J. Agric. Sci. Mansoura Univ., 32 (2): 1329 - 1341, 2007

SEED TUBER PRODUCTION OF SOME HYBRIDS USING TRUE POTATO SEED

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ABSTRACT

Seven true potato seed (TPS) hybrids were evaluated in beds at the International Potato Centre farm (CIP), Kafr El-Zayat, El-Gharbia governorate, Egypt during 2002 and 2003 spring planting seasons, and the resultant seedling tubers were planted during 2002 and 2003 fall planting seasons and during 2003 and 2004 spring planting seasons. This study aimed to produce seed potato free of virus diseases and to reduce the importation of seed tubers from the European countries at expensive prices. The results showed that HPS I/67 hybrid was the best in vegetative characteristics measured as vigor, uniformity and stem length, while HPS I/TPS 13 hybrid showed the lowest values. In addition, HPS I/67, HPS II/67 and Serrana x TPS 67 hybrids gave the highest seedling tuber yield /m^2., whereas, the lowest yields /m^2 were obtained by Atzimba x TPS 13 and Acherrana x TPS 67. The stored seedling tubers that were produced from the seven TPS hybrids in spring season and tubers of Diamant cultivar were used as planting material during fall and spring seasons. Diamant cultivar showed significant increments in uniformity, number of stems and plant height after 45 days from planting. On the other hand, Diamant cultivar recorded the lowest significant values in plant vigor compared with the studied hybrids, but it had the highest mean tuber weight during fall and spring seasons. Highest number of tubers per plant was found in HPS I/67, HPS II/67 and Acherrana x TPS 67 hybrids. Whereas, the highest yield per plot as well as per feddan were recorded by Diamant cultivar and HPS II/67 hybrid in the fall season and by Diamant fallowed by HPS I/67 hybrid in the spring seasons. The highest values of virus infection percentage with PLRV, PVX and PVY were obtained by Diamant and Atzimba x TPS 13, while Serrana x TPS 67 and HPS I/67 hybrids had the lowest virus infection values.

Keywords: True potato seed (TPS), Seedling tuber, Hybrids, Potato production, Virus infection.

INTRODUCTION

In conventional seed potato production systems, potatoes are propagated vegetatively by means of tubers. Vegetative propagation of potatoes is constrained by the accumulation of pathogens, the physiological decline and the low multiplication rates (Upadhya, 1994). In addition, importing high quality seed tubers requires foreign currency that is unaffordable for almost all the developing countries (Malagamba, 1988). The use of true seed as planting material in seed potato production may be a smart approach to break the international monopoly of seed potato sources and could reduce the potato production cost in Egypt and other developing countries. Besides, this can alleviate the problems associated with vegetative propagation. TPS is the result of sexual reproduction and does not transmit most potato diseases,

especially viruses. Due to its small size, TPS is easy to store and transport. Because of these properties, TPS is an alternative seed source for areas where for one reason or another maintenance of clonal stocks and multiplication into good quality seed tubers has not been feasible or economic (Upadhya, 1994). Since TPS is a rather flexible technology that can be implemented in a short period of time, it is particularly suitable for filling the gaps in seed tuber supply left by regular seed tuber programs and systems. There are several methods for planting potato using TPS technology, for example direct sowing or producing of seedling tuber from TPS in nursery beds (Malagamba, 1988). In this respect, Berrios (1994) found that the average percentage of seedling emergence in the field varied from 80 to 100% for progenies Serrana x TPS 13, HPS II 167 and HPS I/67. Moreover, Engels *et al*. (1984) reported that the plant emergence of several grades of seedling tubers of two TPS progenies was 85-99%. Also, they found that the stem number of several grades of seedling tubers of the two TPS progenies, Atz. x Kat. and Atz. x 7 X y.1, were 1.5 and 3.5, respectively. Moreover, Wiersema (1983 & 1984) mentioned that the total seedling tuber yield ranged from 2.55 to 8.97 kg/ m^2 where the corresponding tuber numbers were 224 and 812 tubers/ m^2, respectively, from seed beds of 100 plants /m^2 in Lima, Peru.

In Egypt, El-Bedewy (1994) compared different TPS hybrid progenies in nursery beds and found that the yield ranged from 8.2 to 9.9 kg /m^2 and number of tubers were 540 – 916 /m^2. Chaudhuri *et al* (1995) found that the average yield of promising TPS progenies in clonal generations (F1C1 and F1C2) in progeny HPS I/67 and HPS II/67 was 23.6 and 27.1 t/ha in F1C1, respectively, and reached 25.9 and 26.5 t/ha in F1C2, respectively. Moreover, they found a very low incidence of viral diseases in HPS 7/67, HPS 7/13, HPS I, HPS II/67 and Serrana x LT 7 hybrids.

