 a	6,91 a	1,00 a	0,94 a

* The same letter within a column are not significantly different at P <,05 according to Tukey test.

Second experiment

Effect of studied cultivars and potassium fertilizer as well as their interaction on:

A. Vegetative growth characters:

Data presented in Table (5) show that cv. Mabrouka gave taller plants, higher plant fresh weight and number of branches than cv. Beauregard. Obtained results might be due to genetic differences between cultivars. Similar results were detected by Harmon,(1948) and Reddy *et al.*, (1996) who found significant differences in plant growth characters among cultivars. Chlorophyll content was higher in cv. Beauregard.than cv. Mabrouka but the difference was not significantly.

Plant length and chlorophyll content in leaves were not significantly influenced by K application in the two seasons of study (Table 5). With increasing K rate from 0 to 150 Kg K_2O/fed., plant fresh weight and number of branches were increased (except number of branches in 2004 season). No significant differences in plant fresh weight and number of branches were found between all k rates. Knavel (1971) and Abdel-Razik and Gabr (1999) reported that plant fresh weight was increased by K application. According to the interaction between K fertilizer and cultivars, it is clear from the obtained data that using K application with any cultivar gave the highest values only of plant fresh weight in the second season. Plant length, number of branches and chlorophyll content, on the contrary, did not appear to be significantly affected by the interaction between cultivars and K rate in both seasons.

Table (5): Effect of fertilization with potassium sulphate on plant length, plant fresh weight, and number of branches and chlorophyll content of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Plant length (cm)		Plant fresh weight (kg)		Number of branches		Chlorophyll reading	
		2003	2004	2003	2004	2003	2004	2003	2004
Mabrouka		291,19 b	273,94 b	1,89 b	2,59 b	19,77 b	34,38 b	44,22 a	44,60 a
Beauregard		158,50 a	178,76 a	1,76 a	1,72 a	13,62 a	17,43 a	41,21 a	41,05 a
Treatments									
0 Kg K_2O/Fed.		228,68 a	231,56 a	1,66 a	1,84 a	17,83 a	21,30 a	41,68 a	45,50 a
50 Kg K_2O/Fed.		216,98 a	231,56 a	1,82 ab	2,37 b	15,75 a	26,20 ab	45,80 a	45,50 a
100 Kg K_2O/Fed.		220,38 a	218,48 a	1,87 b	2,27 b	16,36 a	30,85 b	44,03 a	41,48 a
150 Kg K_2O/Fed.		233,33 a	223,80 a	1,95 b	2,16 b	16,85 a	25,28 ab	39,36 a	38,81 a
Interaction									
Mabrouka	**0 Kg K_2O/Fed.**	288,70 a	290,80 a	1,78 a	1,99 a	21,00 a	27,40 a	39,46 a	44,83 a
	50 Kg K_2O/Fed.	294,63 a	278,46 a	1,88 a	2,88 b	19,50 a	33,20 a	43,96 a	46,66 a
	100 Kg K_2O/Fed.	291,43 a	245,13 a	1,95 a	2,67 b	19,40 a	42,03 a	46,50 a	43,13 a
	150 Kg K_2O/Fed.	290,00 a	281,36 a	1,96 a	2,84 b	19,20 a	34,90 a	46,96 a	43,76 a
Beauregard	**0 Kg K_2O/Fed.**	168,66 a	172,33 a	1,55 a	1,70 a	14,66 a	15,20 a	43,90 a	46,16 a
	50 Kg K_2O/Fed.	139,33 a	184,66 a	1,76 a	1,86 a	12,00 a	19,20 a	47,63 a	44,33 a
	100 Kg K_2O/Fed.	149,33 a	191,83 a	1,80 a	1,86 a	13,33 a	19,66 a	41,56 a	39,83 a
	150 Kg K_2O/Fed.	176,66 a	166,23 a	1,94 a	1,47 a	14,50 a	15,66 a	31,76 a	33,86 a

* The same letter within a column are not significantly different at P <,05 according to Tukey test.

B. Yield:

As shown in Table (6), cultivar Beauregard gave significantly more total and marketable yield than cultivar Mabrouka. These results were true in both seasons of the study. These results may be attributed to the genetic differences among cultivars and their response to environmental conditions. In this regard, cv. Mabrouka gave a little number of roots per plant compared with cv. Beauregard. Obtained results are supported by those of Ashari *et al.* (1996) and Marti and Mills (2003), who reported that sweet potato cultivars differ significantly in yield.

