EFFECTS OF HARVEST DATE, NK FERTILIZATION AND CURING ON STORABILITY AND CHEMICAL CONSTITUENTS OF SWEET POTATO TUBEROUS ROOTS DURING STORAGE.

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ABSTRACT

Two storage experiments were carried out at the Post Harvest Center, Faculty of Agriculture, Alexandria University. The objective of these experiments was to follow up the effects of some pre-harvest treatments such as; two harvest dates (after 120 and 150 days from transplanting) and four NK fertilizers treatments combinations (control, 20-36, 40-0 and 40-72 Kg N-K_2O/fed),as well as two curing treatments (curing and non-curing) on storability and chemical constituents of tuberous roots of sweet potato during storage periods. The obtained results illustrated that delaying harvesting of tuberous roots lowered the percentages of weight loss, decays and dry matter throughout the first two storage periods; 30 and 60 days. Whereas, increasing the storage period up to 120 days with late harvested date significantly increased the percentages of decays, weight loss, total sugars, reducing and non-reducing sugars, sucrose and total carotenoids, but decreased the tubers' starch content. Pre-harvest fertilization with 20-36 Kg N-K_2O/fed produced tubers with the highest contents of total sugars, non-reducing sugars, and sucrose at the beginning and end of storage. Whereas, increasing the level of pre-harvest application of NK up to 40-72 Kg/fed, increased the percentages of decays, reducing sugars and starch as well as total carotenoids content, but decreased the crude fibers content at the end of storage period. Curing of sweet potato tubers, before storage, lowered the percentages of weight loss and decays during storage, meanwhile, the tubers' dry matter content did not significantly respond to curing process. Moreover, curing the tuberous roots increased percentages of total sugars, non-reducing sugars, and sucrose, as well as total carotenoids and lowered the percentage crude fibers at the end of storage.

Generally, the cured tuberous roots of sweet potato plants which were fertilized with 20-36 Kg/fed of N-K_2O and harvested after 150 days from transplanting, lowered the percentages of weight loss and decays after 30 and 60 days of storage periods, as well as significantly increased total sugars, non-reducing sugars and sucrose contents at the end of storage.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.) gained a considerable importance as an exportable crop to the European markets and some Arabian countries.

The influence of pre-harvest treatments such as, harvest date and fertilization on sweet potato appearance and yield had been investigated. Nevertheless, pre-harvest treatments effects on storability and chemical constituents of tuberous roots of sweet potato during storage have not been consistent. Many investigators reported that increasing the level of applied N was accompanied with increases in decays, weight loss (Lutz *et al.*, 1949 ; Hammett and Miller, 1982), and decreased dry matter and carbohydrate(Hammett and Miller, 1982), as well as crude fibers (Constantin *et al.*, 1984) of tuberous roots of sweet potato throughout the storage period. However, increasing potassium supply to sweet potato plants increased the weight loss (El-Seifi *et al.*,1990) and glucose content (Sharfuddin and Voican ,1984), but reduced dry matter and carbohydrate contents (Hammett and Miller ,1982) and starch content (Sharfuddin and Voican,1984) of stored sweet potato tuberous roots. On the other hand, Duncan *et al.* (1958) reported that the application of nitrogen and potassium fertilizers to sweet potato plants did not influence the weight loss of tuberous roots during storage period.

The purpose of curing tuberous roots of sweet potato is to rapidly heal any damage (cuts, bruises, etc.) inflicted during harvest by inducing formation of wound periderm over the cuts and bruises to prevent subsequent decay and weight loss during storage (Walter and Schadel, 1982). Many investigators noticed that there were relationship between curing treatment of stored sweet potato tuberous roots and weight loss. Appleman *et al.* (1943), and Strider and McCombs (1958) indicated that rot and moisture loss problems might be effectively controlled by properly curing the roots. Also, Scott and Matthews (1957) showed that weight loss of sweet potato roots was more rapid during the curing period and during six months of storage. Moreover, Jenkins and Gieger (1957), Lambou (1958), McCombs and Pope (1958), Hammett and Barrantine (1961), El-Tamzini (1976) ,Picha (1985) and (1987) reported that sweet potato tuberous roots contents of reducing, non-reducing and total sugars increased during curing process and storage.

This study was designed to follow up the effects of some pre-harvest treatments; two harvest dates and four NK fertilizers treatments combinations ,as well as two curing treatments on storability and chemical constituents of tuberous roots of sweet potato during storage.

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MATERIALS AND METHODS

Two storage experiments were carried out at the Post Harvest Center, Faculty of Agriculture, Alexandria University, during the 1999/2000 and 2000 /2001 seasons. The objective of these experiments was to follow up the effects of some pre- and post-harvest treatments on storability and chemical constituents of tuberous roots of sweet potato during storage.

Each experiment included 16 treatment combinations; which were the combinations of two harvest dates (after 120 and 150 days from transplanting), the four NK fertilizers treatments (0-0, 20-36, 40-0 and 40-72 Kg N-K_2O/fed) and two curing treatments (curing and non-curing). The two experiments were carried out using a split-split-plot system in a randomized complete blocks design with three replications. In the field part, the harvest dates and the NK treatments combination (pre-harvest treatments) were randomly distributed within the main and sub-plots , orderly. While, the medium grade of harvested tuberous roots, in each harvest date which were resulted from plants fertilized with NK treatments combinations, were used in the curing treatments (post-harvest treatments) and arranged as the sub-sub plots .

In the field part, each sub-plot consisted of four rows , 5 m long and 70 cm width. Each two adjacent sub-plots were separated by a guard row. Selected cuttings, 25 cm length, of sweet potato (cv. Abis) were transplanted , at within-row spacing of 25 cm, on April 3 and May 9 1999 and 2000, respectively. Nitrogen, as ammonium nitrate (33.3% N), and potassium, as potassium sulphate (48% K_2O), fertilizers were applied at two equal applications; after 4 and 6 weeks from transplanting. A seasonal total of 60 Kg P_2O_5/fed as calcium super phosphate (15.5% P_2O_5) was broadcasted during soil preparation. Harvesting was carried out on July 31 and August 31, 1999 and on September 6 and October 7, 2000 (Table1).

The medium grade of tuberous roots of each harvest date were cleaned and divided into two groups, the first group (non-cured) was weighed and stored immediately at 13-15°C and 85-90% RH, while the second one was cured in the field for 7 days by covering the tuberous roots with vines, then weighed and stored at 13-15°C and 85-90% RH .

Table 1: Schedule of planting, harvest and storage dates of all treatments, in both seasons.

Planting Dates	Harvest dates	Start of storage		End of storage	
		Uncured roots	Cured roots	Uncured roots	Cured roots
First season 3/4/1999	First harvest date 31/7/1999	31/7/1999	7/8/1999	1/10/1999 (after 2 months storage)	8/12/1999 (after 4 months storage)
	Second harvest date 31/8/1999	31/8/1999	7/9/1999	1/11/1999 (after 2 months storage)	7/1/2000 (after 4 months storage)
Second season 9/5/2000	First harvest date 6/9/2000	6/9/2000	13/9/2000	6/11/2000 (after 2 months storage)	13/1/2001 (after 4 months storage)
	Second harvest date 7/10/2000	7/10/2000	14/10/2000	7/12/2000 (after 2 months storage)	14/2/2001 (after 4 months storage)

Data Recorded:

Weight Loss, Decays and Dry Matter Percentages of Stored Tuberous Roots:

All tuberous roots were weighed before storage and every month until the end of storage period;(the percentage of unmarketable roots, due to decays throughout storage period, reached 50%). Then, weight loss and decays were calculated, every month , as a percentage based on the initial roots weight, as well as dry matter content was determined every month of the storage period.

Chemical Constituents of Stored Tuberous Roots:

Carbohydrates percentage:

Sugars:

At the start and the end of storage period, total sugars were estimated by using the method of phenol sulphuric acid proposed by Malik and Singh (1980), and colorimetrically determined using spectrophotometer at 480 nm.

Reducing sugars were determined by using the Nelson method (Woodman, 1947 and A.O.A.C.1970), and colorimetrically measured using spectrophotometer at 540 nm. Meanwhile, the non-reducing sugars were calculated by the difference between total and reducing sugars. Sucrose was calculated by using the following formula:

% Sucrose = Non-reducing sugars × 0.95.