El-Amin *et al* (1996), in Ethiopia, reported that seedling tuber yield ranged from 0.7 to 32.4 kg m^2 in different agro-ecological zones in Africa, Asia and Latin America. Pande *et al*. (2003) indicated that the HPS I/67 gave significantly higher number of tubers /m^2 than the remaining TPS progenies and the check.

This work aimed to develop a new approach for potato production from seedling tubers appropriate to growers capabilities, using true potato seed hybrids, as a simple method for potato production under our Egyptian conditions as an alternative method for potato production.

MATERIAL AND METHODS

This study was carried out at Kafr El-Zayat station (30°40"N, 30°50"E), Gharbia governorate, during 2002 to 2004 fall and spring seasons. Potato (*Solanum tuberosum,* L.) tubers of Diamant as standard cultivar (moderately late maturity, with tall, thick and erect stems, and very good foliage cover) and seven TPS hybrids, namely HPS I/67, HPS II/67, HPS I/TPS 13, Serrana x TPS 13, Serrana x TPS 67, Atzimba x TPS 13 and Acherrana x TPS 67, were used in this study and were provided by CIP, Lima Peru. This study included the following experiments:

1- Production of seedling tubers from the true potato seed (TPS) hybrids (F_0 Generation).
2- Production of potato tubers (F_1Generation) from seedling tubers (F_0), and evaluation of the resultant plants for common potato viruses (PVX, PVY and PLRV).

1. Production of seedling tubers from the true potato seed (TPS) hybrids (F_0 Generation)

In the spring season, seeds of the seven TPS hybrids introduced from International Potato Center (CIP), Lima, Peru, to CIP of Egypt were sown on Jan. 7 and 8, 2002 and 2003, respectively, in soil nursery beds at Kafr El-Zayat. Sand was well mixed in the top 3 cm of the soil. Phosphorus was applied in form of calcium super phosphate (15% P_2O_5) as a single dressing (400 g /m^2) before sowing. Potassium and nitrogen used in the sulphate form, as well as urea, were split in three doses of 5 gm of N and 5 gm of K_2O /m^2, started 14 days after emergence then every two weeks. Three to four seeds per hill were initially sown, and were thinned five weeks later to one plant per hill (100 plant /m^2). Plastic tunnels were used to protect the seedlings against low temperatures during the first two months after planting, and then plots were covered with insect proof sheets over the remaining period of plant cycle (100 days). Complete randomized block design (CRBD) with four replicates was used. Hilling or earthing up by adding 2-3 cm of seed bed media was carried out by hand six weeks from sowing and repeated four weeks later using normal soil. Irrigation was done by sprinkling cans in the early stage after planting and during emergence and by flooding following establishment of the seedlings. Also, disease and insect control were preformed to protect the plants from aphids, early and late blight infections. Harvesting was done manually about 145 days after sowing (DAS). A grading of TPS hybrids was done and the data were recorded for yield /m^2 and size of tuber grade. Subsequently tubers were cured for 15 days under rice straw after which it was transferred to cold room and kept and 4°C and relative humidity of 85% for the whole storage from May to January.

The following data were recorded:

Field germination percentage calculated by counting the germinated seedlings 30 DAS in nursery beds. Seedling vigor and uniformity of foliage were measured 60 DAS, rating on score of 1 to 9 degree where 1= very poor, 3 = poor, 5 = average, 7 = good and 9 = very good. Stem length was measured from the soil surface to the plant top 120 DAS. Seedling tubers produced from the tested hybrids were divided into four groups: <10g, 10-20 g, 20-40 g and >40 g, tubers in each group were counted and weighed.

2. Production of potato tubers (F1 generation):

The stored seedling tubers, which were produced in the previous experiment, were used as planting material for producing the potato tubers during the fall (October 20) of 2002 and 2003 season, and during spring (January 20) of 2003 and 2004. In both, fall and spring planting seasons, complete randomized block design (CRBD) with four replicates was used. Each plot

consisted of 3 rows of 4.1 m in length and 0.75 m in width, the plot area was 9.2 m^2 seedling tubers were planted at 25 cm spacing. The experiment soil was sandy loam. All agricultural practices to maintain good and healthy plant growth were followed according to the recommendations of CIP station. Yields were harvested in the third week of each of February and May for fall and spring planting seasons, respectively.

The following data were recorded:

Tuber emergence percent, stem height (averaged from 10 plants /plot) was recorded 45 days after planting (DAP), number of stems per plant (averaged from 10 plants /plot) and plant vigor as well as foliage uniformity measured 60 DAP (based on visual score from 1 to 9 a degree, where 1 = very poor and 9 = very good).

Visual virus detection was evaluated and recorded in field depending on external symptoms 75 DAP, then many samples of potato leaves were collected and serologically tested for common potato viruses (PVX, PVY and PLRV) using DAS-ELISA test according to procedures described by Clark and Adams (1977). Number of tubers /plant, mean tuber weight and tuber yield /plot as well as tuber yield /feddan was recorded. Data recorded was as mentioned in fall season. All obtained data were statistically analyzed according to Waler and Duncan (1969) and all recorded percentages were transformed to absolute numbers for statistical analysis according to Fisher and Yates (1963).