Illustrated data in Table (6) indicate that all K rates increased total and marketable yield compared with the control. In this regard, using the highest rates of K (100 and 150 Kg K_2O/fed.) increased the total and marketable yield compared the low rate (50 Kg K_2O/fed.) or control. No significant differences in total and marketable yield were found between K applications with 50 Kg K_2O/fed. and the control, or between 100 and 150 Kg K_2O/fed. These results are

in agreement with Abdel-Razik and Gabr (1999) who found that root yields were increased with K rate increase.

Table (6): Effect of fertilization with potassium sulphate on total and marketable yield of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Total yield (ton/Fedd.)		Marketable yield (ton/Fedd.)	
		2003	2004	2003	2004
Mabrouka		6,21 a*	5,60 a	3,44 a	2,72 a
Beauregard		10,07 b	10,41 b	7,48 b	8,85 b
Treatments					
0 Kg K_2O/Fed.		6,70 a	5,92 a	3,50 a	4,52 a
50 Kg K_2O/Fed.		7,33 a	6,88 a	5,43 b	4,90 a
100 Kg K_2O/Fed.		9,46 b	10,29 b	6,94 c	7,18 b
150 Kg K_2O/Fed.		9,06 b	8,94 b	5,98 bc	6,54 b
Interaction					
Mabrouka	**0 Kg K_2O/Fed.**	5,40 a	3,75 a	2,80 a	2,00 a
	50 Kg K_2O/Fed.	5,49 a	5,38 ab	3,41 a	2,85 a
	100 Kg K_2O/Fed.	6,99 a	6,47 bc	4,02 a	3,02 a
	150 Kg K_2O/Fed.	6,95 a	6,83 bc	3,54 a	2,99 a
Beauregard	**0 Kg K_2O/Fed.**	8,00 a	8,09 c	4,20 a	7,04 b
	50 Kg K_2O/Fed.	9,17 a	8,38 c	7,44 b	6,95 b
	100 Kg K_2O/Fed.	11,93 a	14,12 e	9,86 c	11,33 c
	150 Kg K_2O/Fed.	11,18 a	11,05 d	8,41 bc	10,08 c

* The same letter within a column are not significantly diffe ent at P <,05 according to Tukey test.

Data in Table (6) demonstrated that within each cultivar using 100 Kg K_2O/fed. rate gave the highest values for total (in 2004 season only) and marketable yield. Generally, the combination between Beauregard cultivar and 100 Kg K_2O/fed. gave the highest value of total and marketable yield.

C: Physical root quality:

As shown in Table (7) roots of Mabrouka cultivar significantly surpassed those of the other cultivar in their length and weight of roots. No differences were shown in root diameter between the two cultivars. These results are true in both seasons of study. These results might be attributed to the genetic differences between cultivars. These results are in accordance with the findings of Constantin *et al.* (1984) who indicated that sweet potato cv. "Centennial" produced significantly more No.1 grade than other two cultivars "L3-243" and "Goldrush".

Mean of roots weight was influenced by the all studied K rates (Table 7). The mean of roots weight significantly was increased with increasing K rates up to 100 kg K_2O/fed. Length and diameter of roots were not influenced by K rate.

These results were true in both years of study. These results are in agreement with those of Abdel-Razik and Gabr (1999) who found that potassium fertilization of sweet potato plants at the rate of 50, 100 and 150 kg K_2O /fed. gave significantly higher mean values of fresh weights/tuber as well as tuber length and diameter than the control. No interactions were found between cultivars and K application in both years of study on all the studied parameters of physical quality.