Starch:

It was determined by the direct acid hydrolysis method using concentrated HCl for 2.5 hours. The reducing sugars of the resulted hydrolyzed was determined by Nelson method (Woodman,1947 and

A.O.A.C.1970). Starch was calculated by multiplying the obtained reducing sugars content by a 0.9 conversion factor.

All carbohydrates were expressed as percent on the dry weight basis.

Total carotenoids content:

Fresh roots samples of 5 g each were used to determine the total carotenoids. The pigments were extracted by using acetone hexane solvent (4: 6, *V: V*). The pigment solution in hexane was measured at 450 nm on a spectrophotometer. It was determined as mg/100g fresh weight as described in A.O.A.C. (1970).

Crude fibers percentage:

The crude fibers content were determined as mentioned in A.O.A.C. (1970) using sulphuric acid solution for 30 minutes and then sodium hydroxide solution for 30 minutes, then dried in Gooch crucible at electric muffle furnace at 110°C for 6 hours until constant weight then cooled and weighed. The crude fibers were determined as percentage and calculated by the following formula:

$$\text{\% Crude fibers} = \frac{100 \times \text{Loss of weight noted}}{\text{Weight of sample}}$$

Statistical Analyses:

The recorded data were statistically analyzed according to Al-Rawi and Khalf-Allah (1980). The revised L.S.D. test was used to compare the differences between the means of the studied treatments.

RESULTS AND DISCUSSTION

Weight Loss Percentage of Stored Tuberous Roots

The results of both seasons showed that the weight loss percentage during various studied periods of storage were clearly influenced by harvesting date (Table 2). Delaying harvesting of tuberous roots lowered the percentage of weight loss throughout the first two storage periods; 30 and 60 days. Whereas, increasing the storage period up to 120 days with late harvested date significantly increased the percentage of weight loss in the first season only.

Table (2) shows that the pre-harvest application of different levels of NK did not significantly differ in their effects on the percentage of weight loss during 30-120 days of storage. However, crop produced using fertilization treatment of (40-0 Kg N-K_2O/fed) showed the highest weight loss percentage during storage. Similar results were reported by Duncan *et al.* (1958), and Hammett and Miller (1982), who reported that the application of nitrogen and potassium fertilizers to sweet potato plants did not influence the weight loss of tuberous roots during storage period. Lutz *et al.* (1949) found that the weight loss percentage of stored sweet potato tuberous roots was increased with increasing the level of applied nitrogen from 200 to 1000 pound/acre. Also, Hammett and Miller (1982) indicated that increasing the level of applied N from 101 to 202 Kg N/ha was accompanied with significant increases in weight loss of tuberous roots of sweet potato throughout the storage period. Meanwhile, El-Seifi *et al.* (1990) reported that weight loss decreased with increasing potassium rate, during three months of storage.

The results of the two seasons, also, clarified that the weight loss percentage during storage was less in cured sweet potato tuberous roots than uncured ones throughout the first two storage periods; 30 and 60 days (Table 2). Where, one of the main objectives of curing sweet potatoes is to induce formation of wound periderm over cuts and bruises to prevent subsequent decay and weight loss during storage. Picha (1986) reported that transpiration was the main cause of weight loss of sweet potato roots during storage. He added that transpiration is expected to be high after harvest due to the unavoidable cracking and wounding which happens during separation of root from the vine. Many investigators noticed that there were relationship between the curing treatment of stored sweet potato tuberous roots and weight loss, such as Lauritzen (1935), Appleman *et al.* (1943) and Strider and McCombs (1958) who pointed that rot and moisture loss problems may be effectively controlled by properly curing of the roots. Also, Scott and Matthews (1957) indicated that the weight loss was more rapid during the curing period and during six months of storage than during the two to four months of storage period.

The results of both seasons (Table 2) reveal that pre-harvest application of 40-0 Kg NK_2O/fed resulted in maximum increase of weight loss percentage in early harvested tuberous roots after 30 and 60 days of storage periods, however, such an interaction did not reflect any significant effect on weight loss percentage after 90 and 120 days of storage. On the other hand, weight loss percentage showed the lowest value with late harvest date (150 days from transplanting) when fertilization with 20-36 Kg N-K_2O/fed was applied.

The comparisons among the means of various treatments combinations, listed in Table 2, indicated the presence of clear interaction effects between harvesting date and curing on weight loss after 30 and 60 days of storage periods. The results of the two seasons cleared that after 60 days of storage, the cured crop showed lower percentages of weight loss as compared with uncured one in the two studied harvesting dates. The percentage of weight loss increased with prolonging the storage period from 30 to 60 days.

The results reflecting the effects of the first degree interaction between curing and NK fertilization, in the two seasons, are listed in Table 2. Weight loss percentage was low in cured tuberous roots during storage of crop produced with the different NK levels of fertilization. The percentages of weight loss increased with prolonging the storage period up to 60 days. Uncured tubers produced from the pre-harvest fertilization treatment of 40-0 Kg N-K_2O/fed showed higher levels of weight loss percentage during storage period, in both seasons.

Decays Percentage of Stored Tuberous Roots:

As for the effect of harvesting date on the percentage of decays of stored tuberous roots, the results in Table 3, generally, show that tubers' decays percentage, during post harvest storage, were clearly influenced by harvest date. Early harvested crop (120 days after transplanting) showed increasing decays during 30-60 days of storage then decreased after 90 days of storage, in 1999/2000 season. Late harvested crop (150 days after transplanting) produced lower percentage of decays through the first three periods of storage; 30, 60, and 90 days, than those of early harvesting date, in both seasons.

Concerning the effects of NK fertilization on the decays percentage of stored tubers, the results in Table 3 indicated that the percentage of decays did not significantly respond to the different NK levels after 30, 60 and 90 days of storage, whereas, the highest increase was attained with the fertilization treatment of 40-72 Kg NK_2O/fed. Increasing the time of storage up to 120 days produced the highest decays percentage. Similar results were reported by Lutz et al. (1949) who found that the decays percentages of stored tuberous roots of sweet potato were increased with increasing the level of applied nitrogen from 200 to 1000 pound/acre.

Regarding the effect of curing, the results of the two seasons Table 3 illustrate that decays percentage during various storage periods was less in cured tuberous roots than that of uncured one. Increasing the storage period tended to increase the percentage of decays. Walter and Schadel (1982) reported that curing of sweet potatoes tubers by holding them under conditions of high temperature and humidity is practiced primarily to increase storability by promoting the wound healing process and retard microbial decays and weight loss.

Table 2 : Effects of harvesting date, N-K fertilization and curing on the percentage of weight loss of stored sweet potato tuberous roots in the two seasons of 1999/2000 and 2000/2001.

