Evaluation of Suitable Substrate for Seedling Tuber Production by True Potato Seed through Nursery Raising

M.M.R. Jamro[1,*], A.N. Shah[2], G.M. Laghari[2], A.S. Chandio[3] and M.S. Depar[3]

[1]*Date Palm Research Station KotDiji, Khairpur (Mirs), Sindh, Pakistan*

[2]*Department of Agronomy, Sindh Agriculture University Tandojam, Pakistan*

[3]*Arid Zone Research Institute (PARC) Umar Kot, Sindh, Pakistan*

Abstract: To determine the suitable substrate, five growth substrates viz. Soil + Sand, Soil + FYM, Soil + Sand + FYM, Soil + PM (Poultry manure) and Soil + Sand + PM were used to grow the three true potato seed (TPS) genotypes viz. TPS-9802, TPS-9804 and TPS-9805. Results of the interactive effect of genotypes x substrates on plant and tuber traits concluded that maximum germination (90.5 %), plant height (46.3 cm), micro tubers (212.7), small tubers (45.7), medium tubers (28.2), large tubers (10.2) and total tubers (296.8), maximum weight of micro (1491 g), small tubers (757.6 g), medium tubers (828.9 g), large tubers (483.7 g) and total tuber weight (3561) per unit area ($1m^{-2}$) and total tuber yield (35.6 t ha^{-1}) were found in TPS-9804 grown in the substrate of soil+sand+FYM. However TPS-9805 yielded (32.5 t ha^{-1}) and ranked 2nd with same substrate. Hence, it is recommended for raising TPS nursery.

Keywords: TPS, Substrate, Nursery, Growth and Yield.

INTRODUCTION

True potato seed (TPS) is the tiny botanical seed found in small and tomato like fruits of potato (*Solanum tuberosum* L.) plants [1]. TPS is an alternative technology that is scientifically sound, technically feasible, and economically viable and eco-friendly [2]. TPS has been used for commercial seed production in China, Sri Lanka, Rwanda, Egypt, Philippine, India and Bangladesh [3, 4, 5]. For nursery production, any substrate low in organic matter is not suitable due to low moisture holding capacity. Typically, the suitable substrates used to grow seedlings are mixtures of 50% sand and 50% shredded peat moss by volume, or a mixture of 75% peat moss and 25% sand, or mixtures of well decomposed compost made up of bean residues, manure and leaf litter [6]. The effects of organic and inorganic fertilizers on growth, yield and post-harvest behavior of TPS seedling tubers were studied by [8, 9] and the significant increase in number of tubers and yield of potato by improving the substrate with addition of farmyard manure was also observed by [7]. According to [10], the substrates of soil, and farmyard manure in equal ratio by volume were appropriate for seedling tuber production in nursery beds. Due to preliminary stages of TPS introduction in Sindh, Pakistan, it was necessary to conduct a preliminary experiment to determine a suitable substrate at this location for seedling tuber production for TPS in nursery production.

*Address correspondence to this author at the Date Palm Research Station KotDiji, Khairpur (Mirs), Sindh, Pakistan; Tel: 0243556441, 03003293962; E-mail: mrjamro@yahoo.com

MATERIAL AND METHODS

Three TPS genotypes; TPS-9802, TPS-9804, TPS-9805 and five substrates: (1) Soil + Sand, (2) Soil + FYM, (3) Soil + Sand + FYM, (4) Soil + PM, and (5) Soil + Sand + PM, were laid out in randomized complete block design (RCBD) with three replications. For each treatment combination, 6-8 inches high raised beds having a net bed size of $1m^{-2}$ were prepared.

Each seed bed was initially built using a preparatory substrate that was a mixture of (a) soil, (b) sand, and (c) well-rotted farm yard manure and poultry manure all in a 1:1:1 proportion by volume. After seedling emergence, up to 5 cm of the 5 substrates listed above, were gradually added to a bed according to the plot plan of the experimental design, and for the function of hilling the beds as the plants grew.

