PRODUCTIVITY AND NATURAL STORAGE BEHAVIOUR OF TRUE POTATO SEED PROGENIES

A THESIS
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Dedicated to my

Beloved Parents
Late Bhabani Pada Roy
and
Rekha Roy

ABBREVIATIONS AND ACRONYMS

ATDP	Agro-based Industries and Technology Development Project
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
CIP	International Potato Centre
CV	Coefficient of Variation
CRD	Completely Randomized Design
DAS	Days After Sowing
HPS	Hybrid Potato Seeds
HADS	Humanitarian Agency for Development Services
IFDC	International Fertilizer Development Centre
NS	Non Significant
MP	Muriate of Potash
PRC	Potato Research Centre
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
t/ha	Tons per hectare
TCRC	Tuber Crops Research Centre
TPS	True Potato Seed
TSP	Triple super phosphate
F_1C_0	Seedling tuber generation
F_1C_1	First clonal generation

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ABSTRACT

Twenty True Potato Seed (TPS) progenies supplied from Tuber Crops Research Centre (TCRC) of Bangladesh Agricultural Research Institute (BARI) were evaluated during 2000-2001 for their yield potential in seedling tuber generation (F_1C_0) at Sher-e-Bangla Agricultural University (SAU), Dhaka. Among them only nine progenies were selected as promising and evaluated in their first clonal generation (F_1C_1) along with a check variety, Diamant for keeping quality under natural storage condition. The selected progenies were further evaluated in field during 2001-2002 at same location. There existed significant variation among the progenies in seedling tuber generation for important plant growth parameters. In first clonal generation, the progenies showed significant variation for all the plant growth parameters studied except number and weight of tubers hill^{-1}. Tuberlets yield (t ha^{-1}) was found to be highly correlated with foliage coverage, plant height, number of tuberlets plant^{-1}, number of tuberlets m^{-2} and tuberlets yield (kg m^{-2}) and direct effect was observed with these characters towards increasing tuberlets yield. Regarding post-harvest behaviour under natural storage, small and medium sized tubers performed significantly better storage life compared to large tubers. All the progenies showed superior storage life

(weight loss, rottage loss, days to sprouting and shrivelling etc.) than the check variety, Diamant. Based on both productivity and post-harvest behaviour under natural storage condition, the performances of three progenies namely; HPS-364/9, HPS-9/67 and HPS-364/67 were found satisfactory.

CHAPTER - I

INTRODUCTION

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most productive and widely grown food crops in the world. Its cultivation ranges from large tracts to home gardens and provides a cheap and nutritious food (Appendix VII). It is generally believed to have originated in the Andes region of South Peru and Bolivia (Hawkes, 1966 and Salaman, 1954). The Spanish investigators brought it to Europe from South America in the 16th century (Grewal, 1990). The commercially cultivated potato, *Solanum tuberosum* is a tetraploid species with the chromosome number $2n = 4x = 48$ (Hawkes, 1956 and 1958).

In Bangladesh, it is also an important crop after rice and wheat, ranking fourth and third, respectively in terms of area and production. About 2.76 million tons of potatoes were produced in 1998-99 from about 245 thousand hectares of land with an average national yield of 11.25 t ha^{-1} (BBS, 2000). The national yield in the country is much lower than that of many other potato growing countries like Netherlands (41.9 t ha^{-1}), UK (37.8 t ha^{-1}) (FAO, 1988) and even in neighbouring country, India (18.22 t ha^{-1}) (Gaur and Pandey, 1990). The causes of such low yield of potato might be due to lack of quality seeds of good varieties, disease infestation, unavailability and uneven distribution of certified seeds, use of local cultivar having low yield potential and short growing season are noticeable.

The total potato seed requirement of the country is about 186 thousand tons. Out of which, only about 7-8 thousand tons of certified seed are supplied by the Bangladesh Agricultural Development Corporation (BADC) which covers only 3.8 to 4.3% of the total requirement of seed tuber (Hussain, 1998). A small quantity of seed tuber is also supplied by some private entrepreneurs. The rest of the seed stock used is of inferior quality produced and stored by farmers, having a poor yield potential and heavily infected with degenerative virus. But most of our farmers are compelled to use it. In the traditional system of planting, it requires 1.5 to 2.5 tons of seed tubers of potatoes per hectare, which incurs about 40-60% of the total cost of production (Hussain, 1995). So, the major limiting factor for potato production is the non-availability of good quality seed potatoes at a reasonable price. Consequently, the availability of good quality seed to the majority of potato growers at a reasonable price is the most important negative driving force for limiting the production of potato in Bangladesh (Ali, 2000).

Recently, the use of True Potato Seed (TPS) for the production of high quality seed potatoes has been well established as an acceptable technology instead of tuber seeds in many countries including Bangladesh. This is due to low transmission of disease, high multiplication rate and good tuber yield (Siddique and Rashid, 2000). Available reports indicate that the use of TPS is an approach for reducing cost of production and increasing net return per unit area (Sikka, 1987 and Chaudhury, 1989). Only 50-100g of TPS is required for planting one hectare of land instead of using 1.5-2.0 tons of seed tubers required in the conventional system (Roy *et al.*, 1999).

True Potato Seed (TPS) is sexual seed of potato crop, which is produced through open pollination as well as artificial pollination for producing hybrid seeds in between two known parents as male and female.

The world literatures revealed that TPS technology is highly promising and it may have remarkable contribution to potato production, especially for marginal farmers. In the early days of promotion, the non availability of TPS was the major bottleneck for the diffusion of this technology. Recently, governmental and non-governmental organizations (NGOs) and private seed companies have realized the potential of this technology and its success, and have been encouraged to take up the commercial production of hybrid seed of TPS progenies which are jointly identified by the Tuber Crops Research Centre (TCRC) of Bangladesh Agricultural Research Institute and International Potato Centre (CIP), Lima, Peru.

Under collaborative research activities between the TCRC and CIP, the technology has paved its way to reach the end-users in Bangladesh. As many as 240 hybrid TPS progenies developed by CIP have been screened under different agro-climatic conditions during the last 14 years (Kadian *et al.*, 1995). Most progenies were found to have the desired horticultural traits. Some of the promising hybrid TPS progenies such as BARI TPS-1, BARI TPS-2 and HPS-II/13 have been found suitable in respect of growth and yield attributes for Bangladesh conditions (Moniruzzaman, 1994). The TPS production programmes have been started by Tuber Crops Research Centre during 1980 indicating its prospect in Bangladesh (Brown, 1987; Rashid, 1987 and Upadhya, 1987).

Seedling tubers/tuberlets produced from TPS are healthy planting materials and are used as high quality seed in the next season for the production of either seed tubers or table potato. There are opinions in favour of seedling tuber production using TPS in the first year and table potato in the second year (Anon., 1995; Hussain, 1999; Siddique, 1999 and Siddique and Rashid, 2000).

Storage of potato is a serious problem in Bangladesh. Potato is grown in Bangladesh in Rabi season. The crop is harvested at the end of winter (February to March) when both temperature and humidity begin to rise sharply. Such conditions are favourable for rot and quick termination of dormancy thereby decreasing the quantity and quality of tubers. Cold storage facilities are not available in all places where the crop is grown. In Bangladesh, roughly 75% of the total (about 1.4 million tons) potato production can be stored in about 320 cold storage and the remaining tubers are stored by the farmers under ordinary storage (BBS, 2000).

The growers are interested to store their product up to the hottest period (March to September) at home to sale slowly with high price. During that pariod high temperature and humidity are responsible for quick deteriorations of tuber (Anon., 1993). The harvesting period of this crop is very narrow. Due to its perishable nature farmers can not store potato at home in large quantities for long period. Farmers in most places are under compulsion to sell out the major part of their product immediately after harvest with low price. In years of good harvest, the price goes down to such a low level to make potato growing unprofitable for the farmers. Small farmers can not afford extra investment in cold storing even where cold storage is available. Interestingly, our local potato cultivars have good keeping quality under natural storage but their yield is very poor (7 tha^{-1}) (Anon., 1995).

Knowledge of the nature of storage and its components is of great importance for the selection of TPS progenies having good keeping quality. But the information on TPS progenies for keeping quality under natural storage condition is not sufficient in our country. The selection of suitable TPS progenies having high yield with good storage potentiality under natural condition is of prime importance. Considering the above idea and the scope of work on the productivity and storage behaviour of TPS progenies, the present investigation was undertaken with the following objectives:

1. To assess the productivity of different TPS progenies in their seedling tuber (F_1C_0) and first clonal generations (F_1C_1).

2. To find out the progenies that give reasonably good tuber yields.

3. To assess the character associations and contribution of characters towards yield with different clonal generations.

4. To identify TPS progenies having better keeping ability under natural storage condition.

5. To select suitable size for longer dormancy under natural condition.

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The True Potato Seed (TPS) is now gaining popularity among farmers. Besides, the availability of TPS with desired quality at relatively cheaper rates compared to the high costs of good quality tuber seed is highly desirable (Thankur and Upadhya, 1990). Research activities and results on different aspects of TPS both at home and abroad are reviewed as below:

2.1 Performance of TPS in potato production

Maity and Upadhya (1997) evaluated TPS families for seedlings tuber and ware tuber production. Seedling tuber yields were in the range of 3.39 to 3.86 kg m^{-2}, with TPS-7/13 giving the highest yield of 4.98 kg m^{-2}. The cost of using TPS was reported to be lower than the use of seed tubers. Khurana and Bhatia (1994) stated that the seedling tuber (produced from TPS families) planting rate may be reduced by >50% without any loss of yield.

The TPS technology was being developed as a low cost alternative technology for the improvement of expansion of potato production in the countries where seed tubers are too expensive and are of poor quality (Abera, 1997).

The benefits of using seedling tubers obtained from the TPS as an alternative to the use of seed tubers. The cost of production for TPS seedling tubers was calculated considering six categories of inputs. Nearly 50% of the total expenditure was labour cost. It was indicated that the TPS technology is most appropriate for the marginal farmers' utilizing their own human resources (Dubas, *et al.*, 1994).

El-Bedewy and Crissman (1991) evaluated the cost of seedling tuber production from TPS in plastic tunnel protected nursery bed. The production cost for sufficient seedling tubers to plant one hectare of land was 53% of the cost of producing locally produced seed tubers.

TPS technology is economically sound than traditional technology of potato production. Monares (1984) reported that the cost and returns of the TPS technology versus the traditional technology in potato production and showed that the growers obtained higher yields and economic return by using TPS than by using locally produced seed tubers. The TPS technology was less expensive than the conventional propagation method. He also reported that the advantages of the TPS technology were not only in cost reduction, but also in obtaining higher yield compared to the yields commonly obtained by the farmers through the use of highly disease infected planting material.