Treatments			Weight loss (%)							
			1999/2000				2000/2001			
Harvest date (days)	N-K level (Kg /fed)	Curing process	Days of storage				Days of storage			
			30	60	90	120	30	60	90	120
120			11.8 A**	18.9 A	12.2 A	9.9 B	12.8 A	20.0 A	13.3 A	15.2 A
150			7.8 B	12.8 B	12.2 A	11.2 A	8.8 B	13.8 B	13.3 A	15.9 A
	0-0		9.6 A	14.7 A	12.7 A	9.7 A	10.6 A	15.7 A	13.8 A	15.5 A
	20-36		9.5 A	14.9 A	11.7 A	10.8 A	10.5 A	15.9 A	12.6 A	15.5 A
	40-0		10.0 A	17.2 A	12.7 A	11.3 A	11.0 A	18.2 A	14.0 A	16.2 A
	40-72		10.2 A	16.6 A	11.7 A	10.4 A	11.2 A	17.6 A	12.9 A	14.8 A
		C_1*	14.6 A	23.0 A	--	--	15.6 A	24.0 A	--	--
		C_2	5.0 B	8.7 B	--	--	6.0 B	9.7 B	--	--
120	0-0		11.3 ab	17.9 ab	12.5 a	9.0 a	12.3 ab	18.9 ab	13.5 a	15.7 a
	20-36		11.8 ab	18.6 a	12.0 a	10.4 a	12.8 ab	19.7 a	13.0 a	14.8 a
	40-0		12.8 a	22.3 a	12.8 a	11.3 a	13.8 a	23.3 a	14.1 a	16.2 a
	40-72		11.3 ab	16.9 a-c	11.6 a	8.9 a	12.3 ab	17.9 a-c	12.7 a	13.9 a
150	0-0		7.9 c	11.4 c	12.9 a	10.3 a	8.9 c	12.4 c	14.1 a	15.3 a
	20-36		7.1 c	11.2 c	11.4 a	11.2 a	8.1 c	12.2 c	12.2 a	16.3 a
	40-0		7.2 c	12.1 bc	12.6 a	11.3 a	8.2 c	13.1 bc	13.9 a	16.3 a
	40-72		9.1 bc	16.3 a-c	11.8 a	12.0 a	10.1 bc	17.3 a-c	13.1 a	15.6 a
120		C_1	19.0 a**	28.7 a	--	--	20.0 a**	29.7 a	--	--
		C_2	4.6 c	9.2 c	--	--	5.6 c	10.2 c	--	--
150		C_1	10.2 b	17.3 b	--	--	11.2 b	18.3 b	--	--
		C_2	5.4 c	8.2 c	--	--	6.4 c	9.2 c	--	--
	0-0	C_1	14.0 a	21.7 a	--	--	15.0 a	22.7 a	--	--
		C_2	5.2 b	7.7 b	--	--	6.2 b	8.7 b	--	--
	20-36	C_1	14.6 a	22.0 a	--	--	15.6 a	23.0 a	--	--
		C_2	4.3 b	7.6 b	--	--	5.3 b	8.9 b	--	--
	40-0	C_1	15.3 a	25.2 a	--	--	16.3 a	26.2 a	15.3 a	25.2 a
		C_2	4.8 b	9.1 b	--	--	5.8 b	10.1 b	--	--
	40-72	C_1	14.5 a	23.2 a	--	--	15.5 a	24.2 a	--	--
		C_2	5.8 b	10.1 b	--	--	6.8 b	11.1 b	--	--

*C_1 and C_2 = uncured and cured tubers, respectively.

**Values having the same alphabetical letter in common, *within* a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level.

Decays Percentage of Stored Tuberous Roots:

As for the effect of harvesting date on the percentage of decays of stored tuberous roots, the results in Table 3, generally, show that tubers' decays percentage, during post harvest storage, were clearly influenced by harvest date. Early harvested crop (120 days after transplanting) showed increasing decays during 30-60 days of storage then decreased after 90 days of storage, in 1999/2000 season. Late harvested crop (150 days after transplanting) produced lower percentage of decays through the first three periods of storage; 30, 60, and 90 days, than those of early harvesting date, in both seasons.

Concerning the effects of NK fertilization on the decays percentage of stored tubers, the results in Table 3 indicated that the percentage of decays did not significantly respond to the different NK levels after 30, 60 and 90 days of storage, whereas, the highest increase was attained with the fertilization treatment of 40-72 Kg NK_2O/fed. Increasing the time of storage up to 120 days produced the highest decays percentage. Similar results were reported by Lutz et al. (1949) who found that the decays percentages of stored tuberous roots of sweet potato were increased with increasing the level of applied nitrogen from 200 to 1000 pound/acre.

Regarding the effect of curing, the results of the two seasons Table 3 illustrate that decays percentage during various storage periods was less in cured tuberous roots than that of uncured one. Increasing the storage period tended to increase the percentage of decays. Walter and Schadel (1982) reported that curing of sweet potatoes tubers by holding them under conditions of high temperature and humidity is practiced primarily to increase storability by promoting the wound healing process and retard microbial decays and weight loss.

Table 2 : Effects of harvesting date, N-K fertilization and curing on the percentage of weight loss of stored sweet potato tuberous roots in the two seasons of 1999/2000 and 2000/2001.

Harvest date (days)	N-K level (Kg /fed)	Curing process	Weight loss (%) 1999/2000 Days of storage 30	60	90	120	2000/2001 Days of storage 30	60	90	120
120			11.8 A**	18.9 A	12.2 A	9.9 B	12.8 A	20.0 A	13.3 A	15.2 A
150			7.8 B	12.8 B	12.2 A	11.2 A	8.8 B	13.8 B	13.3 A	15.9 A
	0-0		9.6 A	14.7 A	12.7 A	9.7 A	10.6 A	15.7 A	13.8 A	15.5 A
	20-36		9.5 A	14.9 A	11.7 A	10.8 A	10.5 A	15.9 A	12.6 A	15.5 A
	40-0		10.0 A	17.2 A	12.7 A	11.3 A	11.0 A	18.2 A	14.0 A	16.2 A
	40-72		10.2 A	16.6 A	11.7 A	10.4 A	11.2 A	17.6 A	12.9 A	14.8 A
		C_1*	14.6 A	23.0 A	–	–	15.6 A	24.0 A	–	–
		C_2	5.0 B	8.7 B	–	–	6.0 B	9.7 B	–	–
120	0-0		11.3 ab	17.9 ab	12.5 a	9.0 a	12.3 ab	18.9 ab	13.5 a	15.7 a
	20-36		11.8 ab	18.6 a	12.0 a	10.4 a	12.8 ab	19.7 a	13.0 a	14.8 a
	40-0		12.8 a	22.3 a	12.8 a	11.3 a	13.8 a	23.3 a	14.1 a	16.2 a
	40-72		11.3 ab	16.9 a-c	11.6 a	8.9 a	12.3 ab	17.9 a-c	12.7 a	13.9 a
150	0-0		7.9 c	11.4 c	12.9 a	10.3 a	8.9 c	12.4 c	14.1 a	15.3 a
	20-36		7.1 c	11.2 c	11.4 a	11.2 a	8.1 c	12.2 c	12.2 a	16.3 a
	40-0		7.2 c	12.1 bc	12.6 a	11.3 a	8.2 c	13.1 bc	13.9 a	16.3 a
	40-72		9.1 bc	16.3 a-c	11.8 a	12.0 a	10.1 bc	17.3 a-c	13.1 a	15.6 a
120		C_1	19.0 a**	28.7 a	–	–	20.0 a**	29.7 a	–	–
		C_2	4.6 c	9.2 c	–	–	5.6 c	10.2 c	–	–
150		C_1	10.2 b	17.3 b	–	–	11.2 b	18.3 b	–	–
		C_2	5.4 c	8.2 c	–	–	6.4 c	9.2 c	–	–
	0-0	C_1	14.0 a	21.7 a	–	–	15.0 a	22.7 a	–	–
		C_2	5.2 b	7.7 b	–	–	6.2 b	8.7 b	–	–
	20-36	C_1	14.6 a	22.0 a	–	–	15.6 a	23.0 a	–	–
		C_2	4.3 b	7.6 b	–	–	5.3 b	8.9 b	–	–
	40-0	C_1	15.3 a	25.2 a	–	–	16.3 a	26.2 a	15.3 a	25.2 a
		C_2	4.8 b	9.1 b	–	–	5.8 b	10.1 b	–	–
	40-72	C_1	14.5 a	23.2 a	–	–	15.5 a	24.2 a	–	–
		C_2	5.8 b	10.1 b	–	–	6.8 b	11.1 b	–	–

*C_1 and C_2 = uncured and cured tubers, respectively.

**Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level.

Dry matter Percentage of Stored Tuberous Roots:

Regarding the effects of harvesting date on the percentage of dry matter, the results showed that the two harvest dates did not significantly differ in their effects on the percentages of dry matter during 60-120 days of storage, Table 4. However, the dry matter, in the early harvested crop (120 days after transplanting), increased with the progress of storage period up to 90 days then decreased, in both seasons.

The results in Table 4 show that the pre-harvest application of different NK levels did not significantly differ in their effects on the dry matter percentage after 30, 60 and 120 days of storage. The highest significant increase of tubers' dry matter percentage, after 90 days of storage, was obtained in tubers resulted from plants fertilized with 40-72 Kg N-K_2O/fed, in the both seasons. The point of interest is dry matter percentage decreased with all levels of fertilization at the end of storage. Similar results were found by Hammett and Miller (1982) who reported that dry matter content of stored tubers was reduced by increasing nitrogen rates. In fact, N fertilizer considers as one of the main factors that affect the roots quality of sweet potato, since high N applied rate decrease the roots' content of dry matter.

The percentage of dry matter did not significantly respond to curing process, in both seasons(Table,4). Similar results were found by McCombs and Pope (1958) who found that dry matter content decreased during storage. However, curing process had no significant effect on the dry matter content of stored tubers.

