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Field Performance and Character Association of True Potato Seed (TPS) Progenies

M. K. Munira[1], M. G. Rasul[2], M. A. K. Mian[2], M. Ibrahim[3] and A. Saha[4]
[1]BADC, Gabtali, Dhaka, [2]Genetic and Plant Breeding Department, BSMRAU, Gazipur, [3]BRRI, Gazipur-1701,
[4]BRRI R/S, Sonagazi, Feni, Bangladesh

Abstract: Nine True Potato Seed (TIS) progenies originated from CIP, India (HPS-7/67, HPS-II/67, HPS-II/13, HPS-7/13) and TCRC, Bangladesh (HPS-819, HPS-9/8, HPS-9/67, HPS-364/9) were evaluated for yield potential in F_1C_0 generation at Bangabandhu Sheik Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during November 1995 to March, 96. Bangladeshi progenies performed equally good or even better than Indian progenies for tuber yield, days to tuber initiation, tuber number/m^2, foliage coverage, and harvest index. High genetic variation, high heritability and considerable genetic gain were observed in plant height, foliage coverage, tuber number/ma and also yield. Tuber yield was found highly correlated with tuber number, foliage coverage, plant height, stems per plant and high direct effect was offered by these traits towards increasing yield. Based on yield potentiality, progenies HPS-7/76, HPS-7/13, HPS8/9, HPS-364/9 performed well and were selected for future TPS breeding to develop pr9genies having high yield with good keeping quality.

Key words: Performance, Character, TPS, Progeny.

Introduction

Potato (*Solanum tuberosum* L.) is one of the major food crops of the world. In Bangladesh, it is the third important crop. after rice and wheat. In contribtites more than 50 percent of the vegetables consumed in Bangladesh. Since potato has all the characteristics of a staple food and has high yield potential, there is a bright prospect to promote it as a supplementary staple food in Bangladesh in reducing the shortage of food in the country.

In Bangladesh potato is now growing in about 1,30,000 hectare of land with a production of 1.44 million tons (BBS, 1995). Out of the total area 62 percent is covered by high yielding varieties (Rashid, 1990). The average yield of potato in our country is only 10.9 t/ha, which is very low in comparison to other countries of the world like. The Netherlands (41.9 t/ha), United Kingdom (37.8 t/ha) and even in our neighboring country India (18.22 t/ha). In Bangladesh, cultivable land is very scarce limiting the horizontal expansion of potato. However, there is a wide scope of increasing potato yield vertically. Among the constrains of potato production, lack of quality seed tuber, high cost of imported or certified seed tuber and disease problems are noticeable. Seed tuber alone represent 40-70 percent of the total costs of production. Besides, quality seed tuber production, its storage and transportation costs are also high, particularly where the general infrastructure is inadequate. Upto two tons of these expensive and perishable seed tubers are required to plant a hectare of land, which often yields not more than 10-15 tons of ware potatoes under subtropical conditions. Research in the recent past showed that the use of true seeds for producing the potato crop can highly be profitable where there is a scarcity of quality seeds. Since information on potato progency is not available in our country, the results reported in the study are related to select a suitable plant type having high yield with good natural keeping quality.

The proper evaluation and careful selection provide scope for identifying desirable genes for exploitation, either directly or through hybridization. The effectiveness of selection depends upon the genetic variability present in the population. Therefore, the object of this study was to assess and quantify genetic variability in TPS progeny through univariate and multivariate approaches and to find out the genotype having high tuber yield potentiality.