It was observed from the potato production using TPS that the cost of production had been reduced by 42% with the use of TPS as against tuber seed, and the benefit cost ratio was 3.49 in TPS technology and 2.53 in case of seed tuber technology (Sabur and Chaudhury, 1987).

2.2 Field performance of TPS in tuberlets production

Potato production from TPS is feasible under Bangladesh condition (Sikka, 1987). A number of TPS progenies were developed which are able to produce good yield of tuberlets of uniform shape and colour having resistance to diseases. However, not all progenies are equally adoptable. Since 1981, more than one hundred TPS progenies have been evaluated in Bangladesh in order to select progenies most adaptable to the agro-climatic conditions of Bangladesh. Though some hybrid TPS progenies originated from the International Potato Centre (CIP) viz. Atzimba x DTO–20, Atzimba x R–128 have been found to be the best progeny but some segregation in tuber colour was observed. Recently, region VI of CIP, New Delhi has developed a number of hybrid TPS progenies which have good tuber shape, colour and uniformity and are reported to be well adaptable at short day and mild winter condition.

Accatino and Malagamba (1982) reported that under protective conditions, germination and seedling emergence occurred within one week, and vigorous seedlings are ready for transplanting within 4–5 weeks after sowing.

Commercial production of potato by the use of TPS is new in Bangladesh and there is little information available particularly under Bangladesh condition on different aspects of TPS technology. From the different study of TCRC, it has been found that different HPS progeny (e.g. BARI TPS-1, BARI TPS-2 etc.) are stable for Bangladesh for their uniform tuber size, uniformity and non-segregating tuber colour. TCRC has conducted few studies on the evaluation of hybrid TPS progenies (Anon., 1992; Anon., 1993 and Anon., 1994).

Kidene-Mariam (1984) used different TPS progenies having the necessary characteristics for the production of good tuber yield with acceptable phenotypic uniformity in colour, size, shape and maturity. The results showed that there were several TPS families which gave a marketable tuber yield and uniformity having acceptable to excellent rating. The yield and uniformity of some of the TPS families were as good as that of commercial varieties produced seed tubers.

Promising exotic TPS hybrids were evaluated at two agro-climatic regions in Sri Lanka–a Eliya (WU3-up-country wet zone) and Bandarawela (IU3-up-country intermediate zone) during the 1993-94 season. There were

20 and 17 entries in Sita Eliya and Bandarawela, respectively. These hybrids were compared to local check Manika and six progenies were selected or further evaluation. These included HPS-1/67, Serrana x TPS-13, J-1035 x TPS-13, Lt–9 x Lt–7 and Atzimba x 24. These hybrids have medium maturity, moderately resistant to late blight. However, eight varieties are significantly correlated to each other but differ from Manika (Kahandawela *et al.*, 1995).

Siddique and Rashid (2000) stated that the production of potatoes from botanical or true seed offers a good alternative to the use of traditional seed tubers due to low transmission of diseases, high multiplication rate and good tuber yield. They indicated that 50-60 kg of seedling tubers could be obtained from a 10 m^2 beds in about 100 days. Studies conducted at the TCRC, BARI showed that good TPS progeny can produce 500 to 800 tuberlets (seedling tubers) in a square meter of land (Anon., 1992).

Maleque (1997) conducted an experiment at Bangladesh Agricultural University, Mymensingh. There were nine harvest dates namely 25, 34, 43, 52, 61, 70, 88, 97 and 106 days after sowing (DAS). The yield of seedling tubers was highest (111 t ha^{-1}) in November 30 sowing. At the final harvest distribution of tubers in the < 5, 5 – 10, 10 – 20 and > 20 g size grades were 12.2, 23.6, 43.2 and 21.2%, respectively. Plant height increased up to 97 days, and after that, there was a little or no increase in plant height. The fresh weight of tubers continued to increase significantly up to last harvest (106 DAS). Number of tubers $hill^{-1}$ increased up to 70 DAS and plant emergence was completed by 10 DAS.

Choudhury (1997) conducted an experiment at Bangladesh Agricultural University, Mymensingh. He found that foliage coverage decreased with increase in plant spacing at 45 days and plant spacing had no significant affect on plant height. Number of small sized tubers increased with the decrease of plant spacing. Chowdhury and Rasul (1995) reported that the plant geometry 25 cm x 4 cm not only gave higher yield by 10.3%, but also reduced labour cost by 14.3% over 10cm x 10cm geometry.

Different NGOs and private sector organizations (HADS, Mirza Farm, RDA, BEES, BSF) had successfully produced seedling tubers from TPS in different areas of Bangladesh. The average yield of seedling tubers obtained at RDA, HADS and Mirza Farm was 66.9 t ha^{-1}. The highest tuber yield was obtained at RDA (74.0 t ha^{-1}) after 123 day of sowing (Siddique, 1995).

Siddique (1995) reported that when TPS were sown in 10 m x 1m beds at a spacing of 25 cm x 4 cm, a high yield of seedling tubers was obtained. Out of the tuber produced, 13% were of 1–5 g size, 54% of 5–20 g size and 33% of above 20 g size. The per hectare yield was however calculated on the basis of yield obtained in 635 nursery beds, each having an area of 10 m x 1 m. The effective yield of seedling tubers produced in nursery beds was 35–45 t ha^{-1}.

Sikka *et al.* (1994) conducted an experiment with TPS progenies for seedling tuber production. They reported that the mean yield of TPS progenies was 8.1 kg m^{-2} (range 3.9 to 12.6 kg) in long rain cropping season. Similar results were obtained in the following short rain season. The average tuber yield from in transplanted 9 TPS progenies was 57 t ha^{-1} (range 18.2 to 95.3 t ha^{-1}).

Kamla-Singh and Singh (1994) carried out field trials at Shillong, Meghalaya, India during 1990-91. Potato seedlings grown from true potato seeds were transplanted at 30, 40 or 50 cm inter-row spacing and 10, 15 or 20 cm inter row spacing. The highest average tuber yield of 24.0 t ha^{-1} and the highest yield of tuber weighing 10–20, 20–40 and 40–80 g were obtained with 40 x 10 cm spacing. Yields of tubers <10 g and >80 g were not significantly affected by spacing. Average total tuber yield was lowest (14.3 t ha^{-1}) at 50 x 20 cm spacing.

2.3 Storage performance of TPS progenies in first clonal generation

The True Potato Seed (TPS) technology is a new and most popular among the farmers' especially to small farmers. Research work and results on storage behaviour of different TPS progenies at home and abroad are reviewed below.

Storage life of potato tubers mainly depends on temperature and humidity which influence evaporation, respiration and sprout growth and ultimately causes weight loss of tubers. Low temperature and high humidity in storage result minimum loss. The local varieties having high storage ability under ordinary room condition and high market value are liked by the farmers (Khan *et al.*, 1981).

Dayal and Sharma (1987) reported that stored potatoes deteriorate in quality due to a number of reasons. These are weight loss, sprouting and formation of little tuber and internal sprouts. Such deterioration is pronounced under relatively high temperature. Storage methods of overcoming these problems and prolonging the store life of potatoes have been reported. Sprout suppression are used for prolonging the storage. Successive desprouting of storage potatoes can be employed for harvesting sprouts for use in rapid multiplication techniques.

In Bangladesh, farmers need to store their potatoes from March to September. Tuber loss due to dehydration and rottage under natural storage was reported up to 80% by Hashem (1979) and 40.6% by Khan *et al.* (1984).

In a storage experiment, Roy and Hossain (1981) showed a tuber loss of 8-10% due to rottage and shrinking under non-refrigerated conditions.

Ahmad (1979) reported that the farmers of the north-west part of Bangladesh use local varieties of potato instead of high yielding exotic varieties only because they have a longer dormancy and keeping quality even under ordinary storage.

Sowa and Kuzniewicz (1989) studied the causes of loss during potato storage and indicated that the main causes of storage losses were respiration, evaporation and storage rot. In that study, storability was largely a varietal trait, although environmental conditions during both growth and storage were also important. Storage losses were lowest in the clone Clamp (4.4%) which increased with increasing temperature in the store (about 9%). Overall storage losses ranged from 9.4% in Janka to 32.5% in Sasanka. Storage losses due to rots ranged from 0.8% in Azalia to 22.6% in Sasanka.

Verma (1976) reported rotting of tubers was the highest for Kufri Sindhuri when stored without temperature control under farm conditions. Total sugar concentration increased in all varieties during storage but without temperature control reducing sugar content only increased in Kufri Chandramukhi.

Hossain and Rashid (1991) studied on storage quality of three sizes of tubers of eight TPS progenies against standard variety Cardinal for 120 days after harvest (April to July) under natural storage condition. Weight loss of tubers due to transpiration and respiration was 23.93% in TPS progenies and 11.95% in Cardinal with average monthly loss of 5.98% and 2.99%, respectively. Small size tubers were found to suffer most from dehydration. *Erwinia* sp. and *Fusarium* sp. have been identified to cause rotting of tubers in storage. The incidence of soft rot and dry rot were 33.40% and 34.15%, respectively. No rot was observed in Cardinal during the period of study. Maximum rottage loss was recorded in large size tubers. Tubers of the TPS progenies sprouted earlier than Cardinal. Maximum number of sprouts per tubers and length of the longest sprout were recorded in TPS progenies. Tubers of TPS progenies shrivelled earlier than Cardinal.

Hossain *et al.* (1992a) studied on keeping quality of three sizes of tubers of 20 indigenous potato cultivars for 210 days (March to September) under natural storage condition. Weight loss was 15.23% for indigenous cultivars and 31.15% for Cardinal, while rottage loss was 3.17% and 39.16%, respectively. Smaller tubers suffered maximum weight loss and minimum rottage loss. Indigenous cultivars showed better performance for qualitative characters like days to sprouting, percentage of shrivelling while the check variety, Cardinal was better for quantitative characters like number, length and weight of sprouts per tuber, respectively. No rot was observed in cardinal during the period of study. Maximum rottage loss was recorded in large tuber size. Tubers of the TPS progenies sprouted earlier than Cardinal. Maximum number of sprouts per tuber and length of the longest sprout were recorded in TPS progenies. Tuber of TPS progenies shrivelled earlier than Cardinal.