Table 4: Effects of harvesting date, NK fertilization and curing on the percentage of dry matter content of stored sweet potato tuberous roots in the two seasons of 1999/2000 and 2000/2001.

Treatments			Dry matter (%)									
			1999/2000					2000/2001				
			Days of storage					Days of storage				
Harvest date (days)	N-K level (Kg /fed)	Curing process	0	30	60	90	120	0	30	60	90	120
120			13.8A	17.0A	15.2A	17.1A	13.8A	19.0A	22.0A	20.2A	19.1A	18.4A
150			15.7A	14.6B	14.0A	18.3A	13.4A	20.7A	19.6B	19.0A	20.4A	18.1A
	0-0		14.3A	14.9A	12.9A	16.9B	14.6A	19.3A	19.9A	17.9A	19.0B	18.7A
	20-36		14.3A	14.6A	13.9A	16.1B	12.9A	19.3A	19.6A	18.9A	18.2B	17.9A
	40-0		15.4A	16.7A	16.4A	17.5B	13.0A	20.8A	21.7A	21.4A	19.5B	18.1A
	40-72		15.1A	17.1A	15.1A	20.2A	13.9A	20.1A	22.4A	20.1A	22.2A	18.2A
		C_1*	14.4A	16.5A	14.8A	–	–	19.4A	21.5A	19.8A	–	–
		C_2	15.2A	15.1A	14.3A	–	–	20.4A	20.1A	19.3A	–	–
120	0-0		13.8b	14.9ab	14.3ab	17.6b	18.5a	18.8b	19.9ab	19.3ab	19.7b	21.8 a
	20-36		13.5b	15.8ab	14.5ab	16.2b	13.1ab	18.5b	20.8ab	19.5ab	18.2b	18.1ab
	40-0		13.4b	18.7 a	15.8 b	16.8b	10.7 b	19.2b	23.7 a	20.8ab	18.8b	15.7 b
	40-72		14.7ab	18.6 a	16.0ab	17.7b	13.0ab	19.7ab	23.6 a	21.0ab	19.5b	17.8ab
150	0-0		14.8ab	14.9ab	11.5 b	16.3b	10.6 b	19.8ab	19.9ab	16.5 b	18.3b	15.7 b
	20-36		15.1ab	13.4 b	13.4ab	16.0b	12.7 b	20.1ab	18.4 b	18.4ab	18.2b	17.7ab
	40-0		17.5 a	14.7ab	16.9 a	18.2b	15.4ab	22.5 a	19.7ab	21.9 a	20.2b	20.4ab
	40-72		15.5ab	15.5ab	14.2ab	22.6a	14.8ab	20.5ab	20.5ab	19.2ab	24.9a	18.6ab
120		C_1	13.0 a	19.3 a	16.7 a	–	–	18.0 a	24.3 a	21.7 a	–	–
		C_2	14.7 a	14.7ab	13.6 b	–	–	20.1 a	19.7ab	18.6 b	–	–
150		C_1	15.7 a	13.7 b	12.9 b	–	–	20.7 a	18.7 b	17.9 b	–	–
		C_2	15.7 a	15.5ab	15.0ab	–	–	20.7 a	20.5ab	20.0ab	–	–
	0-0	C_1	14.8 a	15.1ab	12.3 b	–	–	19.8ab	20.1ab	17.3 b	–	–
		C_2	13.8 a	14.7ab	13.5ab	–	–	18.8ab	19.7ab	18.5ab	–	–
	20-36	C	12.7 a	15.1ab	14.6ab	–	–	17.7 b	20.1ab	19.6ab	–	–
		C_2	15.9 a	14.1 b	13.2ab	–	–	20.9 a	19.1 b	18.2ab	–	–
	40-0	C_1	15.2 a	18.4 a	17.9 a	–	–	20.2ab	23.4 a	22.9 a	–	–
		C_2	15.6 a	15.0ab	14.8ab	–	–	21.5 a	20.0ab	19.8ab	–	–
	40-72	C_1	14.8 a	17.5ab	14.5ab	–	–	19.8ab	22.5ab	19.5ab	–	–
		C_2	15.5 a	16.6ab	15.7ab	–	–	20.5ab	21.6ab	20.7ab	–	–

*C_1 and C_2 = uncured and cured tubers, respectively.

**Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level.

Regarding the effects of the interaction between harvesting date and NK fertilization, the results showed that dry matter percentages, after 60 and 90 days of storage, were at the highest values with late harvest date (150 days from transplanting) and fertilization with 40-0 and 40-72 Kg N-K_2O/fed, respectively, in both seasons.

The statistical comparisons, listed in Table 4 indicated the presence of clear interaction effects, between harvesting date and curing on the dry matter percentage of stored sweet potato tuberous roots at 30 and 60 days of storage periods in the two seasons. The percentage of dry matter was high in uncured crop of early harvest date as well as the cured roots of the late harvest date, in both seasons.

The results reflecting the effects of the interaction between curing and N-K fertilization, in the two seasons, are listed in Table 4. Uncured tubers produced from the pre-harvest fertilization treatment of 40-0 Kg N-K_2O/fed exhibited higher levels of dry matter percentage during storage period, in both seasons.

Chemical Constituents of Stored Tuberous Roots:

Carbohydrates percentage:

Data presented in Fig. 1 clarify the effects of harvest date on carbohydrates percentage of stored tuberous roots in 1999/2000 and 2000/2001 seasons. The results indicated that late harvested tuberous roots (150 days from transplanting) contained higher percentages of total sugars, reducing and non-reducing sugars as well as sucrose at the end of storage time, than those of early harvested crop (120 days after transplanting),. Meanwhile, the percentage of starch tended to decrease in late harvested tubers with prolonging the storage period. The results of the two seasons indicated also that the percentages of total and non-reducing sugars and sucrose were increased with the progress of storage, while, decreased the percentage of starch content, in both studied seasons. The results revealed, also, that the two harvest dates did not significantly differ in their effects on tubers' contents of all analyzed chemical constituents at the beginning of the storage.

The results of the two seasons (Fig. 2) reveal that pre-harvest application of 20-36 Kg N-K_2O/fed produced tubers with the highest contents of total and non-reducing sugars, as well as sucrose at the beginning and end of storage period. Meanwhile, increasing the level of pre-harvest fertilization of N-K_2O up to 40-72 Kg/fed significantly increased the percentages of reducing sugars and starch, at the end of storage period. Increasing the storage period tended to increase the stored tubers' contents of total and non-reducing sugars and sucrose, while decreased the contents of reducing sugars and sucrose, in both seasons. These results may attribute to the physiological activities of tuberous roots during storage. It might also be the result of starch break down by enzymes activities. Similar results were reported by Hammett and Miller (1982) who found that carbohydrate content of stored tubers decreased with increasing the rate of pre-harvest application of nitrogen and potassium fertilizers up to 202 and 280 Kg/ha, respectively. Sharfuddin and Voican (1984) showed that the applying mineral fertilizers increased glucose but decreased starch contents after four months of storage in pits at 8-10°C and 80-85% RH.

As for influence of curing on the chemical constituents of stored tubers, the results of the two seasons (Fig. 3) indicate that the cured tubers significantly contained higher percentages of total sugars, non-reducing sugars and sucrose than those of uncured tubers, at the end of storage period. Increasing the period of storage increased most of the determined chemical constituents. The higher content of chemical constituents of tuberous roots, after storage, were the result of the break down of starch during storage period. Similar results were found by Scott and Matthews (1957), McCombs and Pope (1958), Reddy and Sistrunk (1980), Jenkins (1982), Walter and Hoover (1984) and Picha (1987), who reported an increase in carbohydrates during curing and several months of storage.

The results reflecting the influences of the interaction between harvesting date and N-K levels are shown in Table 5 . The results illustrated that pre-harvest application of 20-36 Kg N-K_2O/fed, resulted in significant increases in the percentages of total and non-reducing sugars as well as sucrose in late harvested tubers at the beginning and end of storage. When pre-harvest fertilization of 40-72 Kg N-K_2O/fed was used, early harvested tuberous roots, stored for 120 days, showed an increase in reducing sugars. Late harvested tubers showed lower values of starch in response to all N-K levels as compared with early harvested one throughout the storage period. The results, generally, showed that total and non-reducing sugars as well as sucrose percentages increased during storage period, while reducing sugars and starch decreased.