Materials and Methods

The following nine different TPS progenies were used as the experimental materials

Name of the TPS progenies	Pedigree	Origin/Breeding Station
HPS-7/67	TPS-7 × TPS-67	CIP Region VI, New Delhi India
HPS-II/67	TPS-II × TPS-67	〃
HPS-7/13	TPS-7 × TPS-13	〃
HPS-II/13	MF-II × TPS-13	〃
HPS-9/8	TS 9 × TS-8	TCRC in Bangladesh
HPS-8/9	TS 8 × TS-9	〃
HPS-6/9	TS 6 × TS-9	〃
HPS-9/67	TS 9 × TPS-67	〃
H PS-364/9	P364 × TS-9	〃

The experiment was conducted to study the variability, correlation co-efficient, path analysis of different yield and yield contributing characters in the above nine TPS progenies. The seeds were sown in the field on 22 November 1995. The experiment was lid out in a Randomized Complete Block Design (U) with 4 replications having 1.6 m x 1.0 m unit plot size. Seedbeds were prepared with mixture of soil, sand and well-decomposed cow dung in 1:1 Iv/v) ratio and disinfected by applying 2 percent formalin at of 1 gallon per sq. feet. Seeds treated with dithane M-45 and sown at the depth of 0.5 cm with a spacing of 25 cm × 4 cm. Two days before seed sowing 100 g TSP, 10g Urea and 10g MP per sq. meter were applied in seedbed as basal dose. Urea solution was sprayed as growth hormone on seedlings after 20 days of seeding. Appropriate cultivation practices were followed to raise a good crop. Haulm cutting was done at 110 days after planting and kept on the bed so that the tuber skin becomes hard. Harvesting was done on 5 March 1996. Data were recorded on 10 randomly selected plants of each plots for days to 100 percent emergence, days to stolOnization, days to tuber initiation, plant height (cm), stem/plant, foliage coverage (%), tuber number/ma, harvex index (%), dry matter content (%) and yield (kg/m^2). Path co-efficient was estimated for these 10 characters following Dewey and Lu (1959).

Genotypic and phenotypic co-efficient of variation, broad heritability, genetic advance, genetic_edvance as percentage of mean, genotypic and phenotypic correlation co-efficient for all possible combinations were estimated following Burton (1952), Hanson *et al*. (1956); Johnson *et al*. (1955), (1951), Lush (1949) and Miller *et al*. (1958).

Results and Discussion

Analysis of variance and genetic parameters: The analysis of variance showed significant differences among the progenies for all characters studied (Table 1). The progeny HPS-7/67 and HPS-II/67 (11.00) exhibited maximum days to 100 percent emergence and the minimum was in HPS-9/8 (8.75). Bangladeshi progenies emerged within 9 days and the Indian progenies required around 11 days for this trait. The highest days to stolonization were observed in HPS-II/67 (38.50) and the lowest duration in HPS-9/8, HPS-6/9 and MPS-9/67 (33.00). The progenies of Indian origin were delayed in stolon formation, which might be due to its late seed emergence. The duration of tuber initiation was highest in HPS-II/67 (41.00) and the lowest in HPS-8/9 (35.00). For this trait Bangladeshi group formed stolon earlier than Indian group. Plant height was the highest in HPS-6/9 (85.38) and the lowest in HPS-9/67 (62.70). The number of stem/plant ranged from 4.80 (HPS-8/9) to 1.60 (HPS-7/67). Most of the progenies showed good foliage coverage at 60 DAS ranging from 40.00 (HPS-II/67) to 72.50 (HPS-II/13). The highest and lowest number to tubers/m^2 as compared to Indian progenies. The progeny HPS-7/67 and HPS-6/9 produced maximum (19.14 g) and minimum (17.19 g) dry matter respectively. Maximum and minimum biological yield was found in HPS-8/9 (89.20 g) and HPS-6/9 (73.03 g) respectively. The highest yield w as observed in HPS-7/13 (7.62 kg/m^2) and the lowest in HPS-9/67 (5.38 kg/m^2). All the Bangladesh progenies showed similar yield potentiality around 6.0 kg/m^2. Rasul *et al*. (1990) also found similar yield in Southern areas of Bangladesh. The progeny having second highest yield (6.79 kg/m^2), higher number of tuber/m^2 (656.50) and highest foliage coverage might be used as commercial cultivar or as prospective parent in hybridization program. Rasul *et al*. (1993) also found similar result while worked with eight progenies.

