

FIELD PERFORMANCES OF DIFFERENT SEEDLING TYPES USED IN SWEET POTATO [*Ipomea batatas* (L.) Lam] GROWING

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ABSTRACT

The purpose of the study was to compare field performances of three sweet potato seedlings such as *in vitro* plantlets (IP) rooted cuttings (RC) and cuttings (C). A field trial in the Randomized Complete Block Design (RCBD) with 3 replications arranged in Split Plots (SP) was conducted in 2016 and 2017 in the experimental field of the Ege University located at Bornova. The following results based on the analysis of data could be summarized: *In vitro* plantlets had the higher mean for the number of storage roots (8.4), single storage root weight (684.1 g), single plant yield (5.2 kg) and plot yield (37.0 kg). Genotype Lanceolado had high storage root number. Genotype Yan Shu-1 had high means for single storage root weight (809.8 g), single plant yield (5.9 kg) and plot yield (43.3 kg).

Keywords: *In vitro* plantlets, root cuttings, cuttings, sweet potato

INTRODUCTION

Sweet potato [*Ipomea batatas* (L.) Lam], a native of central America has been grown widely in the tropic, subtropic and temperate climatical regions of the world following after rice, cereals, potatoes and cassava (Alam et al., 2010; Dugassa and Feyissa, 2011). Although sweet potatoes have been introduced to Turkey over Cyprus it has only been grown in Hatay Province of Turkey. Caliskan et al. (2020) reported approximately 100-150 ha production area and average yield 1.439 kg ha⁻¹ in Turkey.

Green parts of sweet potato are rich in protein (Kodjo et al., 2013) so they were used as animal feed and silage (Monteiro et al., 2007; Kebede et al., 2008; Geren et al., 2010). Fresh leaves of sweet potato are also used in salads. Jumbo type sweet potatoes are utilized in starch, alcohol, baby food, food coloring and biodiesel production industry. Storage roots are rich in vitamin A, β -carotene and antioxidants. Hence storage roots with orange color are preferred due to high vitamin A contents (Yildirim et al., 2011; Ogero et al., 2012).

Growing of sweet potato is realized by using storage roots and seedlings (Dugassa and Feyissa, 2011). Wilson (1988) stressed that healthy plant material should be used in sweet potato propagation for high yield. So the grower should consider type, length, age and health of the initial material. Sweet potato is also propagated by using vine cuttings taking from young plants. Storage root sprouts and first cuttings have also been used as seedlings instead of vine cutting (Hall, 1993; Braun, 2001). In practice seedlings obtained from main stems are used widely

(Novak et al., 2007). In general, storage roots are grown in seedbeds at 25-30 C⁰ to obtain seedlings and these seedlings are planted in the field (Novak et al., 2007; Dugassa and Feyissa, 2011). Under cold conditions, the growing is realized by using storage roots since seedling production is not possible due to low temperatures. In large growing areas; there are difficulties in providing sufficient seed material as seedlings from storage roots. Viruses are carried with storage roots resulting in yield losses (Alcenoro, 1975; Jarret, 1990). For that reason tissue culture techniques have been proposed and used in reducing the negative effects of classical production methods by using storage roots or sprouts. Using the tissue culture, healthy seedlings are obtained by taking the apical and axillary buds *in vitro* in the laboratory. These seedlings could be used in field production instead of traditional growing. The advantage of *in vitro* technics is production of healthy and uniform material in a short period, low expenses and avoiding adverse environmental effects (Jarret, 1990; Lizarraga et al., 1992; Ahloowalia et al., 2004; Alberto Cruz-Crus, 2013; Dolinski and Olek, 2013; Kodjo et al., 2013). The *in vitro* plantlets could be sub-cultured at certain periods to produce disease free seedlings (Reed et al., 2004). Since the acclimatization of *in vitro* seedlings is easy, good rooting and stem development could be provided in this way (Pospisilova et al., 1999; Novac et al., 2007; Kodjo et al., 2013).

The purpose of this study was to compare the field performances of *in vitro* seedlings (IP) obtained in the laboratory, root cuttings (RC), and only cuttings (C) in the field trial.

MATERIALS AND METHODS

This study was conducted in the Tissue Culture Laboratory, greenhouse and experimental field of the

Field Crops Department of the Ege University in 2016 and in 2017.

The characteristics of the sweet potato genotypes used as genetic material in the study are shown in Table 1.