Table (7): Effect of potassium fertilization with potassium sulphate on root length, weight and diameter of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		2003			2004		
		Root length (cm)	Root weight (g)	Root diameter (cm)	Root length (cm)	Root weight (g)	Root diameter (cm)
Mabrouka		17,39b*	410,67 b	6,24 a	16,56 b	366,43 b	6,13 a
Beauregard		12,61 a	313,37 a	6,54 a	13,10 a	318,26 a	6,18 a
Treatments							
0 Kg K_2O/Fed.		14,61 a	329,42 a	6,09 a	14,41 a	286,63 a	5,87 a
50 Kg K_2O/Fed.		15,32 a	376,50ab	6,50 a	14,83 a	316,48 a	6,11 a
100 Kg K_2O/Fed.		14,86 a	390,28 b	6,69 a	14,93 a	409,65 c	6,31 a
150 Kg K_2O/Fed.		15,22 a	351,90ab	6,29 a	15,15 a	356,63b	6,33 a
Interaction							
Mabrouka	**0 Kg K_2O/Fed.**	16,82 a	366,94 a	5,79 a	15,93 a	317,40 a	5,81 a
	50 Kg K_2O/Fed.	18,18 a	435,56 a	6,23 a	17,00 a	351,00 a	6,16 a
	100 Kg K_2O/Fed.	16,92 a	458,56 a	6,82 a	16,93 a	415,06 a	6,30 a
	150 Kg K_2O/Fed.	17,64 a	381,63 a	6,14 a	16,40 a	382,26 a	6,26 a
Beauregard	**0 Kg K_2O/Fed.**	12,40 a	291,90 a	6,40 a	12,90 a	255,86 a	5,93 a
	50 Kg K_2O/Fed.	12,46 a	317,43 a	6,76 a	12,66 a	281,96 a	6,06 a
	100 Kg K_2O/Fed.	12,80 a	322,00 a	6,56 a	12,93 a	404,23 a	6,33 a
	150 Kg K_2O/Fed.	12,80 a	322,16 a	6,43 a	13,90 a	331,00 a	6,40 a

* The same letter within a column are not significantly different at P <,05 according to Tukey test.

D: Chemical analysis:

. As shown in Table (8), the roots of Mabrouka cultivar contained higher dry matter, and Beauregard had the higher T.S.S., ascorbic acid and carotene. Massey *et al.* (1956) found that carotene, ascorbic acid and dry matter contents were significantly varied among cultivars.

Table (8): Effect of fertilization with potassium sulphate on chemical compositions of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Dry matter (%)		T.S.S.(%)		Ascorbic acid (mg/ 100g fw)		Carotenoids (mg/100g fw)	
		2003	2004	2003	2004	2003	2004	2003	2004
Mabrouka		23,24 b*	29,69 b	8,00 a	11,33 a	6,62 a	6,77 a	0,48 a	0,79 a
Beauregard		20,61 a	21,51 a	8,45 b	12,00 b	11,14 b	10,33 b	7,25 b	6,33 b
Treatments									
0 Kg K_2O/Fed.		22,93 b	26,42 b	7,50 a	11,00 a	8,67 a	8,44 a	4,07 a	3,48 a
50 Kg K_2O/Fed.		22,58 b	25,49 ab	7,25 a	11,91 ab	9,31 a	8,74 a	3,82 a	3,50 a
100 Kg K_2O/Fed.		21,28 a	25,25 a	8,83 b	11,00 a	8,97 a	8,29 a	3,76 a	3,53 a
150 Kg K_2O/Fed.		20,91 a	25,25 a	9,33 b	12,75 b	8,57 a	8,73 a	3,81 a	3,71 a
Mabrouka	**0 Kg K_2O/Fed.**	24,66 a	30,85 a	7,33 a	10,33 ab	6,47 a	6,62 a	0,41 a	0,84 a
	50 Kg K_2O/Fed.	23,56 a	29,69 a	7,00 a	10,83 ab	6,75 a	6,48 a	0,37 a	0,54 a
	100 Kg K_2O/Fed.	22,76 a	29,24 a	8,83 a	12,00 bc	6,64 a	7,26 a	0,52 a	0,89 a
	150 Kg K_2O/Fed.	21,98 a	29,00 a	8,83 a	12,16 bc	6,61 a	6,74 a	0,63 a	0,88 a
Beauregard	**0 Kg K_2O/Fed.**	21,20 a	22,00 a	7,66 a	11,66abc	10,86 a	10,26 a	7,74 a	6,12 a
	50 Kg K_2O/Fed.	21,60 a	21,30 a	7,50 a	13,00 c	11,86 a	11,00 a	7,27 a	6,47 a
	100 Kg K_2O/Fed.	19,80 a	21,26 a	8,83 a	10,00 a	11,30 a	9,33 a	7,01 a	6,18 a
	150 Kg K_2O/Fed.	19,84 a	21,50 a	9,83 a	13,33 c	10,53 a	10,73 a	6,98 a	6,55 a

* The same letter within a column are not significantly different at P <,05 according to Tukey test.