The recommended fertilizer dose of 225-125-125 NPK kg ha^{-1} in the form of Urea, Single Super Phosphate and Sulphate of Potash were applied on a schedule for recommendations typical to this study location. The phosphoric and potasic fertilizers were applied at the time of seed bed preparation, while the nitrogenous fertilizer was applied in two equal splits at the time of the 1st and 2nd hilling.

A wooden marker developed by the National Potato Program, National Agricultural Research Center (NARC), Islamabad, Pakistan, was used to mark and make holes for seed sowing. Two seeds per hole were planted at 0.5 cm, with 25 cm between rows per bed, and 4 cm between seeds within a row. After sowing of

ISSN: 1814-8085 / E-ISSN: 1927-5129/16

seed, the beds were covered with a rice straw cover and watered early in the morning and late afternoon with a watering cane until germination.

Fifteen days after sowing, the straw cover was removed and irrigation water was applied through furrows within the nursery. Thinning of seedlings and replanting in gaps occurred two weeks after emergence. Regular field visits were carried out to perform all the cultural practices including plant protection measures.

The collected data was analyzed by procedures of [11] through MSTAT-C package. For separation of means, Duncan's Multiple Range Test (DMRT) was applied.

RESULTS AND DISCUSSION

The results for genotypic effect (Table **1**), revealed that germination was maximum (80.0%) for genotype TPS-9804, followed by TPS-9805 (78.4%) and TPS-9802 (78.0%), with tallest plants (39.0 cm) recorded for TPS-9804 genotype. However, TPS-9805 and TPS-9802 genotypes recorded 37.1 and 36.0 cm mean plant height, respectively. The increase in germination percentage and plant height in TPS-9804 might be genetic potentiality of the plant material and nursery substrate. Our results closely agree with the findings of [12] who by planting seven TPS cultivars (RC 767-2, Br. 63-18, Kondor, VC 785-2 Raslin Ruaka, VC 801-4 and CIP 387705-18), obtained average seed germination 81.1% for TPS genotypes.

Tuber size of TPS genotypes differed significantly, the results showing greater numbers of micro (179.5), small (37.7), medium (20.4) and large (7.4) tubers in TPS-9804. TPS-9805 ranked at 2nd place by recording 173.2 micro, 33.3 small, 17.0 medium and 6.2 large tubers. Genotype TPS-9802 was ranked last by recording micro (166.9), small (31.3), medium (13.7) and large (5.4) tubers. The findings are supported by [13] who reported higher total yield in diamant and Sante (with 22.9 and 22.3 t ha^{-1} respectively) than the other varieties. Also the emergence percentage and uniformity of foliage cover in these varieties were better than others.

The maximum tuber weight of micro (1182 g), small (633.7g), medium (670.6 g), and large tubers (326.1 g) with higher total tuber weight (2812 g m^{-2}) and tuber yield (28.1 t ha^{-1}) was recorded with the TPS-9804 genotype. However, TPS-9805 showed 1103 g micro, 553.7 g small, 645.2 g medium, and 269.7 g large tubers with total tuber weight of 2571 g m^{-2} and tuber yield of 25.7 t ha^{-1}. The minimum tuber weight was

Table 1: Response of Genotypes for Agronomic Traits of True Potato Seed Across Nursery Substrates

