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DETERMINATION OF SWEETPOTATO [*Ipomoea batatas* (L.) Lam.] GENOTYPES SUITABLE TO THE AEGEAN REGION OF TURKEY

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ABSTRACT

A total of ten sweetpotato genotypes were grown in a field trial in 2003 and 2004 and certain agronomical and quality characteristics were determined. Local variety Hatay Kirmizi (Hatay Red) was selected as suitable to the Aegean Region for storage root number (7.7) and storage root yield (8.1 tons /ha) as well as acceptable quality characteristics: dry matter content: 41.8 %; sugar content: 2229.3 mg /kg; ßeta carotene 7.03 mg/100 g; vitamin A: 11716.3 IU; vitamin C: 38.6 Mg /100 g. Another introduced variety Regal was also selected for yield (6.6 ton /ha) and starch content (31.1 g/100 g), ßeta carotene (7.04 mg /100 g) and vitamin A (11745 IU) for the Aegean Region.

Key Words: Sweetpotato, [*Ipomoea batatas* L. (Lam)], storage root, ßeta-carotene, genotype, adaptation

INTRODUCTION

Sweetpotato [*Ipomoea batatas* (L.) Lam] originated from South America belongs to Convolvulaceae family and it is a storage root plant. Throughout world 107.6 million tons of sweetpotatoes are produced (Faostat, 2009). Sweetpotato takes the fifth place in production following rice, wheat, corn and cassava (Scott and Maldonado, 1998).

Storage-roots of sweetpotato contain 30% dry matter that 70% of it starch, 5% sugar and 5% protein with vitamin A, C and B. Especially orange colored sweetpotatoes contain vitamin A (ßeta carotene) and vitamin C (Woolfe, 1992).

In a preliminary study conducted in the Department of Field Crops of the Aegean University the phenol content of Hatay Kirmizi variety were determined (Tokusoglu *et al*., 2003; 2005). Storage roots, leaves and stems had 104.4 mg/100g, 333.5 mg/100g and 132.3 mg/100g phenols respectively.

Sweetpotato yields have been reported between 8.8 t/ha-36.2 t/ha in Taiwan by (Sajjponges et al., 1988). Collins et al., (1999) reported the yield of Caroline Ruby variety in North Carolina State as 19.4 t/ha and 22.5 t/ha in 1993 and 1995 respectively.

In Turkey, sweetpotatoes are grown in Hatay province located in Southern Turkey near the coastal area of Mediterranean basin (Calıskan et al., 1999). In this region agronomical and certain quality characteristics of sweetpotatoes obtained from different countries were evaluated in comparison with a local sweetpotato variety Hatay Kirmizi (Calıskan et al., 2001; 2002; 2007ab).

Traditional sweetpotato cultivation have been realized by using tubers and seedlings so it takes extra work and time increasing production expenditure (Saiful et al. 2002).

Therefore new tissue culture technics should be applied in sweetpotato growing in order to expand its production area in Turkey. The purpose of this study was to select suitable sweetpotato genotypes for the Aegean Region of Turkey.

MATERIALS AND METHODS

Genetic Material

Ten sweetpotato genotypes including 8 genotypes from the International Potato Center (CIP) Lima-Peru, 1 genotype from Hatay province and 1 genotype from Greece were grown in the experimental field of the Aegean University located at Bornova, Izmir. Some important characteristics of the genotypes are shown in Table 1.

Increasing Seedlings In Vitro

Seedlings used in the study were obtained from one single storage root from each genotype by using micro propagation techniques in the tissue culture laboratory (Yildirim and Ozturk, 2000). The single storage root from