RESULTS AND DISCUSSION

1. Production of seedling tubers from the true potato seed hybrids (F_0 Generation)

1.1. Vegetative traits:

1.1.1. TPS Germination (%):

The obtained results in Table (1) showed that, in the first season, Serrana x TPS 13 exhibited the highest value without significant difference as compared with other rested hybrids except Serrana x TPS 67 which showed the lowest values. While in the second season, Acherrana x TPS 67 had the highest value with no significant differences between this hybrid and the other tested hybrids except Serrana x TPS 67 which had the lowest values (90.75 %). These results are in agreement with those of Accatino and Malagamba (1982), Wiersema & Cabello (1986) and Berrios (1994). The obtained results might be due to the capability of progeny to germinate under field conditions.

1.1.2. Uniformity:

In both seasons, HPS I/67 and Acherrana x TPS 67 hybrid recorded the highest values (Table, 1), while HPS I/TPS 13 hybrid had the lowest values. These results are in agreement with those obtained by Rowell *et al.* (1986) and Pandey and Gupta (1996).

1.1.3. Vigor:

Selection for seedling vigor prior to transplanting would help in improving transplant survival as well as general performance for tuber yield (Rowell *et al.*, 1986 ; Gopal, 2004). Data in Table (1) indicated that in both seasons HPS I/67 had the highest values. While, Acherrana x TPS 67 rec-

orded the lowest value. This result may be attributed to differences in genetic structure of tested hybrids.

Table 1. Comparison between vegetative traits of seven TPS hybrids sown in spring of 2002 and 2003 seasons.

Progeny No.	Pedigree	Germination % after 30 days	Uniformity 1-9 (score values)	Vigor 1-9 (score values)	Stem Length (cm)
2002					
88002	HPS I/67	95.00 a	8.0a	8.0a	101.50 a
88004	HPS II/67	93.50 ab	7.5 ab	7.5 ab	92.25 b
88001	HPS I/TPS 13	92.25 ab	5.5 c	6.5 bc	40.50 e
989013	Serrana x TPS 13	95.25 a	7.0 abc	7.0 abc	36.50 e
994016	Serrana x TPS 67	90.00 b	7.5 ab	7.5 ab	65.75 d
994001	Atzimba x TPS 13	91.00 ab	7.0 ab	6.5 bc	79.50 c
996003	Acherrana x TPS 67	95.00 a	6.0 bc	6.0 c	64.00 d
		2003			
88002	HPS I/67	93.75 ab	8.0 a	8.5 a	96.25a
88004	HPS II/67	93.00 ab	7.5 ab	7.5 ab	86.75b
88001	HPS I/TPS 13	91.25 b	6.0 b	6.5 bc	38.00 e
989013	Serrana x TPS 13	94.25 ab	7.5 ab	7.0 bc	33.25 e
994016	Serrana x TPS 67	90.75 b	7.5 ab	7.5 ab	62.75 d
094001	Atzimba x TPS 13	92.00 ab	7.5 ab	6.5 bc	73.25 c
996003	Acherrana x TPS 67	95.00 a	6.0 b	6.0 c	60.00 d

Values with the same letter (s) in each column are not statistically different. According to Duncan's multiple range test at 5% level.
Uniformity and vigor score: 1= very poor; 3= poor; 5= average; 7= good; 9= very good.

1.1.4. Stem length:

Significant differences were found among hybrids in both seasons (Table 1). HPS I/67 hybrid showed the highest stem length during 2002 and 2003 seasons, respectively. While Serrana x TPS 13 and HPS I/TPS 13 had the lowest values. This might be due to the genetical constitution of the tested hybrids, or may be due to the differences in seedling emergence and vigor as reported by Berrios (1994).

1.2. Seedling tuber yield:

1.2.1. Number of tubers:

Data in Table (2) clearly reveal that Serrana x TPS 67 produced the highest significant number of tubers /m^2. While, the lowest values were obtained from Atzimba x TPS 13 and Acherrana x TPS 67 hybrids, in the two tested seasons. Concerning the grading of tubers, the same trend was recorded in all hybrids. The differences among hybrids may be attributed to the differences in plant growth, uniformity and vigor of the tested hybrids. The obtained results are in good harmony with these reported by Wiersema (1983, 1984) who tested several hybrids and found that total seedling tuber yield ranged from 2.5 to 8.9 kg /m^2 with tuber number of 224 to 812 tubers /m^2 from seed beds of 100 plants /m^2.

Table 2. The average of total tuber number /m^2 and grading of seven TPS hybrids sown in spring of 2002 and 2003 seasons.