True potato seed traits	LSD$^{0.05}$	True potato seed genotypes		
		TPS- 9802	TPS- 9804	TPS- 9805
Germination (%)	0.9622	78.0^{b}	80.0^{a}	78.4^{b}
Plant height (cm)	1.417	36.0^{b}	39.0^{a}	37.1^{b}
Tuber number (m^{-2})				
Micro tubers	1.779	166.9^{c}	179.5^{a}	173.2^{b}
Small tubers	1.312	31.3^{c}	37.7^{a}	33.3^{b}
Medium tubers	0.2541	13.7^{c}	20.4^{a}	17.0^{b}
Large tubers	0.1184	5.4^{c}	7.4^{a}	6.2^{b}
Total tubers	7.104	217.2^{c}	245.0^{a}	229.7^{b}
Tuber weight (g m^{-2})				
Micro tubers	25.39	1044^{c}	1182^{a}	1103^{b}
Small tubers	9.611	533.1^{c}	633.7^{a}	553.7^{b}
Medium tubers	15.24	520.4^{c}	670.6^{a}	645.2^{b}
Large tubers	6.907	257.6^{c}	326.1^{a}	269.7^{b}
Total tuber weight	36.19	2355.0^{c}	2812.0^{a}	2571.0^{b}
Tuber yield (t ha^{-1})	0.3619	23.6^{c}	28.1^{a}	25.7^{b}

In each row, means followed by a common letter are not significantly different at 5% probability level. **Tuber grading:** micro tuber (1-9 mm), small tuber (10-19 mm), medium tuber (20-39 mm) and large tuber (>40 mm).

observed in genotype TPS-9802 which recorded weights of micro (1044 g), small (533.1g), medium (520.4 g), and large tubers (257.6 g) with total tuber weight (2355 g m^{-2}) and tuber yield (23.6 t ha^{-1}). The findings of [14, 15] found the highest yield of seed tubers (35.6 t ha^{-1}) was obtained through the direct sowing bed method.

The results regarding the effect of substrates (Table **2**) showed maximum germination (87.6 %) when TPS was sown in substrate containing soil+sand+ FYM (1:1:1), followed by 80.9 % germination in soil+sand+PM (1:1:1). The minimum germination (70.7 %) was observed in substrate having soil+sand (1:1).The mean data for plant height showed taller plants (44.3 cm) due to application of substrate containing soil+sand+FYM (1:1:1), followed by 39.5 cm plant height in soil+sand+PM (1:1:1). However, dwarf plants (30.8 cm) were recorded in substrate containing soil+sand (1:1).

The greater tuber numbers of micro (201.4), small (42.6), medium (23.4), and large tubers (9.1), with 276.6 total tubers were found when TPS was grown in the soil+sand+FYM (1:1:1) substrate. The lowest numbers of micro (140.3), small (24.6), medium (11.9), and large (4.0), with total tuber number (180.9) were observed in the soil+sand (1:1) substrate.

The maximum tuber weights of micro (1397 g m^{-2}), small (715.9 g m^{-2}), medium (756.3 g m^{-2}), and large tubers (417.6 g m^{-2}), with higher total tuber weight of (3286 g m^{-2}) and tuber yield of (32.8 t ha^{-1}) were found when seeds were grown in soil+sand+FYM (1:1:1). The lowest weights of micro (894.6 g), small (422.4 g), medium (482.4 g) and large tubers (187.2 g) were observed when TPS was planted in the soil+sand (1:1) substrate, total tuber weight of 1986 g m^{-2}, and tuber yield of 19.8 t ha^{-1}. In general, these findings are supported by [16] who reported that highest total tuber yield (28.7 t ha^{-1}) was observed with the application of city compost at 4 tons ha^{-1}, followed by green plus (27.4 t ha^{-1}) and bio fertilizer (26.4 t ha^{-1}). Similarly, [17] also determined that TPS progenies performed significantly better for all yield parameters (i.e., number and weight of large, medium and small tubers). The findings indicated that the nursery substrate for producing seedling tubers must be sufficient in organic matter and water holding capacity with adequate drainage and low proportion of clay to avoid compaction.