Table 1. Some characteristics of sweetpotato genotypes grown in the study

Genotype	*Origin*	*Plant Type*	*Shape of Storage R*	*Skin Color*	*Flesh Color*
Hatay Kırmızı	Hatay-Turkey	Spread	Long-oval	Red	Creme
Istanköy	Greece	Half spread	Oval-elliptic	Red	Creme
Regal	USA	Erect	Long-elliptic	Red	Orange
NC-262	USA	Erect-Spread	Long-irregular	Pink	Light yellow
Kafrl El Zayad No:1	USA	Spread	Elliptic	Pink	Creme
NC-1508	USA	Spread	Oval	Crème	Dark yellow
Tamayukata	Japan	Erect	Round-elliptic	Crème	Dark crème
Kyukei No:63	Japan	Spread	Long-elliptic	Orange	Creme
Fongsu No:1	China	Spread	Round-elliptic	Crème	Creme
Yan Shu-1	China	Spread	Long-elliptic	Red	Creme

each genotype was planted in pots on March, 2002. When plants developed; 1 cm top and side explants were taken and they were cultured in the MS medium (Murashige–Skoog, 1962) enriched with 20 g/l sugar and 1 mg/l NAA. Seedlings developed from these explants were taken to sub-culture (node culture) for multiplication. Plantlets 4-5 cm in length was transferred to 10 cm plastic pots containing 1:1:1 sand: soil: turf on 26 March 2003 and 2004.

Growing Sweetpotato Plants in the Field

Field trial was arranged in a Randomized Complete Block Design (RCBD) with 3 replicates at the experimental field of the Department of Field Crops, Aegean University at Bornova during the growing seasons of 2003 and 2004. Sweetpotato seedlings were planted in the single row plots between row and within row spacing: 80 x 50 cm. Thus 10 plants were grown in each plot. Irrigations were done at 4-6 day intervals and hoeing was done by hand. Sweetpotato genotypes were harvested in the first week of November by hand in 2003 and 2004.

Measurement of Agronomical Characteristics

During the vegetation period stem number and stem length were measured on 3 randomly selected plants in each plot. First and the last plants on each plot were discarded as border effects and the remaining plants were harvested by hand. Following the harvest, number of storage-roots / plant, weight of storage root / plant were measured on 8 plants and the means of 8 plants were used in statistical analyses. The plot sized was 3.2 m^2 at harvest. Therefore the yield as t/ha was calculated by multiplying the plot yield by 3.125 conversion factor.

Quality Analyses of Storage Roots

Quality analyses were done on the storage root samples in 2004. The representative samples were taken from each plot and they were kept at -20 $^{\circ}$C in a deep freezer. Quality analyses including dry matter content, total protein content, total sugar content, starch content, ßeta-carotene levels, vitamin A and vitamin C (ascorbic acid) values of sweetpotatoes were performed in the Central Laboratory of the Agricultural Faculty of the Aegean University, Izmir.

Dry matter content: The dry sample content of sweetpotatoes was determined by drying a representative 5 g sweetpotato sample at 80 °C for 24 h in a laboratory drying-oven. The dry matter content (%) was calculated by using the loss weight and the fresh sample weight according to the following formula.

Dry matter (%) = Dry weight of sample / Total weigh of sample x 100

Protein Content: The protein content of sweetpotatoes was determined by the Kjeldahl method using Kjeldahl protein units including incineration and distillation apparatus with a representative 3 g sweetpotato powder. Then total nitrogen (N) (%) was multiplied by factor 6.25 to obtain total protein content (AOCS, 1990).

Total Sugar Content*:* The total sugar content of sweetpotatoes was determined according to the spectrophotometric Anthrone method modified by Tokusoglu et.al., (2003; 2005) using saccharose as standard anhydroglycose for sweetpotato. Standard buffer stock solutions containing anthrone reagent and samples were measured for 620 nm at spectrophotometer. Standard analytical calibration was found to be R^2= 09942 (Osborne, 1986).

Total Starch Content: The total starch content of sweetpotatoes was determined by using the method of International Starch Institute-Denmark described by Woolfe (1992).

Beta-Carotene Content: Beta carotene content of sweetpotato was determined as followings: 2 g of sweetpotato was ground with 5 ml of acetone and then with acetone–petroleum ether (20:80;v/v), after filtration and rotary evaporation (35 °C) processes, remaining solvent was removed through N_2 atmosphere and then dissolving in 2 ml petroleum ether. β-carotene (Sigma) stock and standard solutions and sample solutions were measured for 450 nm at spectrophotometer (Yildirim, Tokusoglu and Aygun, 2005).