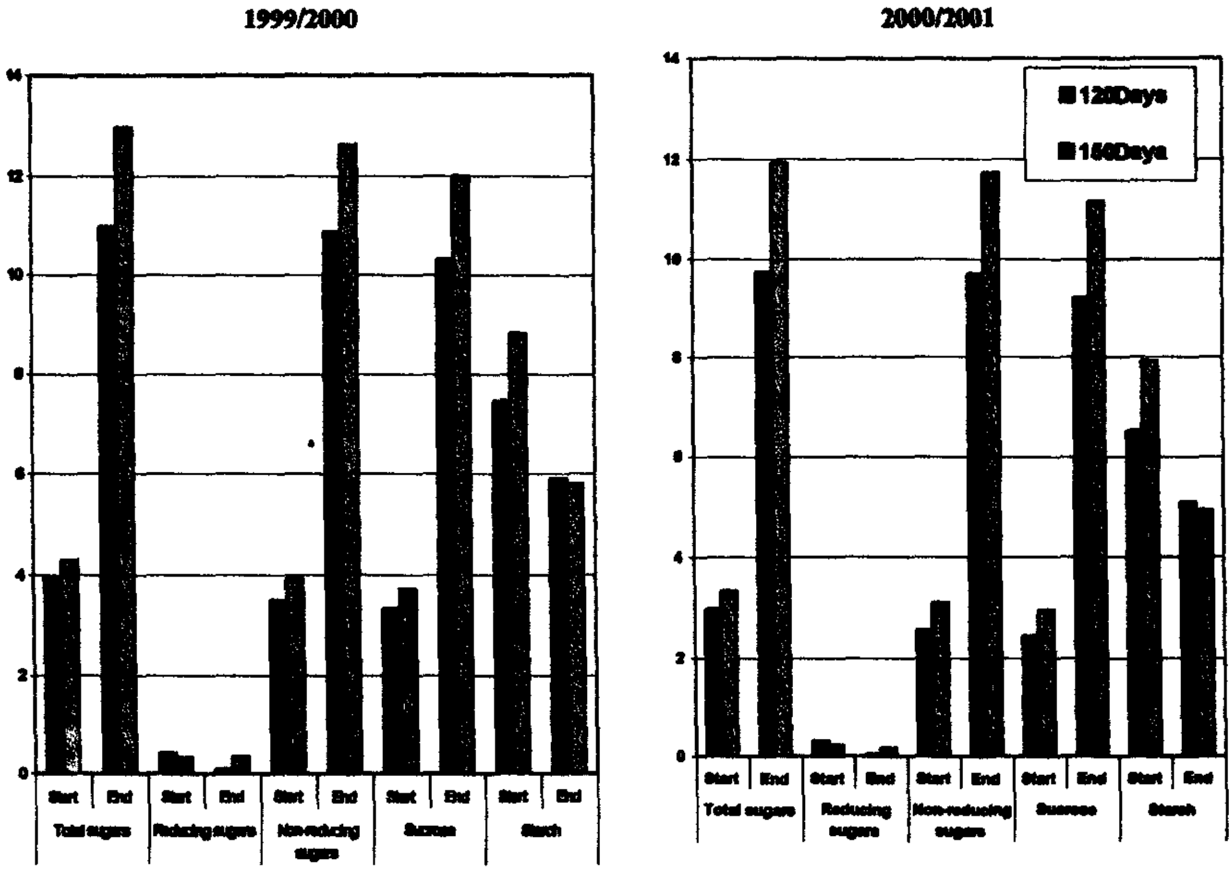

Fig. 1: Effects of harvesting date on carbohydrates (%) of stored sweet potato tuberous roots in 1999/ 2000 and 2000/2001 seasons.

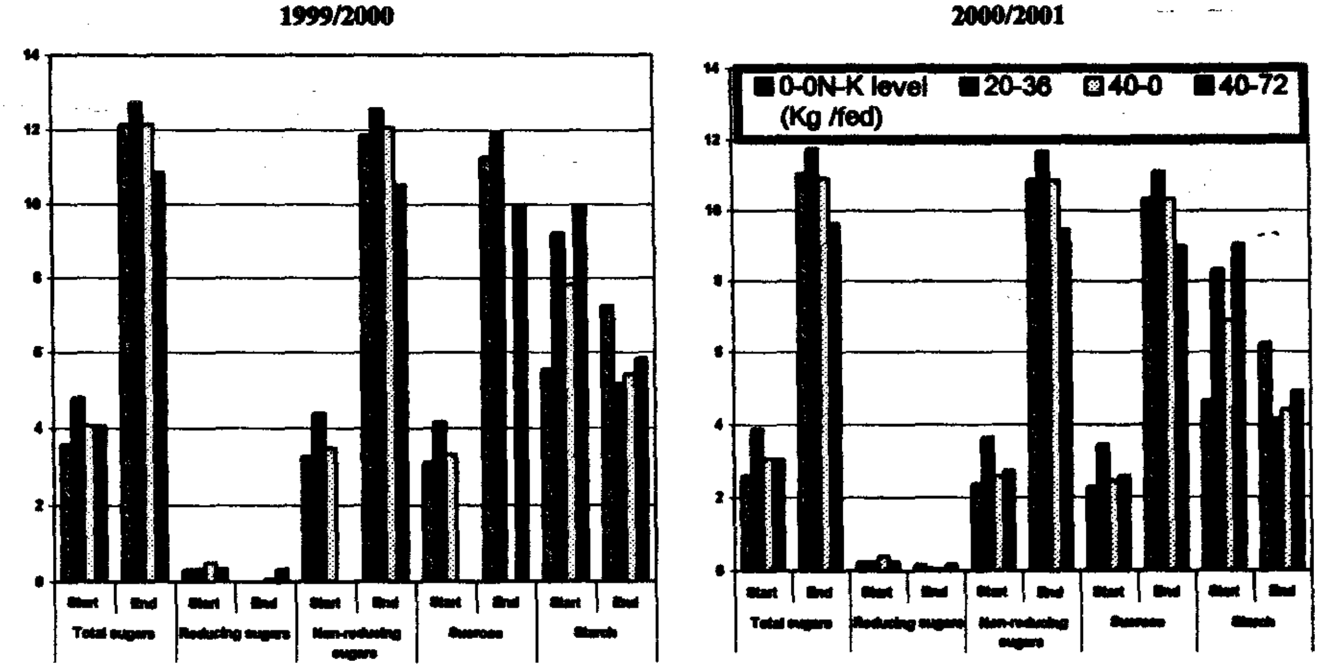

Fig. 2: Effects of NK fertilization on carbohydrates (%) of stored sweet potato tuberous roots in 1999/2000 and 2000/2001 seasons.