Results of the interactive effect of genotypes x substrates on plant and tuber traits of TPS (Table **3**) revealed that maximum germination (90.5%) was observed in TPS-9804 grown in soil+sand+FYM

Table 2: Effect of Different Nursery Substrates on Agronomic Traits of True Potato Seed Across Genotypes

True potato seed traits	$LSD^{0.05}$	Nursery substrates				
		Soil + Sand (1:1)	Soil + FYM (1:1)	Soil + Sand + FYM (1:1:1)	Soil + PM (1:1)	Soil + Sand + PM (1:1:1)
Germination (%)	1.242	70.7^{e}	79.6^{c}	87.6^{a}	74.6^{d}	80.9^{b}
Plant height (cm)	1.829	30.8^{d}	38.0^{b}	44.3^{a}	33.5^{c}	39.5^{b}
Tuber number (m^{-2})						
Micro tubers	2.297	140.3^{e}	183.7^{c}	201.4^{a}	149.4^{d}	191.4^{b}
Small tubers	1.693	24.6^{e}	36.3^{c}	42.6^{a}	27.3^{d}	39.3^{b}
Medium tubers	0.3281	11.9^{e}	16.2^{c}	23.4^{a}	14.2^{d}	19.2^{b}
Large tubers	0.1529	4.0^{e}	6.1^{c}	9.1^{a}	5.1^{d}	7.1^{b}
Total tubers	9.171	180.9^{e}	242.3^{c}	276.6^{a}	196.1^{d}	257.1^{b}
Tuber weight (g m^{-2})						
Micro tubers	32.77	894.6^{e}	1077^{c}	1397^{a}	1005^{d}	1173^{b}
Small tubers	12.41	422.4^{e}	590.7^{c}	715.9^{a}	446.2^{d}	692.5^{b}
Medium tubers	19.68	482.4^{e}	589.2^{c}	756.3^{a}	555.2^{d}	677.3^{b}
Large tubers	8.916	187.2^{e}	257.2^{c}	417.6^{a}	225.1^{d}	335.4^{b}
Total tuber weight	46.72	1986^{e}	2514^{c}	3286^{a}	2231^{d}	2878^{b}
Tuber yield (t ha^{-1})	0.4672	19.8^{e}	25.2^{c}	32.8^{a}	22.3^{d}	28.8^{b}

In each row, means followed by a common letter are not significantly different at 5% probability level. **Tuber grading:** micro tuber (1-9 mm), small tuber (10-19 mm), medium tuber (20-39 mm) and large tuber (>40 mm).

Table 3: Interactive Effect of Genotypes x Substrates on Agronomic Traits of True Potato Seed