Vitamin A Analyses: 2 g sweet potato sample was extracted with diisopropyl ether according to the method. Then re-saponifed with 5% KOH and washed with 10% sodium chloride. Vitamin A (retinol) stock and standard solutions and sample solutions were measured for 325 nm at spectrophotometer (Speek *et al*., 1986).

Vitamin C (Ascorbic Acid) Analyses: Vitamin C analyses were performed with a modified procedure (Sapers *et al.*, 1990). 20 g of sweetpotato samples were blended with 20 ml

of 2.5% metaphosphoric acid plus 50 ml of acetonitrile and 0.05 M KH_2PO_4 (75:25 v/v) solution. After the filtration stage, each final extract (20 microliter) were analyzed by RP-HPLC using UV detection containing 5-μm Hypersil-ODS column (250 x 4.6 mm) and acetonitrile / 0.05 M + KH_2PO_4 (75:25 v/v) mobil phase combination with a flow rate of 1.0 ml/min at 260 nm.

Statistical Analyses

The Agronomical traits and the quality characteristics were analyzed by the Standard ANOVA techniques. The means of the genotypes were compared by the Least Significant Difference Test (LSD) as given by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Agronomical Characteristics

The F values obtained from the combined analyses of traits over two years are given in Table 2.

As seen in Table 2, the variation among genotypes was significant for stem length (cm), stem number, storage root number/plant, weight of storage root/plant and yield of storage root/plot. This significant F values indicate significant differences between the means of the agronomical traits of the genotypes. Genotype x year interactions for the agronomical traits were highly significant. The significant genotype x year interactions indicate that means of the genotypes should be studied separately for 2003 and 2004. Therefore the means of the agronomical traits will be discussed **s**eparately for 2003 and 2004. Then the means of over two years based on combined analyses will be used in selecting suitable genotype

Means of the Genotypes for Agronomical Characteristics measured in 2003.

Stem length, stem number, storage root number, weight of storage root /plant and yield of storage root /plot had genotype means which are significantly different from each other (Table 3). For example for stem length NC-1508 (405.7 cm); for stem number/plant Yan Shu-1 (6.5); for storage root number/plant Fongsu No: 1 (6.2); for weight of storage root /plant Fongsu No: 1 (504.8 g) and Kafrl El Zayat No: 1 (457.0 g); for yield of storage root / plot Fongsu No: 1 (3.1 kg) had the highest means.

Table 2. The F values of the agronomical characteristics based on combined analysis of 2003 and 2004

	Characteristic				
Source	***Stem length (cm)***	***Stem Number***	***Storage root number/plant***	***Weight of storage root/plant***	***Yield of storage root/ Plot***
Year	28.637**	128.388**	93.685**	5.578**	70.080**
Genotype	10.511**	4.396**	4.971**	15.264**	17.118**
Genotype x Year Int/	3.342**	3.394**	5.971**	3.109**	4.318**

*: significant at the 0.05 probability level
**: significant at the 0.01 probability level

Table 3. Means of the agronomical characteristics of the genotypes grown in 2003.

	Characteristic				
Genotype	***Stem length* (cm)***	***Stem number***	***Storage root number/plant***	***Weight of storage root/ plant (g)***	***Yield of storage root/plot** (kg)***
Fongsu No:1	315.0c	3.9b	6.2a	504.8a	3.1a
Kafrl El Zayad No:1	323.0b	4.0b	4.5b	457.0ab	2.0b
Kyukei No.63	361.3b	4.5b	3.9b	233.7b	0.9
Yan Shu-1	177.7c	6.5a	4.7b	378.4bc	1.8b
Tamayukata	213.3cd	3.1b	4.8b	240.3d	1.1c
Regal	286.3c	3.8b	5.1a	309.5cd	1.6b
Hatay Kırmızı	365.3a	4.0b	4.2b	302.9cd	1.2c
NC-1508	405.7a	1.4c	3.8b	314.6cd	1.2c
NC-262	296.3c	3.9b	4.3bc	258.5d	1.1c
Istanköy	295.7c	3.3b	3.7bc	248.0d	0.9c
LDS (0.05)	43.3	1.8	1.5	108.8	0.5