Root dry matter was significantly reduced by K application, the high K rates (100 and 150 Kg K_2O/fed.) reflected the lower values of dry matter percent compared to low rate or control in both seasons of study (Table 8). T.S.S was significantly increased by K application, the high K rates (100 and 150 Kg K_2O/fed.) gave the highest T.S.S compared to low rate (50 Kg K_2O/fed.) or control. Ascorbic acid and carotene contents were not influenced by K fertilizer in both seasons of study. These results are in agreement with those of Constantin *et al.*(1977), who found that dry matter and protein contents were reduced by application of K fertilizer, but had no influence on carotene content. There were significant interaction between cultivars and K application on T.S.S in 2004 season only. In this regard, Beauregard cultivar combined with K rate of 150 Kg/fed. gave the highest value.

Third experiment

Effect of cultivars, time of last irrigation before harvest and their interaction on:

A. Vegetative growth characters:

As shown in Table (9) all vegetative growth characters (plant length, plant fresh weight, number of branches and chlorophyll content in leaves) were higher in Mabrouka cultivar than Beauregard cultivar in both seasons. Obtained results might be due to genetic differences between cultivars.

The prevention period of irrigation before harvest influenced all vegetative growth characters (Table 9). When the period between the last irrigation and harvest were decreased, plant length, plant fresh weight and number of branches were increased, while chlorophyll content, in the first season, was decreased. Decreases in available moisture significantly reduced vine length; this is in agreement with the results of Escalante and Gonzal (1988).

There were significant interactions between cultivars and time of stopping irrigation before harvest on plant length (in the first season only), number of branches and chlorophyll content (in the first season only). Generally, in case the highest values for plant length and number of branches were obtained the combination between Mabrouka cultivar and stopping irrigation at 15 days before harvest.

Table (9): Effect of last irrigation time before harvest on plant length, plant fresh weight, number of branches and chlorophyll content of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Plant length (cm)		Plant fresh weight (Kg)		Number of branches		Chlorophyll reading	
		2003	2004	2003	2004	2003	2004	2003	2004
Mabrouka		273,88 b	209,18 b	2,16 b	2,33 b	21,21 b	33,88 b	44,28 b	44,54 b
Beauregard		163,66 a	143,46 a	1,45 a	1,23 a	18,82 a	16,44 a	38,77 a	39,67 a
Treatments									
15 DBH**		223,50 b	184,96 b	1,95 b	2,05 b	22,40 c	30,86 c	39,05 a	40,91 a
30 DBH		218,53ab	175,31ab	1,82 ab	1,89 ab	19,91 b	24,33 b	42,71 b	43,75 a
45 DBH		214,30 a	168,70 a	1,65 a	1,39 a	17,73 a	20,30 a	42,83 b	41,66 a
Interaction									
Mabrouka	**15 DBH**	272,66 c	215,13 a	2,21 a	2,63 a	24,26 d	39,40 d	43,66 bc	45,90 a
	30 DBH	275,40 c	210,50 a	2,26 a	2,57 a	21,40 c	35,33 d	43,00 bc	44,86 a
	45 DBH	273,60 c	201,93 a	2,01 a	1,80 a	17,96 a	26,93 c	46,20 c	42,86 a
Beauregard	**15 DBH**	174,33 b	154,80 a	1,70 a	1,48 a	20,53 bc	22,33 b	34,43 a	35,93 a
	30 DBH	161,66ab	140,13 a	1,37 a	1,22 a	18,43 ab	13,33 a	42,43 bc	42,63 a
	45 DBH	155,00 a	135,46 a	1,28 a	0,99 a	17,50 a	13,66 a	39,46 ab	40,47 a

* The same letter within a column are not significantly different at P <, 05 according to Tukey test.

** DBH: Days before harvest

B. Yield:

Data presented in Table (10) show that Beauregard cultivar gave more total and marketable yield than Mabrouka cultivar. These results are true in both seasons of study. Marti and Mills (2003) found significantly differences in total and marketable yield between three sweet potato cultivars.

The time of the last irrigation and harvest influenced sweet potato yields (Table 10). Total and marketable yield were highest when plots were irrigated at 15 or 30 days before harvest. These results were true in both seasons.

The interaction between cultivars and time of last irrigation was significant on total and marketable yield only in the first season of study. In this respect cv. Beauregard and stopping of irrigation 15 days before harvest gave the highest total and marketable yield.