Both higher estimates of genotypic and phenotypic variances were observed in plant height, foliage coverage and tuber number/m^2. Characters having high genotypic coefficient of variation (GCV) as compared to phenotypic coefficient of variation (PCV) should be considered as high potential for selection (Alam *et al*., 1985). Characters like stem/plant, foliage coverage and tuber number/m^2 showed higher GCV value (28.01, 16.87 and 16.35).

Less difference between GCV and PCV, moderately high heritability with low genetic advance and genetic advance in percentage of mean were observed in days to 100 percent emergence, days to stolonization, days to tuber initiation and harvex index (%) indicated that the genes acted non-additively for expressing the characters (Table 2). High heritabilitx observed in plant height (74.44), foliage coverage 187.54) and tuber number/m^2 (85.01). High heritability, higher estimates of the genetic advance with higher genetic advance in percentage of mean were observed I plant height (74.44, 30.22, 34.25), foliage coverage (87.54, 21.85, 38.74) and tuber number/m^2 (85.01, 24.90, 37.38) respectively (Table 2) which in agreement with the result of Rasul *et al*. (1990). A higher heritability estimates along with high genetic gain indicates that the characters are governed by additive gene effect to a great extent (Chaudhury *et al*., 1988). According to Katiyar *et al*. (1974),

Table 1: Mean performance of nine different True Potato Seed (TPS) progenies

Parameter	EM	DS	DT	PH	SP	FC	TN	DM	HI	TY
HPS-7/67	11.00a	36.25ab	38.50b	67.13bc	1.60c	50.00c	845.75a	19.14a	78.65bc	6.29bc
HPS-II/67	11.00a	38.500	41.00a	65.13bc	4.15ab	40.00d	700.75b	17.59cd	79.30bc	5.92c
HPS-7/13	10.75ab	35.75bc	37.00bc	76.83a-c	2.60bc	48.75c	497.25e	18.12bc	80.08bc	7.62a
HPS-II/13	10.00ab	34.25bd	36.25bd	79.05ab	2.00c	72.50a	656.50bc	17.83cd	75.70bd	6.97ab
HPS-9/8	8.75c	33.00bd	36.25c-e	64.25bc	3.30a-c	63.75b	556.75de	18.47ac	81.05b	5.63c
HPS-8/9	10.00ab	33.25d	35.00e	67.40bc	4.80a	52.50c	597.50cd	18.48a-c	89.20a	6.00bc
HPS-6/9	10.00ab	33.00cd	35.25de	85.38a	2.80bc	62.50b	672.75bc	17.14d	73.03d	5.76c
HPS-9167	10.00ab	33.00d	35.35de	62.70c	3.35a-c	61.25b	649.50bd	18.86ab	76.58bd	5.38c
HPS-364/9	9.75bc	33.25bd	36.25c-e	77.40a-c	2.50bc	56.25	820.25a	19.03ab	74.73cd	6.09bc
F-test	**	**	**	*	**	**	*	**	**	**

** = Significant at 1 % level * = Significant at 5 % level
Mean followed by uncommon letter (s) differ significantly
EM = Days to 100 % Emergence SP = Stem/plant (No.) DS = Days to stolonization FC = % Foliage Coverage
DT = Days to tuber initiation TN = Tuber number/m^3 PH = Plant height (cm) HI = Harvest index
TY = Tuber yield (kg/m^2) DM = Dry matter content

Table 2: Estimation of statistical and genetic parameters for nine progenies in True Potato Seed (TPS