*Means with different letters are significantly different at the p≤0.05 level
**Plot yield should be multiplied by conversion factor 3.125 to obtain yield as t/ha

Means of the Genotypes for Agronomical Characteristics Measured in 2004

Similar to the results obtained in 2003; NC-1508 had the highest stem length (332.2 cm); Fongsu No: 1 had the highest weight of storage root /plant (738.8 g) and yield of storage root /plot (6.2 kg). This year Istanköy had the highest stem number (14.1) and Hatay Kirmizi had the highest storage root number/plant (11.2) (table 4).

In general means of the agronomical traits obtained in 2004 were comparatively higher than those obtained in 2003.Therefore means of the genotypes based on combined analysis of two years should be considered in selecting suitable genotypes for the Aegean region (Table 5).

Table 4. The means of the agronomical characteristics of the genotypes grown in 2004.

	Characteristic				
Genotype	***Stem length*** [*] ***(cm)***	***Stem number***	***Storage root number/plant***	***Weight of storage root /plant (g)***	***Yield of Storage root/plot*** [**] ***(kg)***
Fongsu No:1	205.5bc	9.0bc	8.3b	738.8a	6.2a
Hatay Kırmızı	313.2a	13.6ab	11.2a	376.8b	4.1b
Yan Shu-1	182.2c	7.2c	6.3c	655.6ab	4.1b
Regal	266.6a	9.7a	9.7ab	264.1cd	2.6c
NC-1508	332.2a	4.2d	6.0c	364.3c	2.2c
Kafrl El Zayat No:1	262.2a	9.5a	5.4d	388.9c	2.1c
Istanköy	239.3bc	14.1a	11.5a	172.9d	2.0c
NC-262	219.9c	7.8c	5.6d	317.4cd	1.8c
Tamayukata	269.9a	10.9a	6.5cd	265.8cd	1.7c
Kyukei No:63	208.8bc	11.4a	5.9cd	213.0d	1.3c
LSD (0.05)	85.6	4.6	2.7	172.3	1.4

[*] Means with different letters are significantly different at the p≤0.05 level.
[**] Plot yield should be multiplied by conversion factor 3.125 to obtain yield as t/ha

Table 5. The means of the agronomical characteristics based on the combined analysis of 2003 and 2004.

	Characteristic					
Genotype	***Stem length*** [*] ***(cm)***	***Stem number***	***Storage root number/plant***	***Weight of storage root /plant (g)***	***Yield of Storage root /plot*** [**] ***(kg)***	***Yield of Storage t/h*** [**]
FongsuNo:1	260.2	6.5	7.3	621.8	4.6	14.4
Yang-Shu-1	179.9	6.9	5.5	516.0	2.8	8.8
Hatay Kırmızı	339.3	8.9	7.7	339.9	2.6	8.1
Regal	292.6	6.8	7.4	286.8	2.1	6.6
Kafrl El Zayat No:1	276.3	6.8	4.9	422.9	2.1	6.6
Istanköy	267.5	8.7	7.6	210.5	1.5	4.7
Tamayukata	241.6	7.1	5.6	253.0	1.4	4.4
NC-1508	368.9	2.8	5.1	339.4	1.7	5.3
Kyukei No:63	285.1	7.9	4.9	223.3	1.1	3.4
NC-262	258.2	3.9	4.9	287.9	1.4	4.4
LSD (0.05)	45.7	2.3	1.6	97.8	8.7	5.0

[*]Mean with different letters are significantly different at the p≤0.05 probability level
[**]Yield t/ha=plot yield x 3.125

Based on the combined means of two years, Fongsu No: 1 had the highest means for weight of storage root / plant (621.8 g) and yield of storage root / plot (4.6 kg). If only the high yield is considered this genotype should be selected. But this genotype had low means for stem length, stem number and storage root number / plant Fongsu No: 1 had very large storage roots so high yield. But the irregularities of tubers in size (Jumbo size) and shape reduce its selection chance of selecting for human consumption. Therefore Fongsu No: 1 could be proposed for industrial purposes.