Genotypes x substrates		True potato seed traits												
		Germination (%)	Plant height (cm)	Tuber number (m^{-2})					Tuber weight (g m^{-2})					
				Micro (1-9 mm) tubers	Small (10-19 mm) tubers	Medium (20-39 mm) tubers	Large (>40) tubers	Total tubers (m^2)	Micro (1-9) tubers	Small (10-19) tubers	Medium (20-39) tubers	Large (> 40) tubers	Total tuber weigh t	Yield (tha^{-1})
TPS-9802	Soil + Sand (1: 1)	69.5 i	29.3 h	136.9 j	22.7 g	9.4 k	3.0 i	171.8 h	838.0 j	378.1 i	436.1 i	142.5 k	1794 k	17.9 k
	Soil + FYM (1: 1)	81.4 d	36.6 ef	175.9 f	31.7 de	13.2 h	5.2 f	226.0 f	1019 g	554.4 e	491.0 h	236.0gh	2.300 h	23.0 h
	Soil + Sand +FYM (1: 1: 1)	84.7 c	42.4 bc	190.6 d	39.7 bc	19.2 c	8.2 c	257.7e f	1315 c	678.4 c	653.1 e	404.9 b	3051 c	30.5 c
	Soil + PM (1: 1)	73.8 fg	33.4 fg	145.4 hi	25.7 fg	11.3 j	4.3 g	186.6 g	938.8 hi	412.6 h	491.5 h	200.5 j	2043 j	20.4 j
	Soil + Sand + PM (1: 1: 1)	80.5 de	38.3 de	185.9 e	36.7 c	15.2 f	6.2 e	243.9 cd	1107 ef	642.1 d	570.4 fg	304.1 e	2623 f	26.3 f
TPS-9804	Soil + Sand (1: 1)	71.9 gh	32.6 g	144.1 i	26.7 f	14.2 g	5.2 f	190.2 g	953.3 h	459.6 g	553.9 g	223.4 hi	2190 i	21.9 i
	Soil + FYM (1: 1)	78.9 e	39.8 cde	190.2 d	43.7 a	19.2c	7.2 d	260.3 b	1119 ef	705.4 b	683.8 de	294.2 e	2802 e	28.0 e
	Soil + Sand +FYM (1: 1: 1)	90.5 a	46.3 a	212.7 a	45.7 a	28.2 a	10.2 a	296.8 a	1491 a	757.6 a	828.9 a	483.7 a	3561 a	35.6 a
	Soil + PM (1: 1)	75.7 f	34.2 fg	153.9 g	29.7 e	17.2 d	6.2 e	206.9 de	1098 f	493.1 f	574.3 fg	263.7 f	2429 g	24.2 g
	Soil + Sand + PM (1: 1: 1)	81.8 d	40.90 cd	196.8 c	42.7 ab	23.2 b	8.2 c	270.8bc	1246 d	753.0 a	753.6 c	365.6 c	3117 c	31.2 c
TPS-9805	Soil + Sand (1: 1)	70.9 hi	30.8 gh	140.0 j	24.7 fg	12.2 i	4.0 h	180.8 g	892.5 ij	429.6 h	512.8 h	195.6 j	2030 j	20.3 j
	Soil + FYM (1: 1)	78.5 e	37.8 de	184.9 e	33.7 d	16.2 e	6.0 e	240.7 cd	1093 f	512.2 f	592.8 f	241.5 g	2439 g	24.4 g
	Soil + Sand +FYM (1: 1: 1)	87.6 b	44.3 ab	200.9 b	42.7 ab	22.9 b	9.0 b	275.4 b	1385 b	711.5 b	791.9 b	364.1 c	3252 b	32.5 b
	Soil + PM (1: 1)	74.3 f	32.9 g	148.9 h	26.7 f	14.3 g	5.0 f	194.7ef	978.6 gh	432.7 h	652.4 e	211.0 ij	2274 h	22.7 h
	Soil + Sand + PM (1: 1: 1)	80.7 de	39.6 cde	191.5 d	38.7 c	19.2 c	7.2 d	256.5bc	1167 e	682.4 c	711.7 d	336.4 d	2897 d	28.8 d
$LSD^{0.05}$		2.152	3.168	3.978	2.933	5.642	0.2648	15.89	56.76	7.646	33.59	15.44	80.93	0.8092

In each column, means followed by common letter are not significant different at 5% probability level.
Tuber grading: micro tuber (1-9 mm), small tuber (10-19 mm), medium tuber (20-39 mm) and large tuber (>40 mm).

(1:1:1). The minimum germination (69.5%) was obtained with the genotype TPS-9802 planted in the soil+sand (1:1) substrate. The mean data for plant height showed taller plants (46.3 cm) in TPS-9804 when seeds were sown in soil+sand+FYM (1:1:1), whereas dwarf plants (29.3 cm) were recorded in TPS-9802 raised in the substrate having soil+sand (1:1).The increase in germination was due to the use of a more appropriate substrate, which was loose and aerated, accommodating the increased respiration rate during germination. This substrate also contributed 1.53, 0.228, and 2.16 NPK percentages as major plant nutrients due to inclusion of FYM. Addition of sand in this substrate improved porosity amplified aeration by playing a role as a mulch effect for seed germination and caused vigorous root and shoot development.