Parameter	EM	DS	DT	PH	SP	FC	TN	DM	HI	TY
Mean	10.14	34.97	36.86	71.76	3.01	56.39	666.33	18.29	78.70	6.19
Range	8.75	33.00	35.25	62.70	1.60	40.00	497.25	17.14	74.73	5.38-7.62
Variance of:	11.00	38.50	41.00	77.40	4.80	72.50	845.75	19.14	89.20	
Genotypic	0.38	2.63	3.21	43.55	0.71	88.81	138.64	0.37	19.42	0.39
Environmental	0.48	2.62	1.42	82.89	1.25	25.58	20.51	0.39	12.11	0.41
Phenotypic	0.86	5.25	4.78	126.43	1.96	113.89	158.16	0.75	31.53	0.80
h^2b	44.36	50.18	69.18	74.44	36.33	87.54	85.01	48.80	61.59	48.57
G.Ad. (1%0)	1.09	3.04	3.99	30.22	1.34	21.85	24.90	1.12	9.13	1.15
G. Ad. in %age	10.72	9.68								
of mean	10.83	34.25	44.57	38.74	37.38	6.11	11.60	18.56		
GCV	6.10	4.64	4.93	9.20	28.01	16.67	16.35	8.31	5.60	10.09
PCV	9.15	6.56	5.93	15.67	46.47	18.93	18.87	4.78	7.13	14.47
ECV	6.83	4.62	3.29	12.69	37.08	8.97	9.43	3.39	4.42	10.38

EM = Days to 100 % Emergence SP = Stem/plant DS = Days to stolonization FC = % Foliage Coverage
DT = Days to tuber initiation TN = Tuber number/m^2 PH = Plant height (cm) HI = Harvest index
TY = Tuber yield (kg/m^2) DM = Dry matter content h^2b = Heritability in broad sense GA = Genetic Advance
GCV = Genetypic coefficient of variation PCV = Phenotypic coefficient of variation

Table 3: Correlation co-efficient of different characters for nine True Potato Seed (TPS) progenies

Parameter		DS	DT	PH	SP	FC	TN	DM	HI	TY
EM	G	0.777*	0.755*	0.712*	-0.085	-0.802**	0.871**	-0.119	0.024	0.505
	P	0.364	0.467*	-0.677*	-0.212	-0.491*	0.153	-0.081	-0.072	0.286
DS			0.991**	-0.140	-0.258	-0.667*	0.356	-0.092	-0.168	0.525
	P		0.887**	-0.034	-0.109	-0.419	0.202	-0.166	-0.039	0.149
DT				-0.851	-0.133	-0.682*	0.315	-0.108	0.035	0.779*
	P			-0.779	-0.012	-0.514	0.025	-0.239	0.073	0.777*
PH					-0.632*	0.449	0.054	-0.639*	0.699*	0.482
	P				-0.287	0.192	0.042	-0.317	0.622*	0.414
SP						-0.409	-0.469	0.108	0.762*	0.488
	P					-0.259	-0.331	0.282	0.723*	0.366
FC							-0.135	-0.069	0.378	0.082
	P						-0.132	-0.078	0.370	0.091
TN								0.408	-0.445	0.891**
	P							0.289	0.356	0.846**
DM									0.231	-0.216
	P								0.178	-0.004
HI										0.069
	P									-0.041

** = Significant at 1 % level * = Significant at 5 % level G = Genotypic
EM = Days to 100 % Emergence SP = Stem/plant P = Phenotypic DS = Days to stolonization
FC = % Foliage Coverage DT = Days to tuber initiation TN = Tuber number/m^2 PH = Plant height (cm)
HI = Harvest index TY = Tuber yield (kg/m^2) DM = Dry matter content

Table 4: Path analysis showing direct (underlined value) and indirect effect of 10 characters on yield in True Potato Seed (TPS) progenies

Parameter	EM	DS	DT	PH	SP	FC	TN	DM	HI	Correlation with yield
EM	-4.786	-0.842	0.010	0.148	0.480	4.483	0.269	0.233	0.085	0.505
DS	-3.717	-0.441	0.014	-0.178	1.315	3.709	0.259	0.180	-0.586	0.524
DT	-3.614	-0.450	-0.014	0.448	0.678	3.812	0.228	0.211	-0.124	0.279
PH	-0.536	0.061	0.005	1.276	3.218	-2.509	0.039	1.435	-2.507	0.482
SP	0.404	0.113	0.001	-0.806	-5.093	2.286	-0.340	0.212	2.732	-0.487
FC	3.839	0.292	0.009	0.573	2.083	-5.589	0.098	0.135	-1.329	-0.081
TN	-1.776	-0.157	0.004	0.069	2.388	0.757	0.726	-0.798	-1.595	-0.390
DM	0.569	0.040	0.001	-0.935	0.552	0.386	0.2-96	1.958	0.830	-0.216
HI	-0.113	0.072	0.005	0.892	-3.879	2.070	-0.323	0.453	3.587	0.068