Table 1. Sweet potato genotypes used in the study*

Genotype	Origin	Known characteristics
Yan Shu-1	China	Spread, long-elliptic, red, creme flesh
Tamayukata	Japan	Erect, round-elliptic, creme, dark creme flesh
Lanceolado	Peru	Erect, long-elliptic, purple, creme flesh

*: obtained from the CIP

Obtaining of *in vitro* plantlets (IP)

Storage roots of three sweet potatoes were grown in pots in the greenhouse to produce seedlings in 2015. Seedlings 1 cm in length were kept in 70 % ethyl alcohol and 2.5 % sodium hypochlorite (NaOCl) solution for surface sterilization. Two different media of MS (Murashige and Skoog, 1962) were used. First medium is 2 mg/l NAA (1-Naphthaleneacetic acid), 0.1 mg/l GA₃ (Gibberellic acid) 20 % sucrose. Axillary buds 0.5 cm in length were taken from each genotype and they were cultured test tubes in 15x2.5 cm. After 10-12 weeks, cultures were transferred to MS + 1 mg/l NAA medium described by Yildirim et al. (2011) for nodal multiplication. The micro seedlings were left to develop in the culture until they were 5-6 cm in

length with roots. *In vitro* plantlets were taken out from the medium and they were left to acclimatization. Then *in vitro* plantlets were planted in plastic pots containing sterile soil + turf in 2:2 ratios and they were left to development for 2 weeks.

Obtaining root cuttings (RC) and cuttings (C)

Storage roots were planted in plastic cages containing soil and turf mixture on February 02, 2016 and they were left to development. Approximately 8-10 cm rooted cutting (RC) and cuttings without root (C) were used in the field trial.



Figure 1. i: *in vitro* nodal propagation, ii: *in vitro* seedlings, iii: rooted cutting, iv: cuttings

Climatical and soil characteristics of the experimental area

Average temperature C⁰ and total precipitation (mm) of the experimental site are shown in Table 2. Soil characteristics of the experimental area are given in Table 3.

Field trial

Seedlings of three different seedlings types of 3 genotypes were transplanted in the field trial on April 20, 2016 and 2017. The design of the trial was the

Randomized Complete Block Design (RCBD) with 3 replications arranged in Split Plots (SP). Plot size was 2 rows in 3 m length with 80 cm x 60 cm spacing. Since sweet potatoes are not grown in the region we accepted C seedlings as control. Composite fertilizers (15%-15%-15%, NPK) and after hilling DAP (diammonium phosphate) were applied at dose of 10 kg da and 5 kg da, respectively. Cultural methods were applied and the trial was harvested on November 4, 2016 and November 3, 2017 by hand. After harvest, the number of the storage root, single storage root weight (g), single plant yield (kg) and plot yield (kg) were measured and recorded.

Table 2. Temperature and total precipitation in Bornova-Izmir-Turkey during the 2016 and 2017 growing seasons*

Months	2016		2017	
	Average Temperature (C ⁰)		Total Precipitation (mm)	
April	18.9	12.8	16.6	15.7
May	21.2	28.2	21.7	27.0
June	27.7	9.2	26.5	1.8
July	29.9	1.2	29.8	1.4
August	29.4	3.0	29.4	0.3
September	25.1	6.4	24.6	0.9
October	19.2	1.4	18.8	45.7
November	14.0	100.6	13.3	62.1

*: from Bornova Meteorological Station

Table 3. Soil characteristics of the experimental field

Physical and Chemical traits	Evaluation	Method
pH	Slightly alkaline	Jackson, 1967
Organic Matter (%)	Low	Jackson, 1967
Lime (%)	Calcerous	Schlichting and Blume, 1966
Sand (%)	Clay loam	Bouyoucos, 1962
Clay (%)		
Silt (%)		
Total N (%)	Middle	Bremner, 1965
P (mg/kg)	Enough	Olsen, 1982
K (mg/kg)	High	Pratt, 1965

Statistical analysis

The data obtained in the field trials run in 2016 and 2017 were analyzed by using standard statistical procedures of Split Plot arrangement described by Acikgoz et al. (2004). The significance of variation was tested by the F test and the means were compared by using

the standard LSD test described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The mean squares and their significance based on F values of the three different seedling types are shown in Table 4.

Table 4. Means squares of the yield characteristics obtained from the combined analysis of variance over 2016 and 2017.

Source of variation	Degree of freedom	Number of storage root	Single storage root weight (g)	Single plant yield (kg)	Plot yield (kg)
Year	1	1.05 ^{ns}	2.01 ^{ns}	3.224 ^{ns}	2.411 ^{ns}
Genotype	2	162.8**	14738**	748.976**	1147.8**
Genotype x year	2	0.116 ^{ns}	0.795 ^{ns}	1.0408 ^{ns}	1.579 ^{ns}
Error 1	12				
Seedlings	2	742.6**	715.5**	1258**	717.44**
Genotypes x Seedlings	4	312.0**	25.12**	57.024**	19.58**
Seedlings x year	2	8.24**	1.500 ^{ns}	3.102 ^{ns}	0.056 ^{ns}
Genotypes x seedlings x year	4	7.39*	1.185 ^{ns}	3.98 ^{ns}	0.493 ^{ns}
Error 2	24				

*: significant at the 0.05 probability level

** : significant at the 0.01 probability level

^{ns}: non-significant

It could be seen in Table 4 that genotype, seedlings and genotype x seedlings interaction had highly significant variation for all traits studied at the $p \leq 0.01$ level. So the means of the traits over two years will be discussed for seedlings and genotypes together. Only seedlings x year interaction had significant variation at the $p \leq 0.01$ level for number of storage roots and the genotypes x seedlings x year second order interaction was significant at the $p \leq 0.05$ level for number of storage roots.