Hossain *et al.* (1992b) studied storage quality of three sizes of 21 Dutch potato cultivars against one recommended cultivar Diamant (check) for 180 days under natural storage condition. The mean weight loss of tubers due to dehydration was 21.38% in Dutch cultivars and 20.62% in the check with monthly loss of 3.56% and 3.42%, respectively. Small sized tubers were found to suffer most from dehydration. *Erwinia* sp. and *Fusarium* sp. have been identified to cause tuber rot in storage loss of tubers due to rotting of 12.57% in Dutch cultivars and 10.00% in the check. No rot was observed in the cultivars Alkon, Binell, Cosmos, Liseta, Mondial and Vital during the period of study. Maximum loss due to rots was observed in larger tubers. The four cultivars, Alkon, Escort, Liseta and Mondial performed better than the check for days to initial sprouting, 100% sprouting and shrivelling.

Number of sprouts, length and weight of sprouts were also lower in the check. For all these characters, large tubers were found to respond earlier to rot than medium and small sized tubers. Shrivelling was the maximum in the tested materials than the check larger and smaller tubers respond equally for these characters.

Hossain *et al.* (1995) worked on physiological behaviour and storage quality of three sizes of tubers of eight British potato varieties in their second and third generations which have been compared with a recommended variety, Diamant of Dutch origin. Average weight loss of the British varieties due to dehydration was 19.00% in second and 17.55% in the third generation, compared to 18.16% and 20.55% tuber loss respectively in the controls. Small tubers were found to suffer most form dehydration. *Erwinia* spp. and *Fusarium* sp. were identified as the cause of rot diseases. Average loss of the British varieties due to rotting was 13.33% in the second and 8.75% in the third generation, compared with 10.0% and 16.67%, respectively in the controls. Maximum loss due to rot was observed in the larger tubers. Ailsa in the second and Kingston and Pentaland squire in the third generation were found to perform better than the controls for days to sprouting, 100% sprouting and shrivelling. For all these characters, larger tubers performed less well than the medium sized and small tubers. Number of sprouts, sprout length and weight was lower in Alisa, Kingston and

Pentland Square than the controls. Physical condition of tubers of the British varieties was better than the control in both generations. Larger and smaller tubers responded easily for this character. Among the British varieties Kingston and Pentland Square were very good, but the performance of Ailsa was excellent.

Storage behaviour of some exotic, recommended and advanced lines of potato were studied in 1991 at RARS, Jessore by storing their tubers in netted wooden box under natural condition (Rasul *et al.*, 1997). Much variation was observed among the varieties/lines for all the characters studied. Percent weight loss was higher in exotic varieties (12.89-35.52%). Cent percent sprouting was earlier in recommended varieties/lines (96 days) than of exotic ones (118.7 days). On an average, tubers shrank earlier in existing varieties per lines than first generation material. Rottage of tubers by bacterial soft rot (*Erwinia* sp) during storage varied from 31.3% to 36.8%. Recommended varieties Kufri Sindhuri, Cardinal, Multa, advanced lines P-93 and first generation varieties viz. Granoloa, Modial, Producent and Vital performed the best on the basis of studied storage characteristics.

All the losses observed during potato storage, in respective of storage methods can be divided into two groups. Quantitative losses including weight losses of tubers due to vital process of tubers (respiration, evaporation, sprouting) and those resulting from parasites and parthogenic microflora. The extent of such losses, apart from varietal properties is affected by the maturity and wholesomeness of tubers as well as internal condition of storage house. Qualitative losses are more difficult to detect since they do not reveal any decrease in the weight of tubers. They include quantitative losses of specific components but total content of dry matter not change significantly. Obviously, the difference between two groups of losses has only theoretical significance (Lisinska and Leszezynski, 1989).

2.4 Field performance of tuberlets in ware potato production

An overview of new technologies for potato production and their implication for developing countries are presented. TPS is seen as an efficient, low cost source of virus-free planting material for farmers in developing countries. Since the TPS is now gaining popularity among farmers and there is limited information available particularly different aspects of TPS technology in our climatic conditions. However, research activities and results based on field performance and correlation analysis of potato crops both in home and abroad are reviewed as below:

Engels *et al.* (1994) observed that the production of ware potatoes from tuberlets in the field in different growing periods. They stated that tuber yields ranged between 12 and 16 t ha^{-1} in the autumn season, and the yield was poor in the spring season.

A field experiment was conducted to study the effect of tuberlet size and spacing on the yield of true potato seed progenies at Bangherpara, Jessore in winter. It was observed that the progeny of potato (C.V. Atzimba x R–128.6) planted at 60 x 25 cm spacing produced the highest tuber yield. The tuberlet diameter was > 35 mm (Asaduzzaman *et al.*, 1993).

TPS technology is gaining importance in the developing world for potato production as a low cost alternative to the conventional mode of potato production through seed tubers. Studies on germination, synchrony in seedling emergence, seedling vigour and tuber yield and its components showed significant positive correlations with the seed size in open pollinated and hybrid families. Seed size has also shown significant relationships with other seed size which could be used as a selection criterion for TPS progenies (Thankur and Upadhya, 1990).

Rasul *et al.* (1995) studied on 30 potato progenies in their first clonal generation revealed that their variations among them were significant for all the characters. High variability was observed for plant height, final crop stand, foliage coverage and days to maturity. Kufri Sindhuri used as check, yielded higher (26.81 t ha^{-1}) than any other progeny. The other check, Cardinal produced only 24.7 t ha^{-1}. Tuber yield ha^{-1} was significantly and positively correlated with yield $hill^{-1}$ (r = 0.95**), plant vigour (r = 0.85**), foliage coverage ($r = 0.8^{**}$) specific gravity and starch content. Specific gravity, dry matter and starch content were highly correlated among them.

Eight TPS progenies of exotic origin evaluated at Regional Agricultural Research Station, Jessore showed that they varied significantly with each other for all the character except number of stem hill^{-1} and tuber grades. Rasul *et al.* (1993) observed high tuberlets yield in HPS-7/13 (3.5 kg m^{-2}) but HPS-7/67 had the second highest yield 3.27kg m^{2} with number of tubers m-^{2}. Progenies of Indian origin (HPS-7/13, HPS-7/67 and HPS-1/13) performed superior to others which were of CIP origin. Correlation studies revealed that foliage coverage, plant vigour, tuber number m^{-2} had maximum contribution towards yield but it had negative association with days to 50% emergence.

Grewal (1990) conducted a field experiment at two locations and determined the correlation between seedling and reproductive characters, including earliness at the two locations. Number of internodes and yield per plant were significantly correlated at Hyancayo and San Ramon and root height and hypocotyls length had a significant correlation with the number of tubers plant^{-1} and yield plant^{-1}. Although significant, the later correlations were not high enough to be used to predict the final behaviour of genotypes by their seedling traits. Thus it may be assumed that certain independence between seedling and mature plant growth characters exists.

Variability and some genetic parameters of 15 potato varieties were studied to select parents for a hybridization program by Rasul *et al.* (1990). The variety Obelix performed the best in respect of yield, weight of tubers $hill^{-1}$ and number of tubers $hill^{-1}$. Correlation studies showed significant positive relationship of yield with all the characters except plant height and number of tubers $hill^{-1}$, while it was negatively correlated with all four qualitative characters viz. dry matter content, starch content, specific gravity and insect infestation. However, starch content, dry matter and specific gravity of tubers were highly interrelated. Whyte (1992) reported that yield was significantly and positively correlated with number and individual weight of whole tuber number was negatively correlated with individual tuber weight.

Twelve variety or strains viz. Ajax x Desiree, Laal-E-Faisal, Laal-E-Faisal x Desiree, Desiree x Jose (A), Desiree x Jose (B), Desiree x Jose (C), Desiree x Laal-E-Fasial, Kondor, W-82-161 Desiree x Hydra P3, Cardinal and Desiree were evaluated on the basis of variability, high yield and good quality. On the basis of results obtained from the experiment, it can be concluded that varieties Desiree x Laal-E-Faisal, Desiree x Jose (C) and (B) and Ajzx x Desiree produced very attractive tuber yield and are more tolerant to various diseases as compared to the check varieties. Desiree x

Jose (B) has also good specific gravity, which is very good character of a variety (Chaudhury and Rasul, 1995).

The present review indicates that although a number of studies were conducted in respect of productivity and natural storage behaviour of TPS progenies, the finding was not conclusive. Considering the above review, the present study was designed in order to make a clear recommendation under Bangladesh condition.

CHAPTER - III

MATERIALS AND METHODS

MATERIALS AND METHODS

The investigation was undertaken through three different experiments.

3.1 Experiment 1. Field performance of 20 True Potato Seed progenies in their seedling tuber generation (F_1C_0)

3.1.1 Materials used

Twenty different progenies of True Potato Seed (TPS) including one check were used as the experimental materials. All these materials were received from the Tuber Crops Research Centre (TCRC) of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The materials used were:

1. HPS-II/13
2. HPS-7/13
3. HPS-I/13
4. HPS-25/67
5. HPS-5/67
6. HPS-1035/67
7. HPS-1035/13
8. HPS-8/67
9. HPS-5/13
10. HPS-8/9
11. HPS-501/Lalmadda
12. HPS-Lalmadda/501
13. HPS-Atzimba/13
14. HPS-6/9
15. HPS-501/67
16. HPS-I/67
17. HPS-9/67
18. HPS-364/67
19. HPS-364/9
20. BARI TPS-2 (Check)

3.1.2 Design of the experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. Twenty progenies were considered as the 20 treatments of the experiment. The treatments were randomly allotted in each block.

3.1.3 Experimental season and site

The experiment was conducted during Rabi season (November to March) of 2000-2001 at the Agronomy Farm, Shere-e-Bangla Agricultural University, Dhaka.

3.1.4 Climate and weather

The experimental area is situated at $23^0 41'$ N latitude and $90^0 22'$ E longitude, at an altitude of 8.6 meters above the sea level and has a sub-tropical climate. The weather data during the study periods were recorded from the National Meteorological Department, Dhaka, Bangladesh is shown in Appendix–I and II. It will be seen from the meteorological data that there were much variation in the maximum and minimum temperatures, rainfall and relative humidity in the crop growing period of 2000-2001and 2001-2002.

3.1.5 Soil characteristics

The soil of the experimental site lies in agro-ecological region of 'Madhupur Tract' (AEZ 28) (FAO, 1971). Deep red brown terrace soil, belongs to 'Nodda' cultivated series. Top soil clay loam in texture, Olive-grey with common fine to medium distinct dark yellowish brown mottles. Sub soil clay loam, yellowish brown with many fine and medium prominent red and few medium prominent black mottles. Substratum clay, brownish yellow with many medium and coarse prominent red and few medium prominent black mottles (Ali, 1993)

Before initiating experiments in each year a number of soil samples were collected from 0 to 30 cm depth from the experimental plot, composite was made from the collected soil samples and analyzed for mechanical and chemical compositions with the help of Soil Resource Development Institute (SRDI). Data on the mechanical, chemical analysis of the soil are presented in Table 1.a and 1.b. The soil of experimental site is clay loam in texture and low in organic matter (1.46-1.48) percent. The soil reaction is acidic (pH 5.47-5.63).