The greater number of micro tubers (212.7) was found for TPS-9804 when seeds were grown in the soil+sand+FYM (1:1:1) substrate. The lowest number of micro tubers (136.9) were noted in TPS-9802 planted in the soil+sand (1:1) substrate. The maximum number of small tubers (45.7) was found in TPS-9804 grown in the substrate containing soil+sand+FYM (1:1:1), followed by 43.7 tubers for TPS-9804 when seed was sown in soil+FYM (1:1) substrate. The results further revealed the minimum number of small tubers (22.7) for TPS-9802 grown in the soil+sand (1:1) substrate. The maximum number of medium tubers (28.2) was obtained in TPS-9804 planted in the soil+sand+FYM (1:1:1) substrate, whereas, the minimum number of medium tubers (9.4) were recorded in TPS-9802 seeded in the soil+sand (1:1) substrate. The highest number of large tubers (10.2) was recorded in TPS-9804 grown in the soil+sand+FYM (1:1:1), whereas, lower number of large tubers (3.0) were found in TPS-9802 planted with the soil+sand (1:1) substrate. The maximum number of total tubers (296.8) recorded in TPS-9804 when planted in soil+sand+FYM (1:1:1). The minimum number of total tubers (171.8) was noted in TPS-9802 seeded in soil+sand (1:1).

The interactive effect of genotypes x substrates showed significant differences for tuber weight according to grading. The results of the study showed maximum weight (1491 g) of micro tubers in TPS-9804 grown in the soil+sand+FYM (1:1:1), with minimum micro tuber weight (838 g) recorded in TPS-9802 sown in the soil+sand (1:1) substrate. The greatest weight of small tubers (757.6 g) was observed in TPS-9804 seeded in soil+sand+FYM (1:1:1), followed by 753 g for TPS-9804 planted in soil+sand+PM (I:1:1) substrate. The minimum weight of small tubers (378.1 g) was recorded in TPS-9802 sown in the soil+sand (1:1) substrate. The maximum weight of medium tubers (828.9 g) was obtained in TPS-9804 grown through soil+sand+FYM (1:1:1), whereas, minimum weight of medium tubers (436.1 g) was recorded in TPS-9802 planted in the soil+sand (1:1) substrate. The higher weight of large tubers (483.7 g) was recorded in TPS-9804 sown in soil+sand+FYM (1:1:1). The genotype TPS-9802 recorded lower weight of large tubers (142.5 g) when grown in the soil+sand (1:1) substrate. The maximum total tuber weight (3561 g m^{-2}) was recorded in TPS-9804 when seeds were planted in the soil+sand+FYM (1:1:1) substrate. The genotype TPS-9802 recorded total minimum tuber weight (1794 g m^{-2}) when planted in the soil+sand (1:1) substrate. Due to luxurious growth of plants, the number and weight of seedling tubers with the soil+sand+FYM (1:1:1) substrate, was significantly more compared to other substrates.

The experimental results showed that a soil substrate with the inclusion of poultry manure can lead to a reduction in the yield and yield parameters, perhaps due to excessive levels of nitrogen present in the poultry manure in the form of ammonium (NH_4), as well as an excess of salts, which caused damage to the roots. According to [18], incorporation of poultry manure had no significant effect on soil density and porosity. Poultry litter could increase pH because of the amounts of calcium found in poultry feed, particularly varying amounts of calcium carbonate.

CONCLUSIONS

Comparing five seeding substrates and three TPS genotypes, it is concluded that the TPS-9804 genotype grown in the substrate containing soil + sand + FYM (1:1:1) proved the most efficient than other substrates for obtaining maximum germination, tuber number, size and yield. Hence, it is suggested that TPS-9804 genotype may be preferably sown in the substrate soil + sand + FYM (1:1:1) for TPS nursery production.

REFERENCES

[1] Fuglie KO, Do NTB, Dao CH, Nguyen HT. Economic returns to research on true Potato seed in Vietnam. CIP program report 2000; 211.