Table (10): Effect of last irrigation time before harvest on total and marketable yield of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Total yield (ton/Fedd.)		Marketable yield (ton/Fedd.)	
		2003	2004	2003	2004
Mabrouka		5,39 a*	5,77 a	3,62 a	3,89 a
Beauregard		6,63 b	6,37 b	4,43 b	4,65 b
Treatments					
15 DBH**		6,85 b	6,49 b	4,77 b	4,88 b
30 DBH		6,11 b	6,35 b	3,92 b	4,28 ab
45 DBH		5,07 a	5,37 a	3,40 a	3,65 a
Interaction					
Mabrouka	**15 DBH**	5,49 ab	5,98 a	3,46 ab	4,38 a
	30 DBH	5,76 ab	5,93 a	3,53 ab	3,75 a
	45 DBH	4,92 a	5,39 a	3,88 ab	3,55 a
Beauregard	**15 DBH**	8,22 c	7,01 a	6,08 c	5,38 a
	30 DBH	6,47 b	6,77 a	4,30 b	4,82 a
	45 DBH	5,22 ab	5,35 a	2,92 a	3,76 a

* The same letter within a column are not significantly different at P <, 05 according to Tukey test.

** DBH: Days before harvest

C: Physical root quality:

Table (11) show the effect of cultivars and stop irrigation time before harvest and their interaction on root length, weight and diameter. Root length and weight were significantly higher in Mabrouka cultivar than Beauregard in both seasons of study. Root diameter was similar in both cultivars.

Root length (in 2003 season) and root weight were significantly increased when the period between last irrigation and harvest decreased, while root diameter not affected. These results are confirmed by the findings of Somyot (1996), how found that root weight and root length from non-water deficit treatment were larger than those of treatment with water deficit.

According to the interaction between cultivars and irrigation, it is clear from the obtained data that cultivar Mabrouka and stop irrigation 15 days before from harvest gave the highest values in root length and weight in the first season of study.

Table (11): Effect of last irrigation time before harvest on root parameters of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		2003			2004		
		Root length (cm)	Root weight (g)	Root diameter (cm)	Root length (cm)	Root weight (g)	Root diameter (cm)
Mabrouka		15,37 b*	280,28 b	6,27 a	16,08 b	340,12 b	5,89 a
Beauregard		12,14 a	207,95 a	5,56 a	14,37 a	260,56 a	6,00 a
Treatments							
15 DBH**		14,70 b	293,08 c	6,10 a	15,58 a	331,41 b	5,91 a
30 DBH		13,51 ab	237,41 b	5,96 a	15,20 a	304,96 b	6,05 a
45 DBH		13,05 a	201,86 a	5,70 a	14,91 a	264,65 a	5,87 a
Interaction							
Mabrouka	**15 DBH**	17,40 c	347,80 e	6,34 a	16,40 a	357,00 a	5,63 a
	30 DBH	14,69 b	272,90 d	6,48 a	16,26 a	361,76 a	6,04 a
	45 DBH	14,01 ab	220,16 bc	6,00 a	15,60 a	301,60 a	6,00 a
Beauregard	**15 DBH**	12,00 a	238,36 c	5,86 a	14,76 a	305,83 a	6,20 a
	30 DBH	12,33 ab	201,93 ab	5,43 a	14,13 a	248,16 a	6,06 a
	45 DBH	12,10 a	183,56 a	5,40 a	14,23 a	227,70 a	5,73 a

* The same letter within a column are not significantly different at P <, 05 according to Tukey test.

** DBH: Days before harvest

D: Chemical analysis:

Table (12) show that the dry matter was higher in Mabrouka cultivar and lower in Beauregard cultivar. T.S.S., ascorbic acid and carotene in Beauregard cultivar were higher than Mabrouka cultivar.

Table (12): Effect of last irrigation before time harvest on chemical analysis of two sweet potato cultivars in the summer seasons of 2003 and 2004.

Cultivars		Dry matter (%)		T.S.S.(%)		Ascorbic acid (mg/ 100g fw)		Carotene (mg/ 100g fw)	
		2003	2004	2003	2004	2003	2004	2003	2004
Mabrouka		24,41 b	30,28 b	6,70 a	10,11 a	6,70 a	6,85 a	0,70 a	0,76 a
Beauregard		20,94 a	21,02 a	10,13 b	11,00 b	10,13 b	9,60 b	6,44 b	6,49 b
Treatments									
15 DBH**		22,17 a	24,39 a	8,30 a	9,91 a	8,30 a	7,93 a	3,34 a	3,23 a
30 DBH		22,09 a	25,80 b	8,78 a	10,66 b	8,78 a	8,35 a	3,50 ab	3,52 ab
45 DBH		23,76 b	26,76 b	8,16 a	11,08 b	8,16 a	8,38 a	3,87 b	4,12 b
Interaction									
Mabrouka	**15 DBH**	23,45 a	30,09 c	6,76 a	9,50 a	6,76 a	6,81 a	0,717 a	0,69 a
	30 DBH	24,09 a	29,88 c	6,51 a	10,00 a	6,51 a	6,71 a	0,640 a	0,82 a
	45 DBH	25,69 a	30,89 c	6,82 a	10,83 a	6,82 a	7,03 a	0,743 a	0,76 a
Beauregard	**15 DBH**	20,90 a	18,70 a	9,83 a	10,33 a	9,83 a	9,06 a	5,973 a	5,76 a
	30 DBH	20,10 a	21,73 b	11,07 a	11,33 a	11,07 a	10,00 a	6,367 a	6,23 a
	45 DBH	21,83 a	22,63 b	9,50 a	11,33 a	9,50 a	9,73 a	7,003 a	7,48 a

