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FIELD PERFORMANCE OF in vitro SWEET POTATO [*Ipomoea batatas* L. (Lam)] PLANTLETS DERIVED FROM SEEDSTOCKS

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ABSTRACT

A field trial was conducted to compare the performance of *in vitro* plantlets derived from the meristem cultures of rootstocks through micro-propagation with the performance of the traditional seed roots in 2009 and 2010. There was no significant difference between the *in vitro* plantlets and the traditional seed root for haulm length (HL), branch number (BN) and stem number (SN). In vitro plantlets had significantly higher means as compared to traditional seed roots for single storage root weight (SSRW) (305.5 g vs 217.6 g), single plant yield (SPY) (4.1 kg vs 3.0 kg) and plot yield (PY) (16.2 kg vs 12.0 kg). Cultivar NC-150 had higher means than those of the other two cultivars in terms of storage root weight (417.6 g), single plant yield (4.6 kg) and plot yield (18.4 kg).

Key Words: Sweet potatoes, growing seed potatoes, in vitro plantlets, seed roots, maintenance of seed stocks

INTRODUCTION

Sweet potato [*Ipomoea batatas* L. (Lam)] is an important food crop for humans and animals due to its desirable starch, sugar, protein and vitamins contents. According to the FAOSTAT statistics the annual sweet potato production in the world was about 106 million tones (Faostat, 2010).

In Turkey sweet potatoes introduced over Cyprus, have mainly been cultivated in Hatay province located in the South (Caliskan et al. 2007). Yildirim et al. (2011) tested several sweet potato cultivars in the Aegean Region and selected Hatay Kirmizi, a landrace variety grown in Hatay along with Regal and NC-150 as suitable to be grown in the Aegean Region.

Sweet potato has been generally cultivated by storage roots, seedlings or vine cuttings (Saiful Islam et al. 2002). The traditional growing of seed potatoes by planting seed roots has disadvantage of loosing yielding capacity. Therefore new techniques in maintaining seed roots, including clean and dependable seed pieces as well as in vitro technique have been investigated (Villordon et al. 2003). Intact seed roots have still been used in production in Turkey. Therefore new techniques in seed preparation will increase sweet potato production.

The usage of *in vitro* plantlets derived from seed stocks through micro-propagation has been proposed as an alternative using seed roots and vine cuttings (Lizarraga et al. 1992; Saiful Islam et al. 2002; Villordon et al. 2003). Meristem culture has also been proposed as a dependable method in obtaining and maintaining sweet potato seed stocks. Thus virus free plantlets derived from these seed stocks have been reported to increase the yield in sweet potato production (Mervat, 2007; Mervat and Ashoub, 2009). Oggema et al. (2007) has also compared tissue culture regeneration and conventional growing in sweet potato. Yildirim et al. (2011) reported the positive effect of in vitro plantlets in the field growing.

The purpose of this study was to compare the field performance of *in vitro* plantlets used in sweet potato production with traditional usage of seed roots in a field trial run in 2009 and 2010.

MATERIALS AND METHODS

The study was conducted in the Tissue Culture Laboratory and at the Experimental Field of the Department of Field Crops of the Aegean University in Bornova-Izmir, Turkey during the 2009 and 2010 growing years. The monthly temperature and rainfall are shown in Table 1. The sweet potato cultivars, Hatay Kirmizi (Hatay Red), Regal and NC-150 were used as plant materials. Some characteristics of these cultivars were given by Yildirim et al. (2011).

Preparation of in vitro plantlets

Original seed stocks of the cultivars tested were constructed by using meristem cuts of the sprouts of selected storage roots in the laboratory. Seed stocks were maintained by sub-culturing the meristem plantlets through nodal cuttings at 3 monthly intervals.

Micro-propagations of plantlets were done by using nodal cultures grown on basic Murashige and Skoog

Table 1. The temperature and rainfall of the 2009 and 2010 growing years*.

Months	Temperature (^{0}C)		Rainfall (kg/m^2)	
	2009	2010	2009	2010
April	16.0	17.4	83.8	20.4
May	21.4	21.8	44.3	27.1
June	26.2	25.5	9.2	76.3
July	29.0	28.8	0	0
August	27.9	30.2	0	0
September	23.2	24.8	51.2	12.3
October	20.8	18.8	26.3	232.5
November	14.6	18.1	160.3	32.4

*: based on the Guzelyali Izmir Meteorological Station records

(1962) medium enriched by salt and vitamin solutions containing 2.0 mg/l Naphthaline-asetic acid (NAA), 2 % sucrose, under the 16 h light period at 23±2 ^{0}C (Yildirim et al. 2011). *In vitro* plantlets were obtained from these subcultures through micro-propagation of nodal cuttings. The plantlets about 4 cm in length were transferred to nylon pots containing soil, turf and fertilizer in 2:1:1 ratio respectively in March 2009. Seed roots used in the trial were obtained from the harvested storage roots of the previous season and they were kept in cold storage. In vitro plantlets and seed roots were planted in the field in April, 2009. The design of the experiment was a split-plot arrangement of Randomized Complete Blocks Design with 3 replications. Main blocks were cultivars. Each plot consisted of 2 rows of 2.0 m long with 90 cm between row and 70 cm within row spacings. The same procedures were followed in seed preparation and in the field planting in 2010.