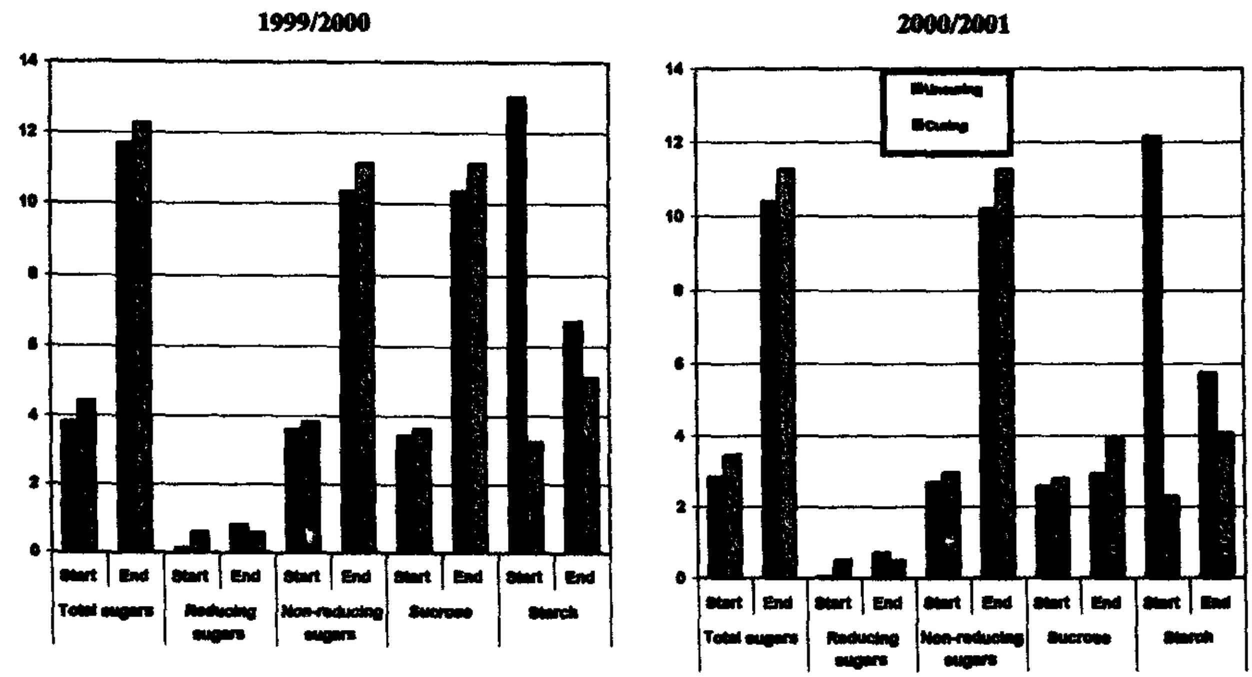

Fig. 3:Effects of curing treatments on carbohydrates (%) of stored sweet potato tuberous roots in 1999/ 2000 and 2000/2001 seasons.

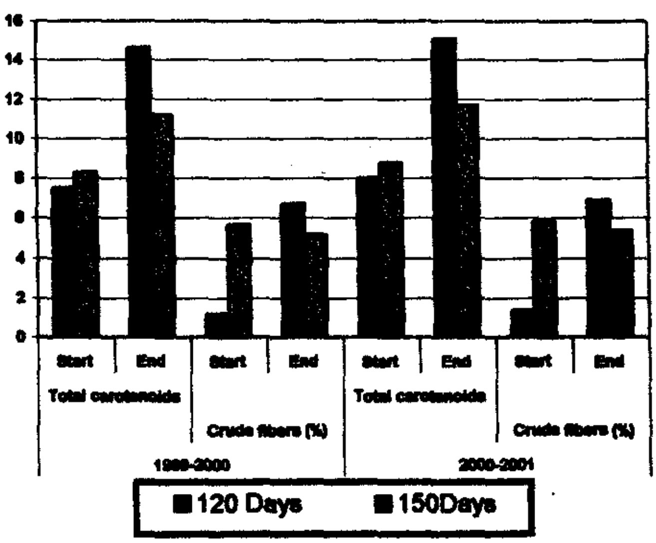

Fig. 4 :Effects of harvest date on total carotenoids and crude fibers (%) of stored sweet potato tuberous roots in 1999/ 2000 and 2000/2001 seasons.

Table 5 : Effects of the first degree interaction between each of two of the three main factors; harvesting date, NK fertilization and curing on carbohydrates (%) of stored sweet potato tuberous roots in 1999/2000 and 2000/2001 seasons.

Treatments			Carbohydrates (%)									
Harvest date (days)	N-K level (Kg /fed)	Curing process	Total sugars		Reducing sugars		Non-reducing sugars		Sucrose		Starch	
			Start of storage	End of storage**	Start of storage	End of storage	Start of storage	End of storage	Start of storage	End of storage	Start of storage	End of storage
1999/2000												
120	0-0		3.41 d*	11.20 e	0.42 b	0.11 b	2.99 cd	11.09 c	2.84 cd	10.53 c	6.35 bc	7.44 a
	20-36		3.93 cd	11.70de	0.35 c	0.07 b	3.58 bc	11.64 c	3.40 bc	11.06 c	9.77ab	5.27 b
	40-0		5.12 ab	11.47de	0.60 a	0.10 b	4.38 ab	11.37 c	4.16 a	10.80 c	6.36 bc	5.56 b
	40-72		3.41 d	9.52 f	0.30 d	0.14 b	3.11 cd	9.38 d	2.96 cd	8.91 d	7.40 bc	5.38 b
150	0-0		3.78 cd	13.10 b	0.23 e	0.47 a	3.55 bc	12.63 b	3.38 bc	11.99 b	4.75 c	7.07 a
	20-36		5.67 a	13.82 a	0.33cd	0.32 ab	5.18 a	13.50 a	4.92 a	12.83 a	8.67ab	5.02 b
	40-0		3.03 d	12.84bc	0.43 b	0.06 b	2.60 d	12.78 ab	2.48 d	12.14ab	9.28ab	5.60 b
	40-72		4.70 bc	12.16cd	0.35 c	0.52 a	4.35 ab	11.64 c	4.13 ab	11.05 c	12.52 a	5.45 b
120		C1	3.46 a	10.87 c	0.16 c	1.06 a	3.22 a	9.32 d	3.06 a	9.32 d	11.49 a	6.08ab
		C2	4.47 a	11.75 b	0.68 a	0.59 b	3.81 a	10.60 c	3.62 a	10.60 c	3.45 b	6.46ab
150		C1	4.21 a	12.21 b	0.14 c	0.56 b	3.99 a	11.07 b	3.79 a	11.07b	14.57 a	7.37 a
		C2	4.38 a	13.75 a	0.53 b	0.58 b	3.85 a	12.51 a	3.67 a	12.51a	3.04 b	3.72 c
	0-0	C1	3.13 d	11.69 c	0.12 e	1.02 a	3.01 c	10.67c	2.86 c	10.14 c	9.02 b	6.71 b
		C2	4.06 bc	12.62 b	0.53 b	0.72 bc	3.53 bc	11.90b	3.36 bc	11.31 b	2.09 c	7.78 a
	20-36	C1	4.41 a-c	12.37 b	0.14 e	0.70 c	4.10 ab	11.67b	3.90 ab	11.09 e	14.42 a	7.28ab
		C2	5.20 a	13.16a	0.54 b	0.55 de	4.66 a	12.61a	4.42 a	11.98 a	4.02 c	3.00 e
	40-0	C1	3.47 cd	11.55 c	0.16de	0.86 b	3.15 c	10.69c	2.99 c	10.16 c	13.67 a	5.31 c
		C2	4.68 ab	12.76 b	0.87 a	0.53 de	3.84 ab	12.23a	3.65 ab	11.62 a	1.97 c	5.50 c
	40-72	C1	4.34 a-c	11.13c	0.18 d	0.66 cd	4.16 ab	10.47c	3.95 ab	9.95 c	15.00 a	7.59 a
		C2	3.77 b-d	10.56d	0.48 c	0.52 e	3.30 bc	10.04d	3.14 bc	9.54 d	4.92 c	4.07 d
2000/2001												
120	0-0		2.41 d	10.00 d	0.32 b	0.05 c	2.09 c	9.95 d	2.03 c	9.45 d	5.50 bc	6.42a
	20-36		2.93cd	10.70 c	0.25 c	0.02 c	2.68 bc	10.69 c	2.55bc	10.16c	8.80 ab	6.08a
	40-0		4.12ab	10.10 d	0.50 a	0.05 c	3.45 b	10.06 d	3.28 b	9.56 d	5.37 bc	4.22c
	40-72		2.41 d	8.15 e	0.23 d	0.06 bc	2.01 c	8.09 e	1.91 c	7.69 e	6.40 bc	4.07c
150	0-0		2.78cd	12.07 b	0.13 e	0.27 a	2.65 bc	11.81 b	2.52bc	11.22b	3.75 c	4.49c
	20-36		4.84 a	12.79 a	0.23 d	0.11 b	4.61 a	12.68 a	4.38 a	12.05a	7.83 ab	4.32c
	40-0		2.03 d	11.71 b	0.33 b	0.01 c	1.70 c	11.70 b	1.62 c	11.12b	8.38 ab	5.23b
	40-72		3.70bc	11.13 c	0.25 c	0.30 a	3.44 b	10.82 c	3.27 b	10.28c	11.70 a	5.29b
120		C1	2.46 a	9.64 c	0.06 c	0.96 a	2.24 a	9.36 d	2.15 a	2.33 d	10.58 a	5.08ab
		C2	3.47 a	9.84 c	0.59 a	0.49 b	2.88 a	10.05 c	2.74 a	2.99 c	2.45 b	5.46ab
150		C1	3.21 a	11.16 b	0.04 c	0.46 b	3.17 a	11.04b	3.01 a	3.51 b	13.73 a	6.45 a
		C2	3.46 a	12.70a	0.43 b	0.48 b	3.03 a	12.47a	2.88 a	4.93 a	2.10 b	2.71 b
	0-0	C1	2.13 d	10.37 c	0.02 h	0.92 a	2.11 c	10.05 c	2.05 c	1.28 e	8.17 b	5.71 b
		C2	3.06 b-d	11.72 b	0.43 c	0.62 bc	2.63 bc	11.71b	2.50bc	2.86 d	1.09 c	6.78 a
	20-36	C1	3.41 a-c	10.06 c	0.04 g	0.60 c	3.37 ab	10.02c	3.20ab	1.34 e	13.45 a	6.28ab
		C2	4.36 a	13.44 a	0.44 b	0.45 de	3.92 a	13.36a	3.73 a	4.52 a	3.18 c	2.00 e
	40-0	C1	2.47 cd	11.45b	0.06 f	0.76 b	2.25 c	11.25 b	2.14 c	5.36 a	12.85 a	4.31 c
		C2	3.68 ab	10.38bc	0.77 a	0.43 de	2.91 bc	10.51c	2.76bc	4.65 a	0.90 c	4.48 c
	40-72	C1	3.34 bc	9.72 d	0.08 e	0.56 cd	3.09 a-c	9.47d	2.9 a-c	3.68 c	14.17 a	6.75 a
		C2	2.77 b-d	9.56 d	0.41 d	0.42 e	2.36 c	9.46 d	2.24 c	3.81 c	3.94 c	3.07 d