Table 1. Physiochemical properties of the soil

a) Mechanical composition of the soil

Soil separates (%)	**2000-2001**	**2001-2002**	**Methods employed**
Sand	37.10	36.90	Hydrometer method (Day, 1965)
Silt	26.30	26.30	-do-
Clay	36.60	36.70	-do-
Texture class	Clay loam	-	-do-

b) Chemical composition of the soil

	2000-2001	2001-2002
Organic matter (%)	1.46	1.48
Nitrogen (%)	0.09	0.10
Available P (μg g^{-1}soil)	17.80	14.90
S (μg g^{-1}soil)	9.20	9.27
B (μg g^{-1}soil)	0.23	0.15
Cu (μg g^{-1}soil)	2.82	3.40
Zn (μg g^{-1}soil)	1.10	1.20
K (m eq 100 g $soil^{-1}$)	0.10	0.15
Ca (m eq 100 g $soil^{-1}$)	3.00	3.50
Mg (m eq 100 g $soil^{-1}$)	0.75	0.75

Source: Soil Resource and Development Institute, Dhaka

3.1.6 Cropping history of the experimental field

Table 2. Cropping history of the experimental field

Year	Kharif crop	Rabi crop
1997-1998	Dhaincha (*Sesbania aculeata L.*)	Wheat
1998-1999	Fallow	Mustard
1999-2000	Aus rice	Wheat
2000-2001	Dhaincha	Present study
2001-2002	Aus rice	Present study

3.1.7 Land preparation of the experimental field

The selected field for sowing TPS was first opened at 4th November 2000 with a power tiller and exposed to the sun for a week. Then the land was prepared to obtain good tilth by several ploughing, cross ploughing and laddering. Subsequent operations such as harrowing, spading and hammering etc were done and finally a desirable tilth was attained to ensure proper condition.

3.1.8 Preparation of nursery bed for seedling tuber production

Raised nursery beds (15 cm high from soil level) of 1 m^2 size were prepared with help of spade. Soils of the nursery beds were specially prepared by mixing soil, sand and well decomposed sun dried cowdung in the ratio of 1:1:1 (Roy *et al.*, 1997). The cowdung was hammered to powder and then sieved through a 20 mm diameter sieve. The soil was also prepared very nicely so that no clods remain. These seedbed substrates were spread very nicely making a fine seedbed. The bed of soil was made friable and the surface of the beds was leveled. The distance of unit plot to plot was 50 cm from both sides.

3.1.9 Application of the manures and fertilizers in the plot

Manures and fertilizers were applied in the following doses and methods as per the recommendation of Hussain (1999), which are shown in the Table 3.

Table 3. Doses and methods of application of manures and fertilizers for the production of seedling tubers using TPS in a 1 m^2 bed

Manure/ fertilizer	Dose ha^{-1} (6350 m^2 effective area) (kg)	Application %			
		Basal	First installment at 30 DAS	Second installment at 40 DAS	Third installment at 55 DAS
Cowdung	15000	40	-	-	-
Urea	350	50	17	17	16
TSP	225	100	-	-	-
MP	260	50	17	17	16
Gypsum	125	100	-	-	-
Zinc sulphate	14	100	-	-	-
Borax	6	100	-	-	-

Three days before sowing of TPS 40% of the basal dose of well-decomposed cowdung was applied to seedbeds and well mixed with the seedbeds soils. Total amount of TSP, gypsum, zinc sulphate, borax, and 50% of both urea and MP were applied during final land preparation. The rest amount of urea and MP were top dressed in 3 equal installments along with the soil cowdung mixture (considering the dose of cowdung) during the first, second and third earthing ups, after 30, 40 and 55 days after sowing.

3.1.10 Sowing of TPS in the seedbeds

Before sowing of TPS, a 1 m^2 wooden frame with 1 cm nails fitted at 25 cm row space and 4 cm between nails in row (Plate 1) was used to make 100 holes in 1 m^2 beds. Three seeds were sown in each hole on 14 November

2000 and then the seeds were covered with sand mixed soils (1:1). After emergence, the seedlings were gradually thinned out to one per hole. The seedbeds were watered as and when necessary. With the development of plants, the beds were kept weed free by hand pulling and added extra soils (amended seedbed soil substrates) in four installments after 20, 30, 40 and 55 days.

3.1.11 Intercultural operations

The seedlings were always kept under careful observation. After emergence of seedlings, the following intercultural operations were accomplished for their better growth and development.

a) **Irrigation:** When the seedlings started to emerge, it was irrigated with a watering cane as and when needed depending on the moisture status of the soil and requirement of plants.

b) **Thinning and gap filling:** The seedlings were first thinned out to two seedling hole $^{-1}$ from the holes where three seedlings were grown at 20 DAS. They were again thinned out at 30 DAS keeping only one healthy seedling hill^{-1}. On the contrary, gap filling was done at the same time with the thinned out seedlings when necessary.

c) **Weeding and mulching:** Weeding and mulching were necessary to keep the plots free from weeds, ease of aeration and conserve soil moisture. The newly emerged weeds were uprooted carefully after complete emergence of TPS seedlings and afterwards when necessary. Mulching was done by breaking the surface crust as and when needed.

d) **Earthing ups and fertilizer application:** The remaining doses of cowdung (60%), urea (50%) and MP (50%) were applied in beds in 3 installments. For each installment, the calculated amount of cowdung, urea and MP were mixed with required quantity of soils to be applied in beds properly and there applied uniformly. The practice was a combination of earthing up and fertilizer application installments, which were done thrice after 30, 40 and 55 days after sowing (DAS).

3.1.12 Plant protection measures

Furadan 5G @ 20 kg ha^{-1} was applied during final preparation of main field to prevent the crops and tubers from the soil insects. Sevin @ 2 kg ha^{-1} was used after sowing the seeds in beds to prevent from ant attack. Fungicide, Ridomil MZ (0.25%) was sprayed at an interval of 15 days, commencing at 45 DAS as a preventive measure against the late blight. Kenalux 0.1% was also sprayed in addition to Ridomil to protect the crop from the attack of virus disseminating aphid.

3.1.13 Harvesting

Harvesting of the crop was started 104 DAS, and continued up to 108 DAS Harvesting was done usually with a country plough. Care was taken to avoid injury of seedling tubers during harvesting.

3.1.14 Collection of data

In order to study the effects of the treatments on yield components and yield of seedling tubers, data in respect of the following parameters were collected during the growth of the plants and at harvesting time of the crop. During the plant growth, 10 plants were selected randomly from each unit plot for collection of data. The sampling was done in such a way that the border effects were completely avoided. For this purpose, the outer two lines and the extreme end of the middle rows were excluded.

a) **Days to 80% seed germination:** Number of days required from seed to 80% seed germination.

b) **Germination (%):** Germination percentage was recorded at 20 DAS before first thinning of seedlings.

c) **Height of plant:** It was recorded at 80 DAS. The height in centimeter was measured from the ground level to the tip the growing plant.

d) Foliage coverage: The foliage coverage was determined by visual estimation of percent land area of the plot covered by the foliage at 60 DAS.

e) Number of tubers plant^{-1}: The number of seedling tubers produced plant^{-1} was recorded from the average of 100 plants, harvested from the each unit plot.

f) Weight of tubers plant^{-1}: The weight of potato tubers produced plant^{-1} was recorded in gram as per the weight of seedling tubers obtained in number of seedling tubers plant^{-1}.

g) Yield of tubers m^{-2}: The yield of potato tubers m^{-2} was calculated out from the plot^{-1} yield data and was recorded in kilogram.

h) Yield of tubers ha^{-1}: The yield of tubers per hectare was estimated on the basis of 635 standard beds (10m x 1m) ha^{-1}, considering bed to bed spacing of 50 cm in all the directions, the effective land area being 6350 m^{2}ha^{-1} (Hussain, 1999). For this reason, the yield of seedling tubers per hectare was calculated as follows:

$$\text{Yield (t ha}^{-1}\text{)} = \frac{\text{Yield of tubers per plot (kg)}}{\text{Area per plot (1m}^2\text{) x 1000}} \times 6350$$

3.1.15 Statistical analysis

The data of the present study were statistically analyzed. The mean, range and standard error (Sx) for each character have been calculated and analysis of variance for each of the characters was performed and means values were separated by Duncan's Multiple Range Test (DMRT) (Stell and Torrie, 1960).

3.2 Experiment 2. Natural storage behaviour of 9 promising TPS progenies in their first clonal generation

3.2.1 Materials used

Nine TPS progenies which were selected as promising from Experiment 1 were used as the experimental materials. The tubers (1st clonal generation) of 9 promising TPS progenies were received from TCRC, BARI, Gazipur. List of 9 progenies and one standard check variety are given below:

1. HPS-II/13
2. HPS-7/13
3. HPS-8/67
4. HPS-501/67
5. HPS-9/67
6. HPS-I/67
7. HPS-364/67
8. HPS-364/9
9. BARI TPS-2
10. Diamant (Check)

3.2.2 Experimental period, design and climate

This study was conducted during 28 March to 28 October 2001. The experiment was conducted completely randomized design (CRD) following a 2-factor (progeny X tuber size) with 3 replications. Climatic conditions like temperature, humidity of the experimental site were recorded properly (Appendix I and II).

Factor A: Tuber size : 3 viz. i) Large (> 45 mm) ii) Medium (25 - 45 mm) and iii) Small(< 28 mm)

Factor B: Variety : 10

3.2.3 Methods of study

Three sizes of tubers (>45 mm, 28–45 mm and <28 mm) were included in the study. Thirty tubers consisting (10 tubers in each unit) of each variety were used. Immediately after harvesting initial weight of tubers of each grade for each variety was taken on 28 March 2001. The tuber of each grade was kept in netted plastic basket and was stored in a well ventilated room under diffused light condition in the laboratory. Weighing of tubers was continued at 15 days interval for 210 days. Tubers were observed at alternate days for recorded rotted tubers. Tubers were checked every day for days to sprouting, 100% sprouting and shrivelling. Number of sprouts tuber^{-1}, length and weight of sprout and physical condition of tuber were recorded after 210 days. Physical condition of tubers was evaluated by eye estimation following an arbitrary scale 1-5 scale (1=No shrinkage and 5=maximum shrinkage).