The standard recommended cultural practices for watering and hoeing were followed in two years. The field trials were harvested in late November in 2009 and 2010. Before the harvest haulm length (HL), stem number (ST) and branch number (BN) were measured. Following the harvest yield characteristics such as storage root number (SRN), single storage root weight (SSRW), single plant yield (SPY) and plot yield (PY) were measured.

Statistical Analyses

The data obtained in the trial were analyzed by applying the standard procedures of statistics and the means were compared by using the least Square Difference test (LSD) as described by Steel et al. (1997).

RESULTS AND DISCUSSION

The F-values of morphological and yield characteristics pertinent to the sources of variation are shown in Table 2 and Table 3.

It could be seen in Table 2 that seed type and cultivar had non-significant F values for haulm length, stem number and branch number. Year had significant variation for these traits. Interactions between seed type, cultivar and year was not significant except the seed type x cultivar x year interaction for stem number.

Table 2. The F values of the morphological characteristics based on the ANOVA combined over 2009 and 2010

Source of Variation	Haulm Length (m)	Stem Number	Branch Number
Seed Type	3.859^{ns}	3.462^{ns}	0.529^{ns}
Cultivar	0.538^{ns}	2.532^{ns}	0.823^{ns}
Seed Type x Cultivar	0.521^{ns}	0.353^{ns}	0.575^{ns}
Year	6.401*	5.568*	17.292**
Seed Type x Year	0.003^{ns}	0.025^{ns}	0.137^{ns}
Cultivar x Year	0.775^{ns}	0.167^{ns}	0.016^{ns}
Seed Type x Cultivar x Year	0.908^{ns}	5.688*	3.298^{ns}

*: significant at the 0.05 probability level
**: significant at the 0.01 probability level
^{ns}: non-significant

Table 3. The F values of yield characteristics based on the ANOVA combined over 2009 and 2010

Source of Variation	Number of Storage Root	Single Storage Root Weight (g)	Single Plant Yield (kg)	Plot Yield (kg)
Seed Type	0.726^{ns}	8.529*	71.823**	75.293**
Cultivar	3.120^{ns}	23.904**	11.990**	11.497**
Seed type x Cultivar	0.885^{ns}	0.112^{ns}	3.219^{ns}	3.005^{ns}
Year	2.099^{ns}	6.919*	6.489*	6.537*
Seed Type x Year	2.668^{ns}	0.043^{ns}	0.333^{ns}	0.382^{ns}
Cultivar x Year	0.204^{ns}	3.123^{ns}	1.768^{ns}	1.727^{ns}
Seed Type x Cultivar xYear	0.622^{ns}	1.769^{ns}	2.096^{ns}	2.133^{ns}

*: significant at the 0.05 probability level
**: significant at the 0.01 probability level
^{ns}: non-significant

The F values of the yield characteristics shown in table 3 indicated significant variation for single storage root weight, single plant yield and plot yield. Number of storage root had non-significant F-values. It could also be seen in Table 3 that the first and second order interactions among the 3 factors had non-significant F values.

Since the interaction components are not significant, the means of the seed type and cultivar will be presented in the two-way tables pooled over 2 years for the traits measured except stem number. This trait had significant second order seed type x cultivar x year interaction component therefore the means of the seed type and cultivar will separately be given for 2009 and 2010.

It could be seen in Table 4 that means for *in vitro* plantlets and seed roots were not significantly different for haulm length and branch number. Means of Hatay Kirmizi, Regal and NC-150 were also not significantly different as similar to the seed type.

In vitro plantlets had significantly higher means than the seed roots for single storage root weight (305.5 g vs 217.6 g), single plant yield (4.1 kg vs 3.0 kg) and plot yield (16.2 kg vs 12.0 kg). Means of in vitro plantlets and seed root were similar for storage root numbers per plant.

Table 4. The means of the morphological and the yield characteristics measured in the field trial run in 2009 and 2010.