Progeny No.	Pedigree	Number of tubers / m^2				
		<10g	10-20g	20-40g	>40g	Total number
2002						
88002	HPS I/67	515	116	70	13	714 bc
88004	HPS II/67	540	105	67	15	727 b
88001	HPS I/TPS 13	510	113	75	9	707 bc
989013	Serrana × TPS 13	489	123	62	10	684 c
994016	Serrana ×TPS 67	600	108	85	16	810 a
994001	Atzimba × TPS 13	413	115	57	5	590 d
996003	Acherrana × TPS 67	425	108	54	7	594 d
		2003				
88002	HPS I/67	455	113	71	11	650 bc
88004	HPS II/67	473	108	65	15	661 b
88001	HPS I/TPS 13	448	115	71	9	643 bc
989013	Serrana × TPS 13	430	119	65	8	622 c
994016	Serrana × TPS 67	531	111	83	11	736 a
994001	Atzimba × TPS 13	367	110	57	5	539 d
996003	Acherrana × TPS 67	369	110	52	9	540 d

Values in the same column followed by same letter (s) are not statistically different according to Duncan's multiple range test at 5% level.

1.2.2. Tuber weight (yield)

The studied hybrids significantly differed in their production and weight of the graded tubers (Table, 3). The highest values were noticed for Serrana x TPS 67, HPS I/67 and HPS II/67 without significant differences among them. The lowest values were observed for Atzimba x TPS 13 and Acherrana x TPS 67, while the rest of hybrids gave intermediate values, in both seasons. The obtained increased production and grade weight of tuber of Serrana x TPS 67 hybrid may be attributed to the fact that this hybrid gave the highest number of tubers /m^2 with the highest tuber number of the heavy tuber (Table, 2). This result is confirmed by those of Wiersema (1983 and 1984) and El-Amin *et al* (1996**)**.

Table 3. The average total weight of tuber (yield /m^2) and grading of seven TPS hybrids sown in spring of 2002 and 2003 seasons.

Progeny No.	Pedigree	Weight of tubers kg / m^2				
		<10g	10-20g	20-40g	>40g	Total weight
2002						
88002	HPS I/67	3.0	1.8	1.65	0.55	7.0 ab
88004	HPS II/67	2.74	1.7	1.7	0.66	6.8 abc
88001	HPS I/TPS 13	2.6	1.7	2	0.4	6.7 bc
989013	Serrana × TPS 13	2.55	1.8	1.7	0.45	6.5 c
994016	Serrana × TPS 67	2.65	1.55	2.3	0.7	7.2 a
994001	Atzimba × TPS 13	2.37	1.6	1.5	0.23	5.7 d
996003	Acherrana × TPS 67	2.45	1.6	1.55	0.3	5.9 d
		2003				
88002	HPS I/67	2.13	1.47	1.77	0.46	5.83 ab
88004	HPS II/67	1.95	1.40	1.69	0.62	5.66 abc
88001	HPS I/TPS 13	2.01	1.46	1.72	0.39	5.58 bc
989013	Serrana × TPS 13	2.08	1.55	1.43	0.35	5.41 c
994016	Serrana × TPS 67	2.18	1.45	1.90	0.47	6.00 a
994001	Atzimba × TPS 13	1.78	1.40	1.36	0.21	4.75 d
996003	Acherrana × TPS 67	1.92	1.40	1.20	0.39	4.91 d

Values with the same letter (s) in each column are not statistically different. According to Duncan's multiple range test at 5 % level.

2. Production of potato tubers (F_1 Generation) from seedling tubers (F_0).

2.1. Vegetative traits:

2.1.1. Tuber emergence percent (percent of stand):

Results presented in Table (4) show that in the two fall seasons, Serrana × TPS 13 recoded the highest values without significant differences with the other hybrids except HPS I/TPS 13 in the first season, which had the lowest values. While in two spring seasons (Table, 5), the highest values were recorded by Acherrana × TPS 67 and HPS I/TPS 13 hybrids with significant differences only between them and Serrana × TPS 13 and serrana × TPS 67 which had the lowest values. The obtained results could be due to the genetic differences among the tested hybrids. These results agree with those of Engles *et al.* (1984) who reported that the plant emergence of several grades of seedling tubers of two TPS progenies ranged from 85 to 99 % and the larger tuber had better emergence rate. Also, agrees with Engles (1987) who found that field emergence of small seedling tubers was slower than large tubers.

Table 4. Vegetative traits of seven hybrid progenies (F_1 Generation) and Diamant (standard cultivar) during fall season of 2002/2003 and 2003/2004.