Residual effect = 0.5974
EM = Days to 100 % Emergence SP = Stem/plant DS = Days to stolonization FC = % Foliage Coverage
DT = Days to tuber initiation TN = Tuber number/m^2 PH = Plant height (cm) HI = Harvest index
TY = Tuber yield (kg/m^2) DM = Dry matter content

heritability value alone provides no indication of the amount of genetic gain that would result from selection of the best individual of a population. This results indicated that improvement of such type of traits might be fruitful in future and these character might be taken into consideration while selecting a suitable line or progeny (Johnson *et al*., 1955).

Analysis of correlation co-efficient: Genotypic and phenotypic correlation co-efficient between different characters were estimated in all possible combinations (Table 3). Days to 100 percent emergence showed high positive significant genotypic correlation with days to stolonization (0.777*), plant height (0.721*) and tuber number/m^2 (0.871**). Positive and significant correlation at both the levels was observed in days to tuber initiation with days to 100% emergence and days to stolonization but negative with foliage coverage and at phenotypic level it was significant and negative with plant height with days to 100 percent emergence only. Days to stolonization had significant negative correlation with foliage coverage at genotypic level (-0.667*) but nonsignificant at phenotypic level. Days to tuber initiation showed positive and significant correlation with tuber yield at both the levels ad negatively with plant height at genotypic level. Stem/plant and dry matter content were significantly correlated with plant height at genotypic level in negative direction but it was significant at the phenotypic level. Foliage coverage, tuber number/m^2 and tuber yield showed considerable positive correlation while it had negligible association with plant height. Singh and Singh (1987) observed significant positive correlation with yield. The results agreed the findings of Rasul *et al*. (1990). Stem/plant showed positive and significant correlation only with harvest index at both the level and showed nonsignificant positive correlation with dry matter content and tuber yield. Singh and Singh (1987) also recorded nonsignificant positive association between number of shoots and tuber yield. No significant association for foliage coverage with other characters was observed but it had positive correlation with harvest index and tuber yield. Dry matter content had negative relationship with tuber yield at both the levels which is agreed with the findings of Rasul *et al*. (1990) and also had negative correlation with all the characters except stem/plant, tuber number/ma and harvex index. Tuber number/ma showed highly positive and significant correlation with tuber yield at both the level, which is supported by Rasul *et al*. (1990).

It was observed that genotypic correlation co-efficient were higher than the phenotypic correlation co-efficient of variation. This situation indicated the masking effect of the environment, which in turn modified the expression of a character thereby reducing the phenotypic character.

Path co-efficient analysis: In this method tuber yield was considered as a resultant variable and all other characters shown in Table 4 were considered as independent variable. Days to 100 percent emergence, days to stolonization, days to tuber initiation, stem per plant and foliage coverage showed direct negative effect on yield. Plant height gave a considerable correlation coefficient (0.48) with yield and also produced stronger direct effect (1:27) to yield. Rasul *et al*. (1995) reported strong correlation for this trait. Tuber number/m^2 had positive (0.726) direct effect on tuber yield and the correlation with it was highly positive. In this trait the relationship explains the true relationship and a direct selection through this trait will be effective which was agree by Rasul *et al*. (1993). Dry matter content and harvest index showed direct positive effect in path analysis. The residual effect of 0.5974 seemed to be high indicated that some more character had left which should be included to lower the value in further study.

From the study of genetic parameters, field performance, character association and path analysis, it can be concluded that selection would be effective based on days to tuber initiation, foliage coverage, tuber number/m^2, harvest index and tuber yield for future breeding program. Bangladeshi progenies performed equally good or even better than Indian ones. Considering yield and other performance both at field and laboratory, progenies, HPS-7167, HPS-7/13, HPS-364/9 and HPS-8/9 might be used for commercial cultivation and also be used for thddevelopment of high yielding long dormant.

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