Cultivar	Haulm Length (m)			Number of Branches			Number of Storage Root			Single Storage Root Weight (g)			Single Plant Yield (kg)			Plot Yield[3] (kg)		
	Seed Type			Seed Type			Seed Type			Seed Type			Seed Type			Seed Type		
	IP[1]	SR[2]	Mean	IP[2]	SR[2]	Mean	IP[1]	SR[2]	Mean	IP[1]	SR[2]	Mean	IP[1]	SR[2]	Mean	IP[1]	SR[2]	Mean
H.Kirmizi	2.9a	2.7a	2.8a	27.8a	22.3a	25.1a	19.4a	16.7a	16.7a	208.3a	139.7a	174.0b	4.1a	2.3b	3.2b	16.3a	9.4b	12.9b
Regal	3.0a	3.0a	3.0a	26.2a	23.5a	24.9a	17.6a	13.8a	13.8a	237.8a	148.5a	193.2b	3.5a	2.0b	2.8b	14.0a	8.0b	11.0b
NC-150	3.3a	2.8a	3.1a	21.8a	22.1a	22.0a	13.0a	13.9a	13.9a	470.3a	364.7a	417.5a	4.6a	4.6a	4.6a	**18.2a**	**18.5a**	**18.4a**
Mean	3.1a	2.8a		25.3a	22.6a		15.7a	15.8a		**305.5a**	217.6b		**4.1a**	3.0b		**16.2a**	12.0b	

[1]: plants grown from *in vitro* plantlets (IP)
[2]: plants grown from seed roots (SR)
[3]:yield (T/ha)=plot yield x 2.65

It could also be seen in Table 4 that cultivar NC-150 had higher means than those of Hatay Kirmizi and Regal for single storage root weight (417.5 g vs 193.2 and 174.0), single plant yield (4.6 kg vs 2.8 and 3.2) and for plot yield (18.4 kg vs 11.0 and 12.9).

The means for haulm length and branch number were not different for *in vitro* plantlets and seed roots as expected. The morphological traits did not show significant variation since haulm length was measured just before the harvest time therefore the late germination of the seed root as compared to plantlets might be compensated during the late stages of the growth so the haulm length seemed to be not influenced by the seed type. Contrary to expectation stem number had significant second order interaction so means of this trait are given in a separate table (Table 5). In vitro plantlets and seed roots had similar means for stem number although significant difference between means of two years was observed (2.9 vs 2.3).

Table 5. Mean of the stem number measured for 3 cultivars at 2 seed types in 2009 and 2010.

Cultivar	2009			2010		
	Seed Type			Seed Type		
	IP[1]	SR[2]	Mean	IP[1]	SR[2]	Mean
Hatay Kirmizi	3.3a	3.1a	3.2a	2.7a	2.3a	2.5a
Regal	3.7a	2.0b	2.9a	2.3a	2.6a	2.5a
NC-150	2.3a	2.7a	2.5a	2.8a	1.1b	2.0a
Mean	3.1a	2.6a		2.6a	2.0a	
			2.9a			**2.3b**

[1]: plants grown from *in vitro* plantlets (IP)
[2]: plants grown from seed roots (SR)

Means of the *in vitro* plantlets and seed roots for stem number were not significantly different in 2009 and in 2010. The similar trend could also be observed for 3 cultivars in 2 years. Table 5 shows only the overall mean of 2009 is higher than that of 2010 and this difference is significant. It could also be observed in Table 5 that cultivar Regal had significantly lower stem number as compared to Hatay Kirmizi and NC-150 for seed roots (2.0 vs 3.1 and 2.7). In 2010 NC-150 had lower stem number for seed roots similar to Regal in 2009.

The comparable high rainfall occurred in 2009 might affect the yield performance of cultivars. This effect might also be confounded with other unknown factors in the experiment.

The means of *in vitro* plantlets and seed roots indicated certain superiority of in vitro plantlets over seed roots for single storage root weight, single plant yield and plot yield. Since the growth and germination of sprouts and vines would take more time in seed root plots, *in vitro* plantlets could have developed earlier than the seed roots. Therefore high single storage root weight and single plant yield resulted in high plot yield. Availability of extra time for *in vitro* plantlets might enhance them to fill storage root earlier although they had same storage root number per plant (15.7 vs 15.8).

Based on the results given above and their discussion it could be concluded that in vitro plantlets derived from seed stocks had superiority over traditional seed roots in sweet potato production for yield and yield components studied in this study. Considering the losses in maintaining seed roots at the storage and long time and extra work for preparation of slips or vine cuttings, maintenance of seed stocks in vitro and usage of in vitro plantlets propagated from seed stocks as seed could be recommended in the sweet potato production.

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