Pedigree	Tuber emergence % 45 DAP	Number of stems /plant	Stem height (cm) 45 DAP	Uniformity 1-9 (score values)	Vigor 1-9 (score values)
2002/2003					
HPS I/67	98.00ab	1.77b	28.85bcd	6.0bc	8.0ab
HPS II/67	98.75ab	1.70b	28.62cd	7.0b	8.5a
HPS I/TPS 13	96.50 b	1.52b	32.89bc	6.0bc	7.5ab
Serrana × TPS 13	99.50a	1.43b	27.28de	5.5cd	7.5ab
Serrana × TPS 67	98.50ab	1.60b	28.34cd	6.0bc	8.0ab
Atzimba × TPS 13	98.50ab	1.51b	33.40b	4.5d	6.5bc
Acherrana × TPS 67	97.00ab	1.75b	23.14e	6.5bc	7.5ab
Diamant	98.00ab	3.88a	40.13a	9.0a	5.5c
		2003/2004			
HPS I/67	97.50a	1.78b	26.35de	6.5bc	8.5a
HPS II/67	98.25a	1.71b	26.37de	7.0b	8.5a
HPS I/TPS 13	97.25a	1.52b	31.63c	6.5bc	7.5abc
Serrana × TPS 13	98.75a	1.42b	26.52de	5.5bc	7.5abc
Serrana × TPS 67	97.75a	1.57b	30.09	6.5bc	8.0ab
Atzimba × TPS 13	98.50a	1.51b	36.65b	5.0d	6.5cd
Acherrana × TPS 67	97.25a	1.74b	22.64e	6.5bc	7.0bc
Diamant	98.25a	4.08a	43.13a	9.0a	5.5d

Values with the same letter (s) in each column are not statistically different. According to Duncan's multiple range test at 5 % level.

Uniformity and vigor score: 1= very poor; 3= poor; 5= average; 7= good; 9= very good.

2.1.2. Number of stems:

In two fall season, no significant differences were detected among the tested hybrids in number of stems /plant but there were significant differences between each of them and Diamant cultivar which recorded the highest values (Table 4). While in the two spring seasons, it was clear from Table

(5) that the Diamant cultivar recorded the highest values, on the other hand, Serrana × TPS 13 had the lowest values, while the rest of hybrids recorded intermediate values. These results are in agreement with those obtained by Engels *et al.* (1984) and Wiersema & Cabello (1986).

2.1.3. Stem height:

Data presented in Table (4) indicated that in the two fall seasons, there were significant differences between all hybrids and Diamant cultivar which recorded the highest values. While, Acherrana × TPS 67 recorded the lowest values. Also, in the two spring seasons, Diamant cultivar recorded the highest significant values. While, the lowest values were recorded by Serrana × TPS 13 (Table 5). This mainly may be due to the differences in tuber size, percent of stand and plant vigor which was higher in Diamant cultivar than those of tested hybrids. These results are agreement with those of Sikka *et al.* (1984), who found significant differences in plant height among several hybrids.

Table 5. Vegetative traits of seven hybrid progenies (F_1 Generation) and Diamant (standard cultivar) during spring season of 2003 and 2004.

Pedigree	Tuber emergence % 45 DAP	Number of stems /plant	Stem height (cm) 45 DAP	Uniformity 1-9 (score values)	Vigor 1-9 score values)
2003					
HPS I/67	96.50abc	3.50b	12.93b	7.50b	8.50a
HPS II/67	98.00ab	3.43b	9.43cd	7.00bc	8.00a
HPS I/TPS 13	98.50a	2.53c	8.63cd	6.50c	7.50ab
Serrana × TPS 13	94.50c	2.05d	6.68d	5.50d	6.50bc
Serrana × TPS 67	95.00bc	2.68c	8.93cd	7.00bc	7.50ab
Atzimba × TPS 13	96.50abc	2.45c	8.55cd	5.00d	6.00cd
Acherrana × TPS 67	98.50a	3.33b	10.35bc	7.50b	7.50ab
Diamant	96.50abc	4.98a	17.60a	9.00a	5.00d
2004					
HPS I/67	96.75abc	3.30b	13.93b	7.50b	8.50a
HPS II/67	97.00abc	3.38b	10.50bcd	7.00bc	8.00ab
HPS I/TPS 13	98.00ab	2.62c	19.13cd	6.50bcd	7.50ab
Serrana × TPS 13	95.00c	2.13d	7.25d	5.50d	6.50bc
Serrana × TPS 67	95.50bc	2.60c	10.03cd	7.00bc	7.50ab
Atzimba × TPS 13	96.50abc	2.65c	8.08cd	6.00cd	6.50bc
Acherrana × TPS 67	98.50a	3.35b	11.25bc	7.50b	7.50ab
Diamant	96.50abc	4.95a	21.10a	9.00a	5.50c

Values with the same letter (s) in each column are not statistically different. According to Duncan's multiple range test at 5% level.

Uniformity and vigor score: 1= very poor; 3= poor; 5= average; 7= good; 9= very good.

2.1.4. Uniformity:

It is clear from Table (4) that in the two fall and spring seasons, the Diamant cultivar had the highest value (9). On the other hand, Atzimba × TPS 13 had the lowest values in fall season and Serrana × TPS 13 in the spring season. These differences in uniformity may be returned to differences in percent of stand, stem number and stem height among the studied hybrids (Tables, 4 and 5). Similar trend was found by Berrios (1994), who reported

that uniformity of F_1 generation seedling tubers ranged from 5 to 9 in several hybrids tested at CIP, Peru.