3.2.4 Collection of data

The following data were recoded during the experimental period:

a) **Weight loss (%):** The tubers were weighed at 15 days interval to record loss of weight due to dehydration. It was continued up to 210 days.

b) **Rottage loss (%):** The tubers were observed at every alternate day to record rottage loss. Usually, dry rot due to *Fusarium* sp. and wet rot due to bacteria, are occurred in stored potato. After recording data, the rotted tubers were discarded.

c) **Days to sprout initiation:** The tubers were keenly observed for sprout initiation. Data were recorded when a very small sprout head was emerged at eyes of tubers.

d) **Days to sprout in all tubers:** The tubers were observed at alternate days for collecting data on sprouting of 100% tubers.

e) **Days to start shrivelling:** The tubers were keenly observed for tuber shrivelling. Shrivelling indicates physical condition of the tubers.

f) **Days to 100% shrivelling:** The data were recorded for shrivelling of 100% shrivelling following arbitrary scale 1–5 (1 = no shrivelling and 5 = maximum shrivelling).

g) **Longest sprout length at 210 days after storing:** At the end of the experiment (after 210 days) the length of the longest sprouts were recorded.

h) **Remaining tuber weight (%):** At the end of the experiment, data on remaining good tubers were recorded.

3.2.5 Statistical Analysis

The recorded data for different characters were analyzed statistically using MSTAT-C programme to find out the variation among the progenies by F-test. Treatments were compared by DMRT and standard errors and coefficient of variances were also estimated.

3.3 Experiment 3. Field performance of 9 promising TPS progenies in their first clonal generation

3.3.1 Materials used

Nine progenies which were selected as promising from Experiment 1 were used in this experiment. The seedling tubers produced in Experiment 1 were cold stored during March to October 2001. The materials used were same as Experiment 2.

3.3.2 Planting season, site and climate

The experiment was conducted during November 2001 to March 2002 at Shere-e-Bangla Agricultural University, Dhaka, Bangladesh. The meteorological data of the experimental site during the experimental period were shown in Appendix I and Appendix II.

3.3.3 Planting of the tuberlets of the TPS progenies

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. In the first clonal generation, unit plot size was 3 m x 3 m and the seedling tubers (produced from TPS in seedbeds during 2000-2001, stored in cold storage) were planted on 19 November 2001 at 60 cm between rows and 20 cm between hills. Only 10-20 g tuberlets were used. Number of tuberlets $plot^{-1}$ was 75 and number of tuberlets $line^{-1}$ was 15. Plot to plot distance was 1 m.

Table 4. Doses of fertilizers for the production of ware potato using seedling tubers (BARC, 1997) (Appendix VI)

Nutrient	Soil test value	Soil test value interpre-tation	Range of values used within the interpretation class	Recommended fertilizer nutrient (kg ha^{-1})	Actual fertilizer required (kg ha^{-1})
N (%)	0.10	Low	0.091-0.180	91-135	283.69-Urea
P (μg g^{-1} soil)	14.90	Low	7.510-15.000	21-30	100.3-TSP
K (meq 100 g^{-1} soil)	0.10	Low	0.091-0.180	81-120	232-MP
S (μg g^{-1} soil)	9.27	Low	7.510-15.000	13-18	93.48-Zypsum
Zn (μg g^{-1} soil)	1.20	Medium	0.910-1.350	0-20	7.11-$ZnSO_4$

Cowdung (10 t ha^{-1}) was applied at the time of land preparation. Half of the MP, full TSP, Gypsum and $ZnSO_4$ were applied at the time of planting in furrow and properly mixed with the soil so that the tuber did not come in contact with fertilizers, thirty days after planting, half of the urea and half of the MP were applied in the furrow when there was sufficient moisture in the soil and properly mixed with the soil and then earthing up. Remaining half of the urea was applied 55 days after planting with same procedure. Normal cultivation practices (i.e. irrigation, weeding, earthing up and other intercultural operations) were done as necessary.

3.3.4 Harvesting

Haulm cutting was done 10 days before harvesting. After cutting the haulm, these were kept on beds so that the tubers skin becomes hard. Harvesting was done on 11 March 2002.

3.3.5 Collection of data

The following data were recorded during the experiment period:

1. **Days to first emergence:** Number of days required from seed sowing to first emergence
2. **Days to 50% emergence:** Number of days required from seed sowing to 50% emergence
3. **Days to tuber initiation:** Number of days required from seed sowing to tuber initiation

4. **Number of stem hill^{-1}:** Mean value of the number of the main stem plant^{-1} of 10 randomly selected plants after 40 DAS

5. **Plant height at 60 DAS (cm):** Average of 10 randomly selected plants measured in centimeters from base of the plant to the apex of the shoot at 60 DAS

6. **Foliage coverage at 60 DAS (%):** Percentage of foliage coverage was taken on eye estimation at 60 DAS on a plot basis

7. **Days to maturity:** Number of days required from planting to become 80% yellowing of stem of plant

8. **Number of tubers hill^{-1}:** Mean value of the number of tubers hill^{-1} of 10 randomly selected hills when harvesting was done

9. **Weight of tubers hill^{-1} (g):** Mean value of weight of tubers hill^{-1} of 10 randomly selected hills when harvested

10. **Yield (t ha^{-1}):** The weight of harvested tubers of each plot was recorded and converted into yield per hectare.

3.3.6 Statistical analysis

Same as Experiment 1.

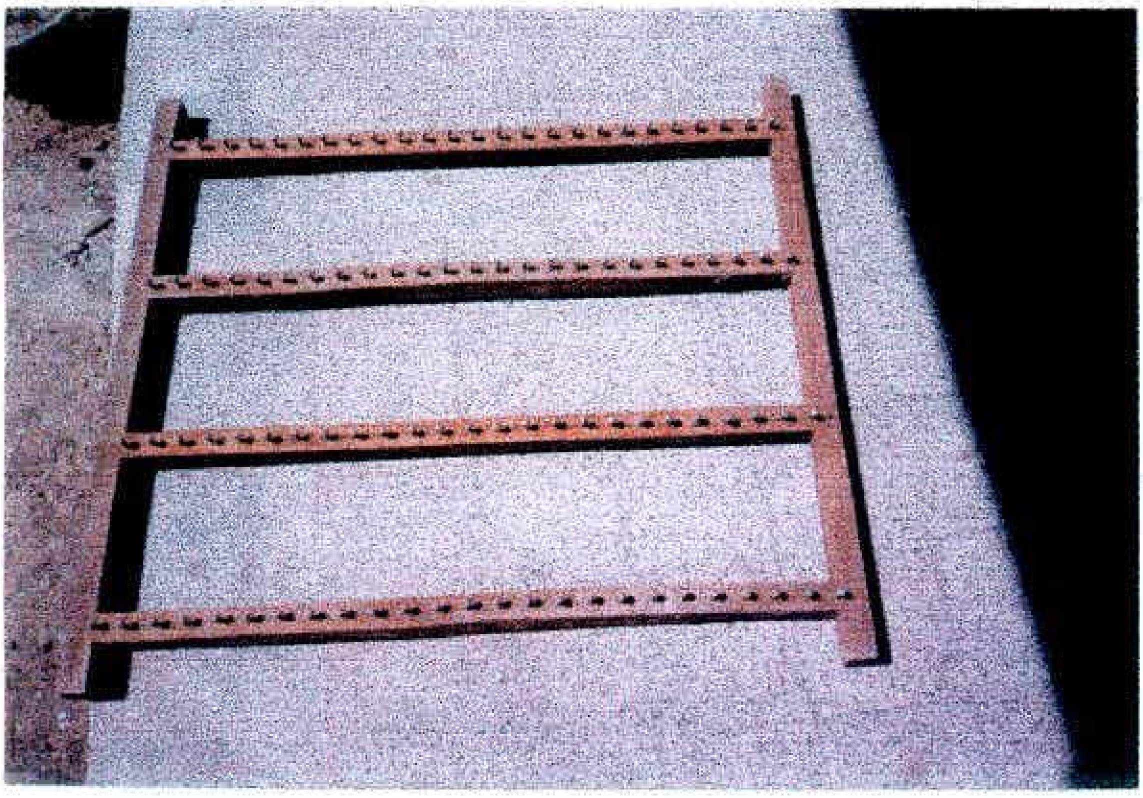

Plate 1. A view of wooden frame for making TPS sowing point

CHAPTER - IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

4.1 Experiment 1. Field performance of 20 TPS progenies in their seedling tuber generation

4.1.1 Analysis of variance and growth parameters

4.1.1.1 Days to 80% seed germination

The analysis of variance showed significant variations among the progenies for days to 80% seed germination (Appendix III). The longest duration for 80% seed germination was needed by the progenies of HPS-Lalmadda/501 (15.0 days) which was statistically similar to HPS-501/ Lalmadda, HPS-I/67, HPS-501/67, Atzimba/13, HPS-5/13, HPS-1035/13, HPS-5/67, HPS-I/13 and HPS-7/13. The minimum duration (9.67 days) required by the progeny of HPS-364/67 which was statistically similar to HPS-8/67, HPS-364/9 and HPS-9/67 and closely followed by other progenies like HPS-II/13, HPS-6/9, HPS-8/9 and check variety, BARI TPS-2 (Table 5). Similar result was stated by Bedeway *et al.* (1987). This variation might be due to soil moisture, soil temperature, genetic constitution etc.

4.1.1.2 Germination (%)

Significant difference among the progenies was observed from the analysis of variance for germination percentage (Appendix III). Most of the progenies had more than 80 % total germination except HPS-501/Lalmadda, HPS-Lalmadda/501 and HPS-501/67 (Table 5). Eight progenies viz. HPS-II/13, HPS-25/67, HPS- 8/67, HPS-8/9, HPS-9/67, HPS- 364/67, HPS-364/9 and check variety, BARI TPS-2 had more than 90% germination. This was corresponded with the results of Roy *et al.* (1999).

4.1.1.3 Foliage coverage

The progenies viz. HPS-364/67, HPS-364/9 and check variety, BARI TPS-2 gave the highest foliage coverage and they were statistically similar while the progeny HPS-Lalmadda/501 had the lowest (63.67%). All the progenies except HPS-8/9, HPS-501/Lalmadda and HPS-Lalmadda/501 were statistically similar (Table 5).