[2] Upadhya MD. True Potato Seed: Propagule for potato production in 21st century. Potato; present and future. Shekhawet GS, khurana SM, Pandey SK, Chandla VK, editors. Proceedings of the national symposium held at Modipuram during 1-3, March 1993. Indian Potato Association, Shimla; 1996; p.15.

[3] Mulatu E, Osman EI, Etenesh B. Improving potato seed tuber quality and producers' livelihoods in Hararghe, Eastern Ethiopia. J New Seeds 2005; 7(3): 31-56.

[4] Guenthner JF. Development of on-farm potato seed tuber production and marketing scheme. Agricultural economics extension series no. 06-01, University of Idaho, Moscow 2006; pp. 1-18.

[5] Gildemacher P, Kaguongo W, Ortiz O, Tesfaye A, Gebremedhin W, Wagoire W, Kakuhenzire R, Kinyae P, Nyongesa M, Struik PC, Leewis C. Improving potato production in Kenya, Uganda and Ethiopia. Potato Res 2009; 52: 173-205.

[6] Malagamba P. Seed bed substrates and nutrient requirements for the production of potato seedlings. Hooker WJ, editor. In: Proceedings International Congress "Research for the Potato" International Potato Center, Lima, Peru 2000; pp. 127-28.

[7] Hernandez A. Integrated agronomic management of substrates, sowing methods and bio-fertilization on the sustainable production of potato seed tubers from true seed. Cultivos Tropicales 2001; 22(2): 21-27.

[8] Okonkwo JC, Lang AJ. Effect of organic and inorganic fertilizers on the yield of true potato seed in Jos Plateau, Nigeria. J Sust Agri and Envir 2003; 5: 99-104.

[9] Rahman EHMS, Siddique MA, Rabbani MG. Effect of cow dung and NPK on the yield and storability of seedling tubers raised from true Potato seed. Bangladesh J Trai and Devel 2002; 15: 151-156.

[10] Tuku BT. The utilization of true potato seed (TPS) as an alternative method of potato production. Indonesian J Agric Sci 2002; 1(2): 29-38.

[11] Gomez KA, Gomez AA. Statistics for Agricultural Research.2nd ed. John Willey and Sons, New York 1984; p. 680.

[12] Okonkwo JC, Chibuzo AC. Performance of potato varieties raised from true potato in Jos plateau, Nigeria. National Root Crops Research Institute, Irish Potato program, Kuru, Nigeria. Niger Agri J 2002; 33: 60-67.

[13] Mortazavi A, Pooriaye Vali M. Study of summer planting possibility of Potato cultivars by using two tuber seed dormancy-breaking methods. Pajouhesh and Sazandegi 2007; 19(1): 79-86.

[14] Salomon JL, Estevez A, Gonzalez ME, Castillo JG. Performance of potato (*Solanum tuberosum* L.) hybrid progenies derived from true seed. Cultivos Tropicals 2002; 23: 59-61.

[15] Begum S, Siddique MA. Yield and economic return in potato production using true potato seeds as influenced by different methods of production and variety. Bangladesh J Train and Devel 2002; 15(1/2): 101-105.

[16] Krishnamurthy N, Khalak A, Sujith GM. Response of potato grown from TPS to integrated use of organic manures and fertilizers in alfisols of eastern dry zone of Karnataka. South Indian Hort 2001; 49: 165-167.

[17] Ahmed CMS, Saqib S, Abbasi NA. Performance of seedling potato tubers from true seed in second generation in comparison with local varieties. Sarhad J Agri 2001; 17(1): 69-73.

[18] Aluko OB, Oyedele DJ. Influence of organic incorporation on changes in selected soil physical properties during drying of a Nigerian alfisols. J App Sci 2005; 5: 357-362.

Received on 08-01-2016 Accepted on 26-02-2016 Published on 22-03-2016

http://dx.doi.org/10.6000/1927-5129.2016.12.25