Caliskan et al (1999; 2002; 2007ab) reported that Fongsu No.1 and Kafrelzayad genotypes had the highest yield for storage roots. The high yield of Fongsu No.1 was explained by its very large and irregular storage roots. This genotype and Yangshu1 had high yields at Adana province. Hatay Kirmizi and Regal were reported to have low yields at Hatay and Adana provinces of Turkey. In this study Hatay Kirmizi and Regal had high yield of storage root in acceptable size (U.S#1). This discrepancy could be due to the genotype x location interactions.

Hatay Kirmizi had high means for stem length (339.3 cm), stem number (8.9) and storage root number / plant (7.7) and high yield of storage root (8.1 t/ha). Therefore Hatay Kirmizi could be suitable for human consumption and it could be recommended as an adaptive genotype to be grown in the Aegean Region.

Another genotype could be proposed to be grown in the region is Regal (6.6 t/ha). This genotype had suitable storage roots in medium size (U.S#1). A final decision will be made after studying the quality characteristics of the genotypes Hatay Kirmizi, Regal, Fongsu No.1, Yangshu1 and Kafrelzayad.

Quality Characteristics of Sweetpotato Genotypes

It could be seen in Table 6 that Kyukei No:63 (51.1%) and Istanköy (44.2%) had the highest Dry Matter Content. Dry matter contents obtained in this study were considerably higher than those reported by Calıskan et al., (1999). Regal (2.64%), Hatay Kirmizi (2.59%) and Yan Shu-1 (2.82%) had high protein content. Hatay Kirmizi had the highest sugar content (2223.3 mg/kg) and vitamin C (38.6 mg/100g). Regal had the highest starch content (31.1g/100g), ß carotene content (7.04 mg / 100g) and vitamin A (11745.0 IU).

Table 6. The means of the certain quality characteristics measured in the yield trial run in 2004.

	Quality Characteristic						
Genotype	***Dry matter content %***	***Protein content %***	***Sugar content mg/kg***	***Starch content mg/100g***	***ß- carotene mg/100 gr***	***Vitamin A IU***	***Vitamin C mg/100g***
Hatay Kırmızı	41.8bc	**2.59ab**	2223.3a	29.5a	7.03a	11716.3a	38.6a
Fongsu No: 1	37.9c	2.35a	1603.3a	27.7c	6.05ab	10077.3abc	25.5f
Istanköy	**44.2b**	2.31a	1466.7ab	29.3a	5.90b	9833.0abc	35.9abc
NC-1508	36.8d	2.04b	1200.7b	30.8a	6.04ab	10060.7abcd	23.7f
Regal	31.4d	2.64a	1136.7b	**31.1a**	**7.04a**	**11745.0a**	27.9de
Kafrl El Zayat No:1	29.2e	2.0b	958.3b	28.4b	5.19b	8661.0cd	25.2f
Yang-Shu-1	38.9c	**2.82a**	806.7b	28.0b	5.39b	8980.0bcd	32.0cde
Tamayukata	42.6b	1.87c	615.0b	28.2c	5.10b	8505.3d	32.5bcd
NC-262	29.8e	1.60c	423.3c	29.5a	5.88b	9799.7abc	38.1ab
Kyukei No:63	**51.1a**	2.5a	306.7c	29.9a	5.01b	8355.0d	28.5def
LSD (0.05)	4.7	0.6	1006.9	1.8	1.07	1780.6	5.9
F value			2.986*	3.503*	4.115**	4.128**	7.521**

Means with different letters are significantly different at the p≤0.05 level.

In conclusion, although the quality analyses run only in 2004, it could be concluded that Hatay Kirmizi had high means for sugar content, starch content, vitamin A, vitamin C as well as high yield performance. Therefore Hatay Kirmizi could be selected as suitable to be grown in the Aegean Region for yield and quality traits.

Another adaptive genotype Regal had superiority for starch content, vitamin A and vitamin C. This genotype could also be proposed to be grown in the region following Hatay Kirmizi.

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