The present investigation indicated that as high as 82.67% foliage coverage was obtained at 60 days after sowing. Similar opinion has been suggested by Asandhi and Satjadipura (1988) which clearly supported the present findings. The result of the present invstigation is also in agreement with the results of other workers (Hossain, 1987; Kabir, 1987; Sarker and Kabir, 1989 and Elias *et al.*, 1992). From India, Singh *et al.* (1997) stated that foliage coverage depends on the number of leaves plant^{-1} and leaf size which contributes the yield of potato through assimilation of carbohydrates by harvesting sunlight.

4.1.1.4 Plant height

Plant height is a character of great agronomic importance. Closer planting caused mutual shading, which resulted in taller plants. The mean value for plant height showed significant differences among the progenies. Plant height ranged from 67.33 to 88.00 cm with the minimum and the maximum, respectively by HPS-501/Lalmadda and HPS-364/67. The progenies like HPS-1/67, HPS-9/67, HPS-364/67, HPS-364/9 HPS-7/13, HPS-1035/67, HPS-8/9 and check BARI TPS-2 attained statistically similar height. Most of the progenies ranged from 70 to 88 cm, although a few progenies like HPS-1/13 (68.00 cm), HPS-1035/13 (68.33 cm), HPS-501/Lalmadda (67.33 cm), HPS-Lalmadda/501 (67.67 cm) and HPS-6/9 (70.00 cm) were below 71 cm and they were statistically similar. Variation of plant height among TPS progenies was also reported by Asandhi and Satjadipura (1988) which supports the present investigation.

4.1.2 Analysis of variance and yield attributes

4.1.2.1 Number of tuberlets plant^{-1}

The progenies showed wide variations in yield attributes. The progeny HPS-364/9 produced significantly higher number of tuberlets plant^{-1} (9.33) but it showed statistically similar to rest progenies except HPS-501/Lalmadda, HPS-Lalmadda x 501 and HPS-Atzimba/13 (Table 6).

Fifteen progenies produced 6.33 to 8.67 tuberlets plant^{-1} and they were statistically insignificant. Two progenies like HPS-Lalmadda/501 and HPS-501/Lalmadda produced less than 6 tuberlets plant^{-1}, which was statistically inferior. This was in line with the findings of Elias *et al.* (1992).

4.1.2.2 Number of tuberlets m^{-2}

Significant variations among the progenies were observed in number of tuberlet m^{-2}, which ranged from 541.7 (HPS-501/Lalmadda) to 872.3 (HPS-364/67). The highest producer (HPS-364/67) was statistically similar to HPS-II/13, HPS-7/13, HPS-I/13, HPS-25/67, HPS-5/67, HPS-1035/67, HPS-9/67, HPS-364/9 and BARI TPS-2. All the progenies produced a good number of tuberlets unit area^{-1}. Seven progenies namely HPS-1035/13, HPS-8/67, HPS-5/13, HPS-8/9, HPS-6/9, HPS-501/67 and HPS-1/67 produced 699 to 716 tuberlets m^{-2} and they were statistically similar. HPS-501/Lalmadda, HPS-Lalmadda/501 and Atzimba/13 progenies produced less than 600 tuberlets m^{-2}, which did not differ significantly with each other. The present findings are in agreement with the reports of Goma *et al.* (1970); Chaudhury *et al.* (1987); Rasul *et al.* (1990) and Chaudhury & Rasul (1995).

4.1.2.3 Tuberlets yield (kg m^{-2})

Yield (kg m^{-2}) showed significant variations among the progenies which ranged from 4.75 kg (Lalmadda/501) to 7.07 kg (HPS-9/67 and HPS-

364/67) (Table 6). Most of the progenies gave 5-7 kg tuberlets m^{-2}, while a few progenies like HPS-501/Lalmadda and HPS-Lalmadda/501 gave statistically inferior yield. Progenies HPS-7/13, HPS-501/67, HPS-1/67, HPS-II/13, HPS-I/13, HPS-25/67, HPS-8/67, HPS-6/9, HPS-364/9 and BARI TPS-2 also gave statistically similar yield. Chaudhury and Rasul (1995) evaluated six promising TPS progenies and obtained 6-7 kg tuberlets m^{-2}. Similar yield trend was also claimed in India (Shivanandam *et al.*, 1998). All the Bangladeshi progenies showed similar yield potentiality around 5.0-6.0 kg m^{-2} (Rasul *et al.*, 1990 and Roy *et al.*, 1999). Alam *et al.* (1985) opined that yield is a complex character which is not only polygenically controlled but also influenced by its component characters.

4.1.2.4 Tuberlets yield (t ha^{-1})

The yield of tuberlets ha^{-1} was calculated out from the available effective area i.e. 635 standard-bed (10 m x 1 m) per hectare (6350 m^2). Since, tuberlets are produced in beds, the estimated yield of tuberlets ha^{-1} is not realistic, and consideration of effective yield of tuberlets ha^{-1} is about 36.5% lower than the estimated yield.

In beds, the tuberlets yield was usually high due to close spacing. However, among the TPS progenies, the yield of tuberlets was exceptionally high in HPS-9/67 (44.88 t ha^{-1}) and HPS-364/67 (44.88 t ha^{-1}) and closely followed by HPS-364/9 (44.04 t ha^{-1}), BARI TPS-2 (44.16 t ha^{-1}) and HPS-II/13 (44.04 t ha^{-1}). The minimum yield was 30.18 t ha^{-1} for the progeny HPS-Lalmadda/501 which was at par with HPS-501/Lalmadda (30.80 t ha^{-1}). Almost similar yield was obtained by Chaudhury and Rasul (1995).

Table 5. Growth parameters of different TPS progenies in their seedling tuber generation (F_1C_0)

Parameters / Progenies	Days to 80% seed germination	Germination (%)	Foliage coverage at 60 DAS	Plant height (cm)
HPS-II/13	10.33cd	94.00ab	77.00ab	75.67b-e
HPS-7/13	14.33ab	85.00a-e	76.67a-c	83.67a-c
HPS-1/13	13.00a-d	81.00c-f	76.00a-c	68.00e
HPS-25/67	11.00b-d	91.33a-d	72.33a-c	73.67c-e
HPS-5/67	12.67a-d	88.33a-d	73.33a-c	71.33de
HPS-1035/67	11.00b-d	87.33a-d	70.00a-c	77.33 a-e
HPS-1035/13	13.67a-c	88.67a-d	73.00a-c	68.33e
HPS-8/67	10.00d	90.10a-d	74.33a-c	72.33de
HPS-5/13	12.67a-d	84.67b-e	74.67a-c	75.67b-e
HPS-8/9	10.67cd	90.67a-d	65.00bc	82.00a-d
HPS-501/Lalmadda	14.67a	75.00ef	64.67bc	67.33e
HPS-Lalmadda x 501	15.00a	75.00ef	63.67c	67.67e
HPS-Atzimba/13	12.33a-d	80.00d-f	70.33a-c	73.33c-e
HPS-6/9	10.33cd	84.33b-e	71.67a-c	70.00e
HPS-501/67	12.00a-d	71.67f	72.00a-c	76.00b-e
HPS-1/67	11.67a-d	80.33d-f	72.67a-c	85.33ab
HPS-9/67	10.00d	96.33a	73.67a-c	86.00ab
HPS-364/67	9.67d	94.33ab	82.00a	88.00a
HPS-364/9	10.00d	94.33ab	82.67a	86.67ab
BARI TPS-2 (Check)	10.67cd	92.33a-c	82.67a	86.00ab
Mean	11.78	86.23	73.42	66.72
CV (%)	11.93	5.16	6.85	5.72
$S\bar{x}$	0.8114	2.567	2.904	2.532
Level of significance	**	**	**	**

** Significant at 1 % level of probability

Values in each column followed by same latter (s) are not significantly different

Table 6. Yield attributes of different TPS progenies in their seedling tuber generation (F_1C_0)

Parameters / Progenies	Number of tuberlets $plant^{-1}$	Number of tuberlets m^{-2}	Tuberlets yield ($kg\ m^{-2}$)	Tuberlets yield ($t\ ha^{-1}$)
HPS-II/13	8.33a-d	823.0a	6.93ab	44.04ab
HPS-7/13	8.00a-d	812.7a	6.85a-c	43.50a-c
HPS-1/13	8.67a-c	828.7a	5.88a-d	37.35a-d
HPS-25/67	8.67a-c	863.0a	5.81a-d	36.98a-d
HPS-5/67	8.00a-d	813.7a	5.65b-d	35.88a-d
HPS-1035/67	8.00a-d	809.0a	5.57b-d	35.35b-d
HPS-1035/13	7.00a-d	716.7b	5.20d	32.98d
HPS-8/67	7.00a-d	716.0b	5.92a-d	37.57a-d
HPS-5/13	7.17a-d	700.0b	5.55b-d	35.14b-c
HPS-8/9	7.00a-d	700.3b	5.60b-d	35.90b-d
HPS-501/ Lalmadda	5.33d	541.7c	4.85d	30.80d
HPS-Lalmadda x 501	5.67cd	546.7c	4.75d	30.18d
HPS-Atzimba/13	6.00b-d	585.3c	5.48cd	34.80cd
HPS-6/9	6.33a-d	701.7b	5.72a-d	36.30a-d
HPS-501/67	7.67a-d	699.0b	6.78a-c	43.08a-c
HPS-1/67	8.00a-d	706.7b	6.71a-c	42.61a-c
HPS-9/67	8.33a-d	869.3a	7.07a	44.88a
HPS-364/67	8.67a-c	872.3a	7.07a	44.88a
HPS-364/9	9.33a	863.7a	6.93ab	44.04ab
BARI TPS-2 (Check)	9.00ab	842.7a	6.93ab	44.16ab
Mean	7.61	750.60	6.06	38.52
CV (%)	15.22	4.04	9.00	9.06
$S\bar{x}$	0.6706	17.52	0.3152	2.016
Level of significance	**	**	**	**

** Significant at 1 % level of probability

Values in each column followed by same latter(s) are not significantly different

4.1.3 Analysis of correlation co-efficient

4.1.3.1 Seedling tuber generation (F_1C_0)

Correlations between yield and its components are presented in Table 7. Positive and highly significant correlation was observed between number of tuberlets plant^{-1} and number of tuberlets meter^{-2} (0.939**) followed by foliage coverage at 60 DAS and number of tuberlets plant^{-1} (0.796**), number of tuberlets plant^{-1} and tuberlets yield (t ha^{-1}) (0.769**), foliage coverage and number of tuberlets meter^{-2} (0.757**), number of tuberlets meter^{-2} and tuberlets yield (t ha^{-1}) (0.703**), plant height and tuberlets yield (t ha^{-1}) (0.677**), germination percentage and number of tuberlets plant^{-1} (0.618**), germination percentage and number of tuberlets m^{-2} (0.579**) and tuberlets yield (kg m^{-2}) and tuberlets yield (t ha^{-1}) (0.567**) (Table 7). The highly significant negative correlation was observed between days to 80% seed germination with germination percentage (-0.698**) and tuberlets yield (t ha^{-1}) (-0.590**) followed by number of tuberlets plant^{-1} (-0.532*), plant height (-0.515*) and foliage coverage (-0.486*). Yield (t ha^{-1}) showed significant positive correlation with all the parameters except with days to 80% seed germination. It was evident from the results, yield (t ha^{-1}) was found positively correlated with number of tuberlets plant^{-1}, foliage coverage at 60 DAS, number of tuberlets m^{-2}, plant height and tuberlets yield (kg m^{-2}). So, selection on the basis of these characters should get preference for selection of progenies.