This could be due to the genotype seedlings interaction. Due to this an expected situation two way table will be used in discussion. Means of seedlings type of genotypes for yield characteristics are shown in Table 5.

Table 5. The means of yield characteristics for seedlings of 3 genotype observed in field trial run in 2016 and 2017

Genotypes	Number of storage roots*						Single storage root weight (g)				Single plant yield (kg)				Plot yield (kg)						
	IP ¹		RC ²		C ³		Mean	IP ¹		RC ²		C ³		Mean	IP ¹		RC ²		C ³		Mean
	2016	2017	2016	2017	2016	2017		IP ¹	RC ²	IP ¹	RC ²	IP ¹	RC ²		IP ¹	RC ²	IP ¹	RC ²	IP ¹	RC ²	
Yan Shu-1	7.8	8.0	7.0	7.0	7.0	6.2	7.2	962.2	806.5	660.7	809.8	7.7	5.6	4.3	5.9	55.3	41.7	33.0	43.3		
Tamayukata	5.8	5.3	5.0	5.5	5.2	5.0	5.3	770.0	627.0	559.8	652.3	4.2	3.2	2.7	3.4	31.7	24.3	18.5	24.8		
Lanceolado	11.8	11.3	8.2	8.2	5.7	5.7	8.5	320.0	235.0	155.5	236.8	3.7	1.9	0.8	2.1	23.9	15.8	8.5	16.1		
Mean	8.5	8.2	6.7	6.9	6.0	5.6		684.1	556.2	458.7		5.2	3.6	2.6		37.0	27.2	20.0			
LSD _(0.05)	0.350						13.021				0.369				2.193						

¹: *in vitro* plantlets from storage roots

²: rooted cutting from storage roots

³: cutting from storage roots (was used as control treatment)

*: interaction was significant

Table 6. Means of the characteristics for seedlings based on field trial run in 2016 and 2017

Seedlings	Number of storage roots		Single storage root weight (g)		Single plant yield (kg)		Plot yield (kg)	
	2016	2017						
IP (<i>in vitro</i> plantlets)	8.5	8.2	684.1		5.2		37.0	
RC (Rooted cuttings)	6.7	6.9	556.2		3.6		27.2	
C (Cuttings)	6.0	5.6	458.7		2.6		20.0	
LSD _(0.05)	0.202		7.517		0.213		1.266	

It could be seen in Table 5 means of *in vitro* plantlets for number of storage root, single storage root weight (g), single plant yield (kg) and plot yield (kg) had significant LSD values supporting significant statistical differences among them. For storage root number, *in vitro* plantlets had high mean (8.4) than that of other seedling types. We can also observe this permanent trend for other characteristics such as 684.1 g for single storage root weight 5.2 kg for single plant yield and 37.0 kg for plot yield.

Genotype Lanceolado (8.5) had high mean for number of storage root; genotype Yan Shu-1 had high mean for single storage root weight (809.8 g), single plant yield (5.9 kg) and plot yield (43.3 kg).

When the means of the seedlings types in Table 5 were evaluated; *in vitro* plantlets (IP) had higher means than those of the rooted cuttings (RC) and cuttings (C). Genotype Yan Shu-1 and Tamayukata had high mean for single storage root weight, single plant yield and plot yield. Genotype Lanceolado had high means for number of storage roots except of cuttings (C). This genotype has been offered as consumption due to its standard type storage roots and it is expected to have low yield. Saiful et al. (2002) has reported high yield from single node leaf cuttings in the field experiment. They explain this situation with early development due to rooted system and reaching to high photosynthesis rate earlier. In our study *in vitro* plantlets (IP) have started early vegetative development as compared to other two seedlings types so they resulted in high means for the characteristics. Novak et al. (2007) compared the seedlings obtained directly from root sprouts and young root slips and obtained higher yield from young root slips. In this study the IP seedlings obtained young axillary buds and had a fast and healthy growth potential compared to rooted cutting and cuttings. So IP seedlings had the high means for the characteristics studied.

Saiful et al. (2002) and Novak et al. (2007) have reported the high yield from root cuttings. It could be seen in table 6 that the RC (Rooted cutting) had high mean for the traits studied. The IP (*in vitro* plantlets) had higher yield than the RC (Rooted cutting) in this study indicating high yield in sweet potato grown. Yildirim et al. (2012) have also stated the highest yield from *in vitro* plantlets compared to the seed roots. They pointed out that *in vitro* plantlets developing earlier than the seed roots.

It could be seen that *in vitro* plantlets (IP) had apparent superiority over rooted cuttings (RC) and cuttings (C) for the characteristics studied so the IP seedlings could be used in sweet potato propagation. Besides, genetically uniform, disease-free and healthy seedling can be produced by using *in vitro* plantlets in all growing seasons.

CONCLUSION

In vitro plantlets (IP) were found to have higher means of storage root characteristics as compared to the RC

(Rooted cutting) and C (cuttings) type seedlings. Therefore *in vitro* plantlets could be used as seedlings in sweet potato propagation to obtain high yields of storage roots.

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