*C_1 and C_2 = uncured and cured tubers, respectively.

**Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level

Regarding the effects of the interaction between harvesting date and curing on the chemical constituents of tuberous roots, Table 5.The results of the two seasons reveal that late harvested (150 days after *transplanting)-cured* tubers, at the end of storage period, contained the highest percentages of total and non-reducing sugars, as well as sucrose contents, in both seasons. Meanwhile, late harvested-uncured tubers showed the highest starch content. The results also indicated that the absence of any significant differences due to the effects of such an interaction on the percentages of total and non-reducing sugars and sucrose, at the beginning of storage, in both seasons.

The interaction effects between the used NK fertilization levels and curing on various chemical constituents of stored tuberous roots, in the two studied seasons, are listed in Table 5. The results of the two studied season indicate that pre-harvest fertilization of 20-36 Kg N-K_2O/fed significantly increased the percentages of total and non-reducing sugars as well as sucrose of cured tuberous roots at the beginning and end of storage. Reducing sugars contents tended to decrease during storage. Pre-harvest application of any N-K levels decreased reducing sugars percentages of both cured and uncured tubers. While, pre-harvest application of 40-72 Kg N-K_2O/fed increased the starch percentage of uncured tuberous roots at the beginning and end of storage.

Total carotenoids and crude fibers:

Data presented in Fig. 4 clarify the effects of harvest date on total carotenoids and crude fibers of stored tuberous roots in 1999/2000 and 2000/2001 seasons. The results indicated that delaying harvesting to 150 days significantly decreased the content of total carotenoids at the end of storage period. Meanwhile, the percentage of crude fibers tended to decrease in late harvested tubers and with prolonging the storage period.

The results of the two seasons (Fig. 5) reveal that increasing the level of pre-harvest fertilization of N-K_2O up to 40-72 Kg/fed significantly increased the percentages of total carotenoids, but decreased the percentage of crude fibers with the progress of storage period. Increasing the storage period tended to increase the stored tubers' contents of total carotenoids, and crude fibers in both seasons.

Concerning the influence of curing on total carotenoids and crude fibers of stored tuberous roots in 1999-2000 and 2000-2001 seasons, the results in Fig. 6 indicat that the cured tubers significantly contained higher percentage of total carotenoids than those of uncured tubers, at the end of storage period. However, curing process lowered the percentage of crude fibers with prolonged the storage period. Similar results were found by Ezell and Wilcox (1958) who showed that storage of cured tubers for several months increased beta-carotene and total carotenoids.

The results reflecting the influences of the interaction between harvesting date and N-K fertilization levels, on total carotenoids and crude fibers of stored tuberous roots, are shown in Table 6. The results indicated clearly that pre-harvest application of 40-72 Kg N-K_2O/fed significantly increased the tubers' contents of total carotenoids before storage as well as at the end of storage period. Crude fibers percentage decreased during storage of late harvested tubers in response to all N-K levels while increased in early harvested one in response to all combinations of N-K levels, in both seasons.

The results (Table 6) indicated that the absence of any significant differences due to the effects of the interaction between harvesting date and curing on the percentage of crude fibers in the two growing seasons. However the best treatment combination which produced the highest significant increases in total carotenoids percentage, at the beginning of storage, appeared to be that involved early harvesting date together with curing process. On the other hand, early harvested-cured roots contained the highest and lowest contents of total carotenoids and crude fibers, respectively with prolonging the storage period.

Regarding the effects of the interaction effects between the used N-K fertilization levels and curing on total carotenoids and crude fibers of stored tuberous roots, the results (Table 6) indicat that cured tubers resulted from plants fertilized with 40-0 Kg N-K_2O/fed contained the highest total carotenoids during storage. On the other hand, cured tubers produced from the pre-harvest application of 40-72 Kg N-K_2O/fed recordedlower crude fibers percentage during storage period, in both seasons.

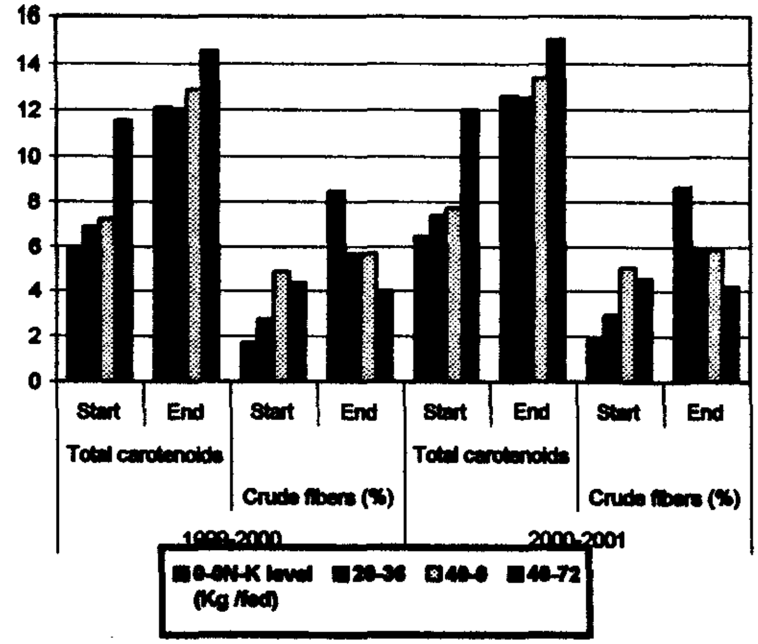

Fig.5 :Effects of NK fertilization on total carotenoids and crude fibers (%) of stored sweet potato tuberous roots in 1999/2000 and 2000/2001 seasons.

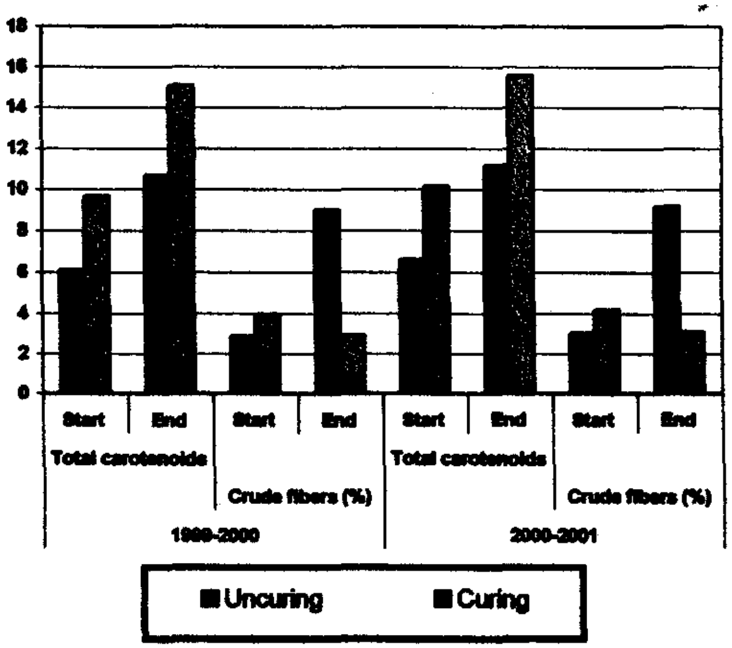

Fig. 6:Effects of curing treatments on total carotenoids and crude fibers (%) of stored sweet potato tuberous roots in 1999/2000 and 2000/2001 seasons.