From the above discussion on production of tuberlets from TPS, it revealed that all the 20 progenies produced tuberlets in nursery beds. Among the progenies, only 9 viz. HPS-II/13, HPS-7/13, HPS-8/67, HPS-501/67, HPS-1/67, HPS-9/67, HPS-364/67, HPS-364/9 and BARI TPS-2 have been identified as promising.

Table 7. Correlation coefficient of different characters for TPS progenies in their seedling tuber generation (F_1C_0)

Parameters	Days to 80% seed germination	Germination (%)	Foliage coverage at 60 DAS (%)	Plant height (cm)	Number of tuberlets plant^{-1}	Number of tuberlets m^{-2}	Tuberlets yield (kg m^{-2})	Tuberlets yield (t ha^{-1})
Days to 80% seed germination	1	-0.698**	-0.486*	-0.515*	-0.532*	-0.584**	-0.253	-0.590**
Germination (%)			0.578**	0.266	0.618**	0.579**	0.249	0.473*
Foliage coverage at 60 DAS				0.338	0.796**	0.757**	0.495*	0.760**
Plant height (cm)					0.469*	0.396	0.361	0.677**
Number of tuberlets plant^{-1}						0.939**	0.249	0.769**
Number of tuberlets m^{-2}							0.240	0.703**
Tuberlets yield (kg m^{-2})								0.567**
Tuberlets yield (t ha^{-1})								1

* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

4.2 Experiment 2. Natural storage behaviour of 9 TPS progenies in their first clonal generation (F_1C_1)

4.2.1 Effect of progeny and tuber size on storage characters

The effect of progeny and tuber size on different storage parameters are discussed below:

4.2.1.1 Days to sprout initiation

The days to sprout initiation showed significant differences among the progenies (Appendix IV). The longer days to sprouting was observed in HPS-364/9 (54.00), followed by HPS-364/67 (53.67), HPS-1/67 (53.22), HPS-9/67 (51.44) and BARI TPS-2 (51.00) which were statistically at par (Table 8). The lowest days to sprout initiation was recorded by HPS-II/13 (41.78) which was statistically lower to the check cultivar, Diamant (44.33). So, all TPS progenies except HPS-II/13 and HPS-8/67 had longer dormancy than Diamant.

For tuber size, days to sprout initiation varied significantly over tuber sizes. The longer days (55.63) to sprouting took by small sized tuber (Table 9) which significantly differed from medium (47.30) and large (43.17) size. Large tubers sprouted earlier than small and medium tubers in present study are in agreement with Hossain and Rashid (1991). Small sized tuber took longer days to sprouting which might be due to immaturity of tuber.

4.2.1.2 Days to sprout in all tubers

Days to sprouting in all tubers are an important parameter for storage as sprouting decreases the storage life of tuber. The analysis of variance for days to sprouting in all tubers differed significantly among the progenies (Appendix IV). The highest number of days (115.22) required to sprouting in all tubers was observed in HPS-1/67 (Table 8), which was about 4 months after storing and was statistically similar to rest progenies except HPS-II/13 and Diamant. The progenies HPS-7/13 (103.89), HPS-8/67 (103.67) and BARI TPS-2 (105.22) sprouted almost at the same time. The lowest days to sprouting in all tubers (86.11) was required in check cultivar, Diamant and its days to sprout initiation was also shorter (44.33) indicating a close relationship between these two characters.

Considering the tuber size, significant difference was observed among the sizes. The longer days to sprouting in all tubers (118.07) was observed in small tuber size (Table 9) which differed significantly from other two sizes. The lowest number of days (97.30) needed to sprouting in all tubers were observed in the large tubers. Hossain *et al.* (1995) reported that large tubers sprouted most quickly and smaller tuber required longer durations which are in line with the present investigation.

4.2.1.3 Days to start shrivelling

The analysis of variance for days to start shrivelling of tubers showed significant variations among the progenies (Appendix IV). The highest number of days to start shrivelling was observed in the HPS-364/67 (147.78) followed by HPS-364/9 (145.33) and they were significantly similar. The third highest days to start shrivelling were found in HPS-I/67 (139.89) followed by HPS-501/67 (137.89) and it was about five months after storing. The lowest days to start shrivelling (100.00) was noticed in the check cultivar, Diamant (Table 8) and it differed significantly with all the rest progenies.

There were significant differences among tuber sizes (Table 9). The highest days to start shrivelling (134.40) was obtained in large tuber size numerically but it did not differ significantly with medium size (131.83). Small tubers had the required lowest days (126.27) to start shrivelling (Table 9). Similar result was stated by Hossain *et al.* (1992b).

4.2.1.4 Days to 100% shrivelling

The analysis of variance for days to 100% shrivelling showed significant differences among the progenies (Appendix IV). The highest days to 100% shrivelling (177.33) was exhibited by HPS-364/67 which was statistically similar only with the progeny HPS-364/9 (175.77) and differed significantly with rest progenies. The lowest days to 100% shrivelling (141.67) was obtained from the check cultivar, Diamant. Rest of the progenies was statistically similar (Table 8). All the TPS progenies took longer days than Diamant for days to 100% shrivelling.

In case of tuber sizes, the highest days to 100% shrivelling was observed in large tuber (163.67) followed by medium (160.40) and they were statistically at par (Table 9). The lowest days to 100% shrivelling was in small tuber sizes (153.47). More or less similar trend of shrivelling behaviour has been documented by (Singh, 1980).

4.2.1.5 Longest sprout length at 210 days after storing

The differences among the progenies for longest sprout length at 210 days were significant. The highest sprout length was in HPS-364/9 (19.54 mm), which was statistically similar to the progenies HPS-501/67, HPS-9/67 and HPS-364/67 and the lowest sprout length was in BARI TPS-2 (13.49) (Table 8). Singh (1980) commented that length of the longest sprout increased high respiration rate which released the water from the tuber and ultimately decreased the weight of tuber.

Significant differences were observed for the longest sprout length among the tuber sizes (Table 9). The highest sprout length was in large tuber

(17.69 mm) which was statistically similar to medium size (17.45 mm) but differed significantly with small size tuber.

4.2.1.6 Weight loss (%)

The analysis of variance for weight loss differed significantly among the TPS progenies. The maximum weight loss was observed in check variety, Diamant (31.9%) that causing shorter dormancy (Table 8). The second highest weight loss was found in BARI TPS-2 (27.09%) which showed statistically similar effect with HPS- II/13 (25.03%). The minimum weight loss exhibited by HPS-I/67 (16.19%) that may be probably due to less evaporation, respiration and relatively long dormancy. This progeny also showed shorter sprout length.

Tuber sizes showed significant variations in weight loss (Table 9). Maximum weight loss was in small sized tuber (29.74%) followed by medium size (22.57%). Minimum weight loss (16.20%) was obtained from the large size. Weight loss was inversely proportional to size of tuber (late forming tubers are small and immature). This might be due to immaturity of small tuber. Similar results were also reported by Bedeway *et al.* (1987), Hossain and Rashid (1991) and Rasul *et al.* (1997).

4.2.1.7 Rottage loss (%)

The analysis of variance for rottage loss showed significant differences among the progenies (Appendix IV). The maximum rottage loss was obtained from HPS-501/67 (42.87%) which was statistically similar to HPS-1/67 (42.56%), HPS-7/13 (41.32%), HPS-8/67 (38.10%), HPS-364/67 (36.90%) and BARI TPS-2 (36.62%). The HPS-II/13, HPS-364/9 and HPS-9/67 showed 35.62, 30.37 and 27.33% rottage loss, respectively (Table 8). The minimum rottage loss was observed in Diamant (18.87%). Tuber rot was mainly caused by bacteria as soft rot and *Fusarium* as dry rot.

Maximum rottage loss (61.99%) of large tuber size might be due to the loss of maximum amount of tuber weight. The medium tuber showed 33.47% rottage loss while the minimum rottage loss (10.31%) was revealed in the small sized tuber (Table 9) .

4.2.1.8 Remaining tuber weight (%)

The maximum remaining tuber weight was found in HPS-364/9 (49.89%) which was statistically similar to Diamant (49.22%) and HPS-9/67 (49.16%). This might be due to minimum weight loss of the said progenies. The progenies HPS-364/67, HPS-I/67, HPS-501/67, HPS-II/13 and BARI TPS-2 had 42.86, 39.44, 39.19, 39.40 and 39.00% of remaining tuber weight, respectively. The minimum remaining tuber weight was (36.58%) obtained from HPS-7/13 that was similar to HPS-8/67 (37.94%) (Table 8). Among the TPS progenies, HPS-364/9 and TPS-9/67 showed good performance in remaining tuber weight.

Remaining tuber weight varied significantly for different tuber sizes. The maximum remaining tuber weight (59.99%) was obtained from small sized tuber (Table 9). This might be due to minimum rottage loss. The medium sized tuber had 44.78% remaining tuber weight and the minimum remaining tuber weight (22.04%) was found in large sized tuber which might be due to high rottage loss.