2.1.5. Vigor:

It is clear from Tables (4 and 5) that in the two fall and spring seasons the vigor values ranged from (5 to 8.5). Diamant cultivar recorded the lowest significant values, compared with HPS I/67 and HPS II/67 which had the highest values. These results might be due to differences in tuber size, stand percent, stem number and stem height per plant which found in this study (Tables, 4 and 5). Similar conclusions were reported by Berrios (1994), who found that the vigor of F1-generation seedling tubers ranged from 7 to 9 in several hybrids compared with standard cultivar**.**

2.2. Tuber yield:

2.2.1. Number of tubers /plant:

As presented in Table (6), HPS II/67 hybrid recorded the highest values in the two fall seasons (8.3 and 8.4). While, Serrana x TPS 13 hybrid recorded the lowest values (6.2 and 6.4). In first spring season HPS I/67 had the highest value (8.9) without significant differences with HPS II/67, Acherrana x TPS 67 and Diamant. In second season, the same hybrid record the highest significant value with all hybrids except Acherrana x TPS 67 (Table, 7). While, Serrana x TPS 13 had the lowest value in both seasons (6.0 and 6.2). These results might be attributed to the differences in number of stems /plant and plant vigor (Tables, 4 and 5) which directly affect number of tubers /plant. Similar conclusions were found by Sikka *et al* (1984), who found that number of tubers per plant differ with TPS hybrids and ranged from 10-22 tuber /plant.

Table 6. Production of plants of TPS hybrid progenies (F_1 Generation) and Diamant cultivar during 2002/2003 and 2003/2004 fall seasons.

Pedigree	Number of tubers/ plant	Mean tuber weight (g)	Yield (kg) /plot	Yield (ton /fed.)
2002/2003				
HPS I/67	7.7abc	89.6 b	31.85b	13.5 b
HPS II/67	8.3 a	84.33 b	32.33 ab	13.7 ab
HPS I /TPS 13	7.0 cd	78.14 b	28.64 c	12.1 c
Serrana × TPS 13	6.2 d	85.48 b	25.67 d	10.9 d
Serrana × TPS 67	7.8 abc	73.07 c	27.05 cd	11.5 cd
Atzimba × TPS 13	7.3 bc	71.23 c	25.18 d	10.7 d
Acherrana × TPS 67	8.1 ab	71.60 c	27.95 c	11.8 c
Diamant	7.1 c	101.0 a	34.20 a	14.5 a
		2003/2004		
HPS I/67	8.0 ab	90.73 b	31.10 b	13.2 b
HPS II/67	8.4 a	85.63 b	33.58 a	14.2 a
HPS I /TPS 13	7.1 cd	85.92 b	27.89 c	11.8 c
Serrana × TPS 13	6.4 d	84.48 b	24.42 d	10.3 d
Serrana × TPS 67	8.0 ab	74.40 c	28.05 c	11.9 c
Atzimba × TPS 13	7.4 bc	72.38 c	24.68 d	10.5 d
Acherrana × TPS 67	8.2 ab	72.65 c	27.18 c	11.5 c
Diamant	7.0 cd	100.03 a	33.15 ab	14.1 ab

Values of the same letter (s) in each column are not statistically different. According to Duncan's multiple range tested at 5 % level

2.2.2. Average tuber weight

It is clear from Tables (6 and 7) that Diamant cultivar recorded the highest significant average tuber weight in the two fall (101.0, 100.03g) and spring (100.0, 101.03g) seasons. While, tubers of Atzimba x TPS 13 hybrid had the lowest values in the two fall seasons (71.23, 72.38g). But HPS II/67 had the lowest value in the first spring season (65.43 g), while the lowest value in the second spring season was recorded by Atzimba x TPS 13 (64.67g). These results may be due to the differences in number of tubers /plant and plant vigor. Similar conclusions were reported by Weirsema and Cabello (1986**).**

2.2.3. Yield:

It is obvious from the results presented in Table (6) that in the two fall seasons the highest values were recorded by HPS II/67 hybrid (32.3, 33.5 kg/plot and 13.7, 14.2 ton/fed.) and Diamant cultivar (34.2, 33.1 kg/plot and 14.5, 14.0 ton/fed.). While, Serrana x TPS 13 and Atzimba x TPS 13 had the lowest yield (25.6, 24.4 kg/plot and 10.8, 10.3 ton/fed.) and (25.1, 24.6 kg/plot and 10.6, 10.4 ton/fed.), respectively. Regarding the yield in the spring seasons, Diamant cultivar recorded the highest yield (39.08, 38.53 kg/plot and 16.6, 16.3 ton/fed.) followed by HPS I/67 hybrid (31.15, 31.98 kg/plot and 13.2, 13.6 ton/fed.) compared with the other studied hybrids, (Table, 7). On the other hand, Atzimba x TPS 13 recorded lowest values (21.4, 22.04 kg/plot and 9.1, 9.3 ton/fed.) during 2003 and 2004, respectively. The obtained results could be explained based on the differences in plant vigor, number of tubers and stems /plant (Tables, 4 and 5). In this respect, Sharma *et al.* (1995) found similar results and reported that the yield of various progenies ranged from 13.7 to 15.5 ton /fed. compared with 13.8 ton /fed. for the standard cultivar (Kufri Bahar). In other words, HPS II/67 hybrid in the fall season and HPS I/67 hybrid in the spring season, were the best for tuber yield production compared with the other tested TPS hybrids.