Generally, the cured tuberous roots of sweet potato produced from plants fertilized with 20-36 Kg/fed of N-K_2O and harvested after 150 days from transplanting, lowered the percentages of weight loss and decays after 30 and 60 days of storage periods, as well as significantly increased total sugars, non-reducing sugars and sucrose contents at the end of storage.

General observations indicated that uncured roots were infected by fungi and bacteria after two months of storage, but cured roots stored well up to four months

Table (6): Effects of the first degree interaction between each of two of the three main factors; harvesting date, N-K fertilization and curing on total carotenoids and crude fibers of stored sweet potato tuberous roots in the two seasons of 1999-2000 and 2000-2001.

Treatments			1999-2000				2000-2001			
Harvest date (days)	N-K level (Kg /fed)	Curing process	Total carotenoids(mg/100g) F.W Base		Crude fibers (%)		Total carotenoids(mg/100g) F.W Base		Crude fibers (%)	
			Start of storage	End of storage***	Start of storage	End of storage	Start of storage	End of storage	Start of storage	End of storage
120	0-0		7.57 bc	15.04 b	1.78 cd	6.29 ab	8.04 bc	15.54 b	1.95 cd	6.49 ab
	20-36		7.12 cd	14.40 b	1.10 cd	8.29 ab	7.62 cd	14.90 b	1.30 cd	8.49 ab
	40-0		7.36 c	17.10 a	0.41 d	7.35 ab	7.86 c	17.60 a	0.61 d	7.52 ab
	40-72		8.03 b	11.89 c	1.44 cd	4.96 ab	8.54 b	12.39 c	1.63 cd	5.13 ab
150	0-0		4.35 e	9.15 de	1.59 cd	10.66 a	4.85 e	9.65 de	1.78 cd	10.85 a
	20-36		6.65 d	9.64 d	4.36 bc	3.01 b	7.15 d	10.14 d	4.56 bc	3.21 b
	40-0		7.11 cd	8.69 e	9.28 a	4.02 b	7.61 cd	9.19 e	9.46 a	4.21 b
	40-72		15.01 a	17.19 a	7.31 ab	3.03 b	15.51 a	17.69 a	7.48 ab	3.23 b
120		C1	4.46 c	10.84 c	0.84 a	11.16 a	4.94 c	11.34 c	1.02 a	11.36 a
		C2	10.58 a	18.38 a	1.53 a	2.28 b	11.09 a	18.88 a	1.73 a	2.45 b
150		C1	7.85 b	10.50 c	4.85 a	6.84 ab	8.35 b	11.00 c	5.04 a	7.04 ab
		C2	8.72 b	11.84 b	6.42 a	3.52 ab	9.22 b	12.34 b	6.60 a	3.71 ab
	0-0	C1	4.68 f	9.42 c	1.03 cd	12.96 a	5.14 f	9.92 c	1.20 cd	13.16 a
		C2	7.25 d	14.77 b	2.34 b-d	3.99 bc	7.75 d	15.27 b	2.53 b-d	4.18 bc
	20-36	C1	5.51 e	9.07 c	4.66 a-c	9.59 ab	6.01 e	9.57 c	4.86 a-c	9.79 ab
		C2	8.25 c	14.97 b	0.80 d	1.71 c	8.75 c	15.47 b	1.00 d	1.91 c
	40-0	C1	3.57 g	9.83 c	3.66 a-d	7.06 bc	4.07 g	10.33 c	3.86 a-d	7.26 bc
		C2	10.90 b	15.96 a	6.03 ab	4.31 bc	11.40 b	16.46 a	6.21 ab	4.48 bc
	40-72	C1	10.85 b	14.36 b	2.03 cd	6.40 bc	11.35 b	14.86 b	2.19 cd	6.60 bc
		C2	12.20 a	14.73 b	6.71 a	1.59 c	12.70 a	15.23 b	6.91 a	1.76 c

*C_1 and C_2 = uncured and cured tubers, respectively.

**Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level.

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الملخص العربى

تأثير ميعاد الحصاد و مستويات التسميد النيتروجيني ــ البوتاسي و العلاج على القدرة التخزينية و المكونات الكيماوية لجذور البطاطا أثناء التخزين

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أجريت تجربتان في مركز التداول و معاملات ما بعد الحصاد ــ كلية الزراعة ــ جامعة الإسكندرية وذلك خلال موسمي ١٩٩٩/٢٠٠٠ ، ٢٠٠٠/٢٠٠١ ، لتتبع تأثير مواعيد الحصاد (بعد ١٥٠،١٢٠ يوماً من الشتل) و لأربعة مستويات من التسميد النيتروجيني ــ البوتاسي معاً (كنترول ، ٢٠- ٣٦ ، ٤٠- صفر ، ٤٠- ٧٢ كجم ن- بو٢أ/ فدان) ، و كذلك عملية العلاج (بدون علاج ، علاج) والتداخل بينهم على القدرة التخزينية و المكونات الكيماوية لجذور البطاطا (صنف أبيس) خلال التخزين .

و قد أظهرت النتائج أن تأخير ميعاد الحصاد لجذور البطاطا أدى إلى خفض النسب المئوية لكل من الفقد في الوزن ، و إصابة الجذور بالأعفان و المادة الجافة بالجذور بعد ٣٠ و ٦٠ يوماً من التخزين ، بينما تأخير ميعاد الحصاد مع إطالة فترة التخزين إلى ١٢٠يوماً أدى إلى زيادة معنوية في النسبة المئوية لاصابة الجذور بالأعفان و الفقد في الوزن و محتوى الجذور من السكريات الكلية و المختزلة و غير مختزلة ، و السكروز ، و الكاروتينات الكلية ، في حين أدى إلى خفض محتوى الدرنات من النشا.

ولوضحت النتائج أيضا أن جذور البطاطا التي نتجت عن نباتات سمدت بحوالي ٢٠ــ٣٦ كجم ن- بو٢أ/ فدان كانت أعلى في محتواها من السكريات الكلية و الغير مختزلة ، و السكروز في بداية و نهاية التخزين ، بينما زيادة معدلات التسميد حتى ٤٠ــ٧٢ كجم ن-

بو٢أ/ فدان أدي إلي زيادة النسبة المئوية لاصابة الجذور بالأعفان، و محتواها من السكريات المختزلة ، و النشا ، و الكاروتينات الكلية ، و أدي كذلك إلي نقص محتوى الجذور من الألياف الخام و ذلك في نهاية فترة تخزين الجذور.

أظهرت النتائج أيضا أن إجراء عملية العلاج للجذور قبل التخزين أدى إلي نقص النسبة المئوية للفقد في الوزن و لاصابة الجذور بالأعفان ، بينما لم تتأثر النسبة المئوية لمحتوى الجذور من المادة الجافة بعملية العلاج . كذلك أظهرت النتائج أن علاج الجذور قبل تخزينها أدى لزيادة النسبة المئوية لمحتوى الجذور من السكريات الكلية و الغير مختزلة ، و السكروز، و الكاروتينات الكلية ، و لكنها خفضت من محتوى الجذور من الألياف الخام في نهاية التخزين .

و بصفة عامة فأن تأخير ميعاد الحصاد مع إضافة ٢٠–٣٦ كجم ن- بو٢أ/ فدان مع إجراء عملية العلاج للجذور قبل تخزينها أدى الي نقص النسب المئوية للفقد في الوزن، و لأصابه الجذور بالأعفان بعد ٣٠، ٦٠ يوماً من التخزين ، بالإضافة إلي زيادة محتوى الجذور من السكريات الكلية و السكريات الغير مختزلة ، و السكروز، في نهاية التخزين .