* The same letter within a column are not significantly different at P <, 05 according to Tukey test.

** DBH: Days before harvest

Dry matter, carotene and T.S.S were increased by increasing the period between last irrigation time and harvest, while ascorbic acid was not affected. No significant differences were found between stopping of irrigation at 15 and 30 days before harvest. These results are in accordance with this obtained by Constantin *et al.*(1974), who found significant decrease in dry matter content and total carotene pigments due to increasing the soil moisture levels.

No significant interaction was found between cultivars and stopping of irrigation time before harvest in all characters except dry matter in 2004 season.

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تأثير التسميد والرى على انتاجية وجودة البطاطا

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أجرى هذا البحث بمحطة التجارب الزراعية التابعة لكلية الزراعة– جامعة القاهرة (الجيزة) فى الموسم الصيفى لعامى ٢٠٠٣و٢٠٠٤ وذلك لدراسة تأثير كل من ١) التسميد النتروجينى بمعدل صفر – ١٥–٣٠–٤٥ كجم نتروجين / فدان و الرش بالعناصر الصغرى بمعدل ١,٥ سم / لتر. ٢) الاصناف (مبروكة و بيوريجارد) و التسميد البوتاسى بمعدل صفر – ٥٠– ١٠٠–١٥٠ كجم بوتاسيوم / فدان. ٣) ميعاد اخر رية قبل الحصاد (١٥–٣٠– ٤٥ يوم قبل الحصاد) وذلك على النمو الخضرى و المحصول وبعض المكونات الكميائية لدرنات البطاطا.

اوضحت نتائج التجارب ان زيادة معدل النتروجين ادت الى زيادة صفات النمو الخضرى مثل طول ووزن النبات الطازج وعدد الفروع / نبات. كما وجدت زيادة معنوية فى المحصول الكلى و جودة الجذور مثل طول الجذر ووزنة بزيادة التسميد النتروجينى حتى ٣٠ كجم نتروجين / فدان. كما ادت زيادة التسميد النتروجينى الى زيادة المادة الجافة و انخفاض المواد الصلبة الذائبة الكلية فى حين لم تؤثر على محتوى حمض الاسكوربيك أو الكاروتين. أدى الرش بالعناصر الصغرى الى حدوث زيادة معنوية فى كل من مواصفات النمو الخضرى ولكنها لم تؤثر على المحصول الكلى او القابل للتسويق و مواصفات الجذور و المكونات الكيمائية.

أدت الزيادة فى التسميد البوتاسى من صفر الى ١٥٠ كجم بوتاسيوم / فدان الى حدوث زيادة معنوية فى الوزن الطازج / نبات وعدد الفروع/ نبات ولكنها لم تؤثر على طول النبات، كما ادت الى حدوث زيادة معنوية فى المحصول الكلى و القابل للتسويق. لم يؤثر التسميد البوتاسى على طول او قطر الجذر ولكنة قد عمل على زيادة وزن الجذر. ادت زيادة التسميد البوتاسى ايضا الى تقليل المادة الجافة ولكنها ادت الى زيادة كل من المواد الصلبة الذائبة الكلية وحمض الاسكوربيك و محتوى الكاروتين و الكلوروفيل فى الاوراق.

أدى تقليل الفترة بين اخر رية والحصاد الى حدوث زيادة معنوية فى كل مواصفات النمو الخضرى و المحصول الكلى و متوسط وزن الجذر وطولة و ايضا الى زيادة المواد الصلبةالذائبة الكلية و المادة الجافة و الكاروتين و لكنها لم تؤثر معنويا على قطر الجذر او حمض الاسكوربيك