Table 7. Production of plants of TPS hybrid progenies (F_1 Generation) and Diamant cultivar during 2003 and 2004 spring seasons.

Pedigree	Number of tubers /plant	Mean tuber weight (g)	Yield (kg) /plot	Yield (ton /fed.)
2003				
HPS I/67	8.9 a	74.15 c	31.15 b	13.2 b
HPS II/67	8.1 ab	65.43 d	25.28 cd	10.7 cd
HPS I/TPS 13	6.1 d	78.68 bc	23.28 e	9.9 e
Serrana × TPS 13	6 .0 d	81.66 b	22.64 ef	9.6 ef
Serrana × TPS 67	7.4 bc	66.22 d	23.53 de	10.3 de
Atzimba × TPS 13	6.7 cd	65.67 d	21.47 f	9.6 f
Acherrana × TPS 67	8.4 a	65.47 d	26.08 c	11.9 c
Diamant	8.0 ab	100.0 a	39.08 a	16.6 a
		2004		
HPS I/67	9.1 a	76.66 c	31.98 b	13.6 b
HPS II/67	8.2 b	66.01 d	26.93 c	11.4 c
HPS I/TPS 13	6.2 c	79.68 bc	23.78 d	10.1 d
Serrana × TPS 13	6.2 c	83.20 b	23.64 d	10.0 d
Serrana × TPS 67	7.6 b	67.10 d	25.90 c	11.0 c
Atzimba × TPS 13	6.8 c	64.67 d	22.04 d	9.3 d
Acherrana × TPS 67	8.4 ab	66.75 d	27.10 c	11.2 c
Diamant	7.9 b	101.03 a	38.53 a	16.6 a

Values of the same letter (s) in each column are not statistically different. According to Duncan's multiple range tested at 5 % level.

3. Virus diseases:

Production of seedling tubers from the TPS hybrids (F_0 Generation): plants grown under field conditions and kept under insect proof cages showed no virus symptoms (PVX, PVY and PLRV). Serological tests ensured their freedom from any of the above mentioned viruses. These results ensured the non transmissibility of the tested viruses through true potato seed (TPS). These results are agreement with those of Beukema and Zaag (1990).

Evaluation of seedling tubers of hybrids (G_1) to virus infection: this experiment was carried out to evaluate the obtained seedling tubers to virus infection under field condition. Data tabulated in Tables (8 and 9) revealed that Diamant and Atzimba × TPS 13 had the highest values of infection percentage by PLRV and Mosaic viruses while Serrana × TPS 67 and HPS I/67 had the lowest values.

Natural infection with PLRV and Mosaic was low during the different growing seasons in hybrids plants as compared with Diamant variety. The differences in infection ratio among different seasons may by returned to different in activity of transmitted insects during different seasons. These results were confirmed by ELISA for PLRV, PVY and PVX and are in agreement with those of Wiersema (1984), Hoang *et al* (1988) and Chaudhuri *et al* (1995).

Table 8. Susceptibility of plants of different TPS hybrid progenies (G1) compared to Diamant cultivar for virus diseases during 2002/2003 and 2003/2004 fall seasons.

Progenies/variety	Virus disease incidence %			
	2002/2003		2003/2004	
	PLRV	PVY & PVX (Mosaic)	PLRV	PVY & PVX (Mosaic)
HPS I/67	4.00e	13.25d	3.50e	12.50c
HPS II/67	6.75c	15.75c	6.25c	12.50c
HPS I/TPS 13	7.50b	15.00c	7.00bc	12.25c
Serrana × TPS 13	4.75d	13.50d	4.25de	11.75c
Serrana × TPS 67	5.25d	12.75d	4.50d	9.75d
Atzimba × TPS 13	9.00a	18.25b	7.75b	14.75ab
Acherrana × TPS 67	8.75a	17.75b	6.75c	13.25bc
Diamant	9.00a	20.50a	8.75a	16.50a

Values with the same letter(s) in each column are not statistically different. According to Duncan's multiple range test at 5% level.

Table 9. Susceptibility of plants of different TPS hybrid progenies (G1) compared to Diamant cultivar for virus diseases during 2003 and 2004 spring seasons.

Progenies/ varieties	Virus disease incidence %			
	2003		2004	
	PLRV	PVY & PVX (Mosaic)	PLRV	PVY & PVX (Mosaic)
HPS I/67	8.50cd	18.25de	7.25c	15.50c
HPS II/67	10.50b	21.25b	9.75b	18.50b
HPS I/TPS 13	9.50bc	21.00bc	8.75bc	18.25b
Serrana × TPS13	9.50bc	18.00de	9.50b	16.25c
Serrana × TPS 67	7.50d	17.50e	8.00c	15.25c
Atzimba × TPS13	12.50a	26.50a	12.00a	22.25a
Acherrana × TPS67	10.50b	19.50cd	9.75b	18.00b
Diamant	13.25a	26.25a	12.25	23.25a

Values with the same letter(s) in each column are not statistically different. According to Duncan's multiple range test at 5% level.

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إنتاج تقاوي البطاطس باستخدام البذور الحقيقية لبعض الهجن

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سبعة هجن من بذور البطاطس الحقيقية تم تقييمها في المركز الدولي للبطاطس في كفر الزيات، محافظة الغربية، حيث زرعت البذور الحقيقية للهجن في مشاتل بالعروة الربيعية لعامي ٢٠٠٢ و ٢٠٠٣ ومن ثم تم زراعة درنات الشتلات الناتجة من تلك الهجن خلال العروة الشتوية لعامي ٢٠٠٢ و ٢٠٠٣ وفي العروة الربيعية لعامي ٢٠٠٣ و ٢٠٠٤. بهدف إنتاج تقاوي بطاطس خالية نسبياً من الإصابات الفيروسية وذلك كمحاولة لإنتاج تقاوي البطاطس من خلال استخدام البذور الحقيقية لهجن البطاطس (TPS) للتغلب على المشكلات الناجمة من ارتفاع أسعار تقاوي البطاطس المستوردة وكسر احتكار الشركات المصدرة. وأوضحت النتائج أن الهجين HPS I/67 كان الأفضل في صفاته الخضرية المقدرة على أساس قوة النمو وتجانسه وطول الساق وأقلها الهجين HPS I/TPS 13. وأعطت الهجن Serrana X TPS 67, HPS I/67 and HPS II/67 أعلى محصولاً من درنات الشتلات في حين أعطى كل من الهجينين Acherrana X TPS 67 و Atzimba x TPS 13 أقل قيمة محصوليه في المتر المربع. وعند زراعة درنات الشتلات للهجن السابقة ومقارنتها بالصنف التجاري دايمونت وجد أن الصنف دايمونت تفوق على الهجن من حيث التجانس وعدد السيقان و ارتفاع النبات وذلك بعد ٤٥ يوم من الزراعة بينما تفوقت الهجن في قوة النمو على الصنف التجاري. سجل الصنف دايمونت أعلى متوسط لوزن الدرنة في العروتين الشتوية و الربيعية بينما أعلى عدد من الدرنات على النبات وجد في الهجن Acherrana X TPS 67، HPS I/67، HPS II/67. وبالنسبة لمحصول القطعة التجريبية والفدان فقد حقق الهجين HPS II/67 و الصنف دايمونت أعلى قيمة في العروة الشتوية المنزرعة بتقاوي محلية بينما في العروة الربيعية فكانت أعلى إنتاجية للصنف التجاري يلية الهجينHPS I/67. وكذلك فإنه عند اختبار النباتات الناتجة من البذور الحقيقية بالنسبة للإصابة ببعض الأمراض الفيروسية مثل فيروس X البطاطس وفيروس Y البطاطس وفيروس التفاف الأوراق تبين أن أغلب الهجن كانت إصابتها منخفضة مقارنة بالصنف التجاري وأقل نسبة إصابة سجلت في الهجينين HPS I/67, Serrana x TPS 67 بينما أعلى نسبة إصابة سجلت في نباتات الهجين Atzimba x TPS 13 و نباتات الصنف دايمونت. وعلى هذا يفتح هذا البحث الاتجاه إلى دراسة إمكانية استخدام البذور الحقيقية لبعض هجن البطاطس في إنتاج تقاوي درنات على النطاق التجاري تحت الظروف المحلية وخاصة في العروة الشتوية نظرا لما تتمتع به تلك الهجن من إنتاجية عالية وإنها لا تعطي مدى واسع من التباين في الشكل المظهري عند الزراعة بالبذور من هذه الهجن و ينصح بزراعة الهجين HPS I/67 ، Serrana x TPS 67 ذلك لتفوقهما على باقي الهجن ولمقاومتها للأمراض الفيروسية وبخاصة فيروس PLRV ، PVY ، PVX مما يساعد على المضي قدما في هذا المجال المتعلق بإنتاج تقاوي البطاطس عن طريق البذور الحقيقية للهجن التي تثبت أداء جيد تحت الظروف المحلية.

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1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341