Table 8. Post-harvest behaviour of 9 TPS progenies with check var. Diamant under natural storage condition

Parameters / Progenies	Days to sprout initiation	Days to sprout in all tubers	Days to start shrivelling	Days to 100% shriveling*	Longest sprout length at 210 days after storing (mm)	210 days after storing		
						Weight loss (%)	Rottage Loss (%)	Remaining tuber weight (%)
HPS-II/13	41.78d	99.22b	128.56d	154.56b	13.99de	25.03bc	35.62bc	39.40bc
HPS-7/13	47.89b	103.89ab	130.67d	153.33b	14.69d	22.51c-e	41.32ab	36.58c
HPS-8/67	43.77cd	103.67ab	122.89e	156.44b	17.67b	23.99c	38.10ab	37.94c
HPS-501/67	45.88bc	114.44a	137.89bc	160.78b	19.07a	18.07fg	42.87a	39.19bc
HPS-9/67	51.44a	114.00a	132.88cd	160.33b	19.00a	23.37cd	27.33d	49.16a
HPS-I/67	53.22a	115.22a	139.89b	158.77b	14.27d	16.19g	42.56a	39.44bc
HPS-364/67	53.67a	111.89a	147.78a	177.33a	18.93a	20.34d-f	36.90ab	42.86b
HPS-364/9	54.00a	114.11a	145.33a	175.77a	19.54a	19.83ef	30.37cd	49.89a
BARI TPS-2	51.00a	105.22ab	122.44e	152.78b	13.49e	27.09b	36.62ab	39.00bc
Diamant (check)	44.33cd	86.11c	100.00f	141.67c	15.68c	31.97a	18.87e	49.22a
CV (%)	5.08	7.66	3.16	3.93	3.23	10.29	13.48	7.71
$S\bar{x}$	0.8248	2.727	1.376	2.087	0.1792	0.7837	1.584	1.087
Level of significance	**	**	**	**	**	**	**	**

*Following an arbitrary scale 1-5 (1= No shrivelling and 5=maximum shrivelling)
** Significant at 1 % level of probability
Value in each column followed by same latter(s) is not significantly different

Table 9. Effect of tuber size on storage behaviour of 9 TPS progenies under natural storage condition

Parameters / Tuber size	Days to sprout initiation	Days to sprout in all tubers	Days to start shrivelling	Days to 100% shrivelling	Sprout length at 210 days after storing (mm)	210 days after storing		
						Weight loss (%)	Rottage loss (%)	Remaining tuber weight (%)
Large (>43 mm)	43.17c	97.30c	134.40a	163.67a	17.69a	16.20c	61.99a	22.04c
Medium (28-45 mm)	47.30b	104.97b	131.83a	160.40a	17.45a	22.57b	33.47b	44.78b
Small (<28 mm)	55.63a	118.07a	126.27b	153.47b	14.76b	29.74a	10.31c	59.99a
CV (%)	5.08	7.66	3.16	3.93	3.23	10.29	13.48	7.71
$S_{\bar{x}}$	0.4517	1.494	0.7537	1.143	0.09815	0.4292	0.8674	0.5953
Level of significance	**	**	**	**	**	**	**	**

** Significant at 1 % level of probability
Value in each column followed by same latter (s) is not significantly different

4.2.2 Interaction between progeny and tuber size for different storage parameters

For natural or ordinary storage, tuber size is the most important selecting criterion. Different tuber sizes showed different response to different storage characters. The interaction of size with progeny for different storage characters are discussed below:

4.2.2.1 Days to sprout initiation

The interaction between tuber sizes and TPS progenies showed significant difference among the progenies for days to sprout initiation (Appendix IV). The highest number of days (60.33) to sprout initiation was taken by HPS-364/9 with small size tuber (Fig. 1) which was statistically similar to HPS-7/13 and HPS-364/67 with same sized tuber. In the same progeny (HPS-364/9) medium and large size required 52.67 and 49.67 days to sprouting, respectively. The lowest days to sprouting (36.00) was recorded in Diamant with large tuber size. The trend of sprout initiation was small > medium > large.

4.2.2.2 Days to sprout in all tubers

The interaction between tuber size and progenies was significantly differed for days to sprouting in all tubers (Appendix IV). The longest days to sprout in all tubers were revealed in small tuber size in the progeny HPS-

364/9 (132.00) that similar to HPS-I/67. The check variety, Diamant with large tuber size showed significantly lowest duration (78.33). Fig. 2 showed that small tubers always required longer time for sprouting in all tubers than medium and large tubers in all progenies. The check, Diamant required relatively shorter time for sprouting in all tubers for each size which was undesirable for selection of long dormant variety.

4.2.2.3 Days to start shrivelling

The interaction between tuber size and progenies showed significant differences for days to start shrivelling. The longest duration (157.33) for start to shrivelling was found in HPS-364/9, having large tuber size which was similar to HPS-364/67 whereas shortest duration (98.67) was in medium sized tuber of Diamant (Fig.3). Large sized tuber for maximum progenies required relatively longer duration for start shrivelling than medium and small sized tuber.

4.2.2.4 Days to 100% shrivelling

The highest days to 100% shrivelling was obtained from HPS-364/67 (178.00) with medium size tuber that followed by HPS-364/9 with statistically similar durations (Fig. 4). In the same progeny, small and large sized tuber required similar days to 100% shrivelling indicating that this variety might be selected as parent for breeding high dormant variety. The check variety, Diamant needed lowest duration to 100% shrivelling and their trend was small < medium < large.

4.2.2.5 Longest sprout length at 210 days after storing

Significant the longest sprout (24.63 mm) was found in the progeny HPS-364/9 with large tuber size followed by HPS-364/67 (23.17 mm). The progeny BARI TPS-2 (11.43 mm) showed shortest sprout with large sized tuber which was at par with the progeny HPS-I/67 of small sized tuber (Fig. 5).

4.2.2.6 Weight loss (%)

The maximum weight loss (38.60%) was found in Diamant having small tuber size whereas the minimum weight loss revealed in HPS-I/67 (7.57%) with large tuber size (Fig. 6). Trend of weight loss (%) was small > medium > large except HPS-501/67 The small tubers performed always maximum weight loss than medium and large sized tubers and such loss might be due to the relative immaturity and high water content.

4.2.2.7 Rottage loss (%)

The rottage loss was exhibited in reverse order than that of weight loss. The higher weight loss showed the lower rottage loss. The maximum rottage loss was given by HPS-364/67 (75.43%) with large tuber size which was statistically similar to HPS-I/67 (74.60%) and HPS-8/67 (74.67%). The minimum rottage loss was in HPS-364/9 (5.70%) having small tuber size which was statistically similar to the Diamant (6.57%) of same sized tuber. The small tuber size had the lowest rottage loss showed by all progenies (Fig. 7). The trend of tuber size for rottage loss (%) was large > medium > small.

4.2.2.8 Remaining tuber weight (%)

The Fig. 8 revealed that small tuber size had always maximum remaining tuber weight for maximum progenies. The maximum remaining tuber weight for small size was obtained from HPS-364/67 (69.20%) followed by HPS-364/9 and HPS-I/67 and minimum (8.23%) was in the same progeny (HPS-364/67) with large sized tuber (Fig. 8). Large size had the lowest remaining tuber weight due to high rottage loss. The Diamant gave the maximum remaining tuber weight among the progenies for large and medium sized of tuber. The trend of tuber size for remaining tuber weight (%) was large < medium < small for maximum progenies.

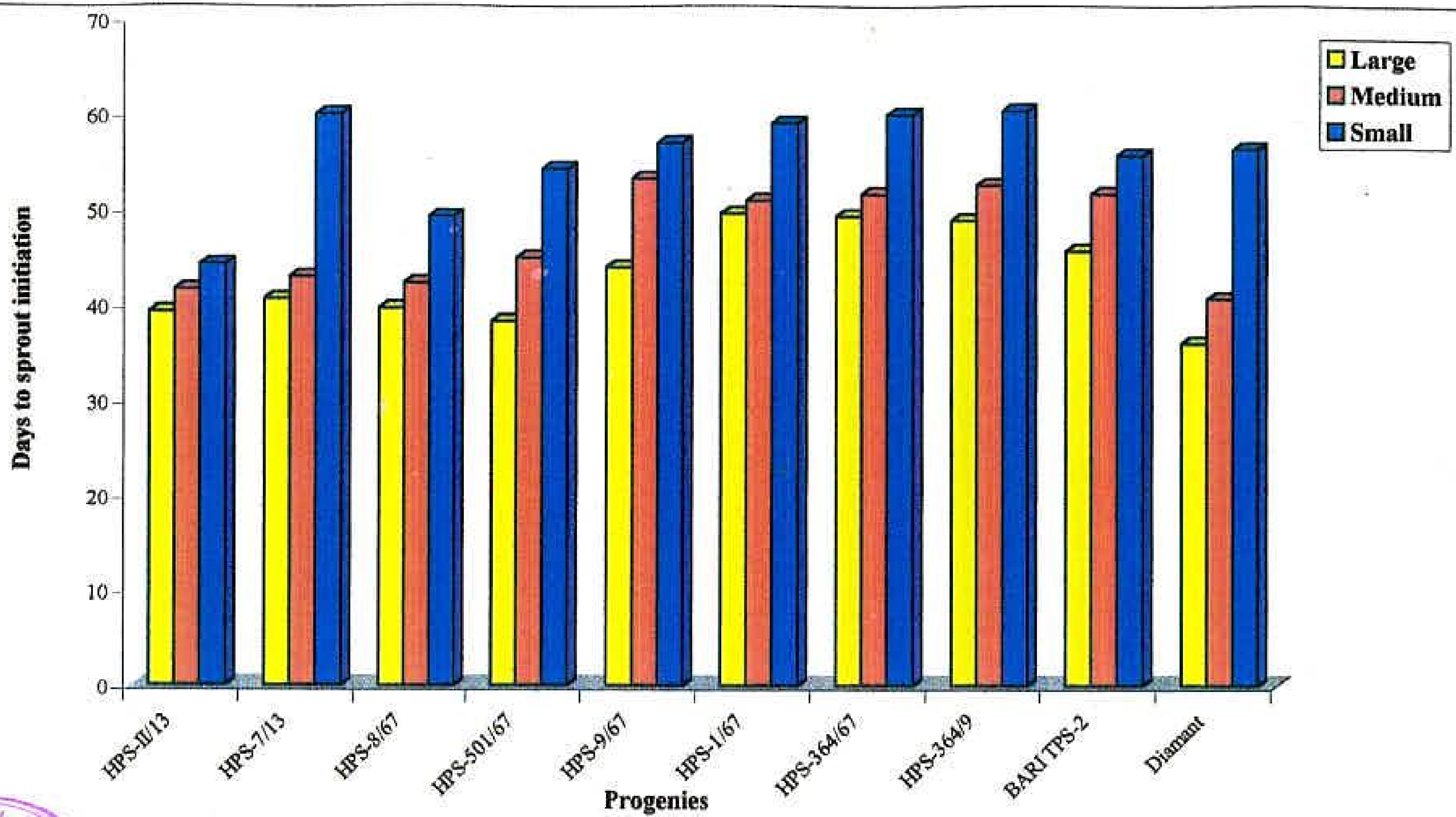

Fig. 1. Effect of tuber size on days to sprout initiation in different TPS progenies

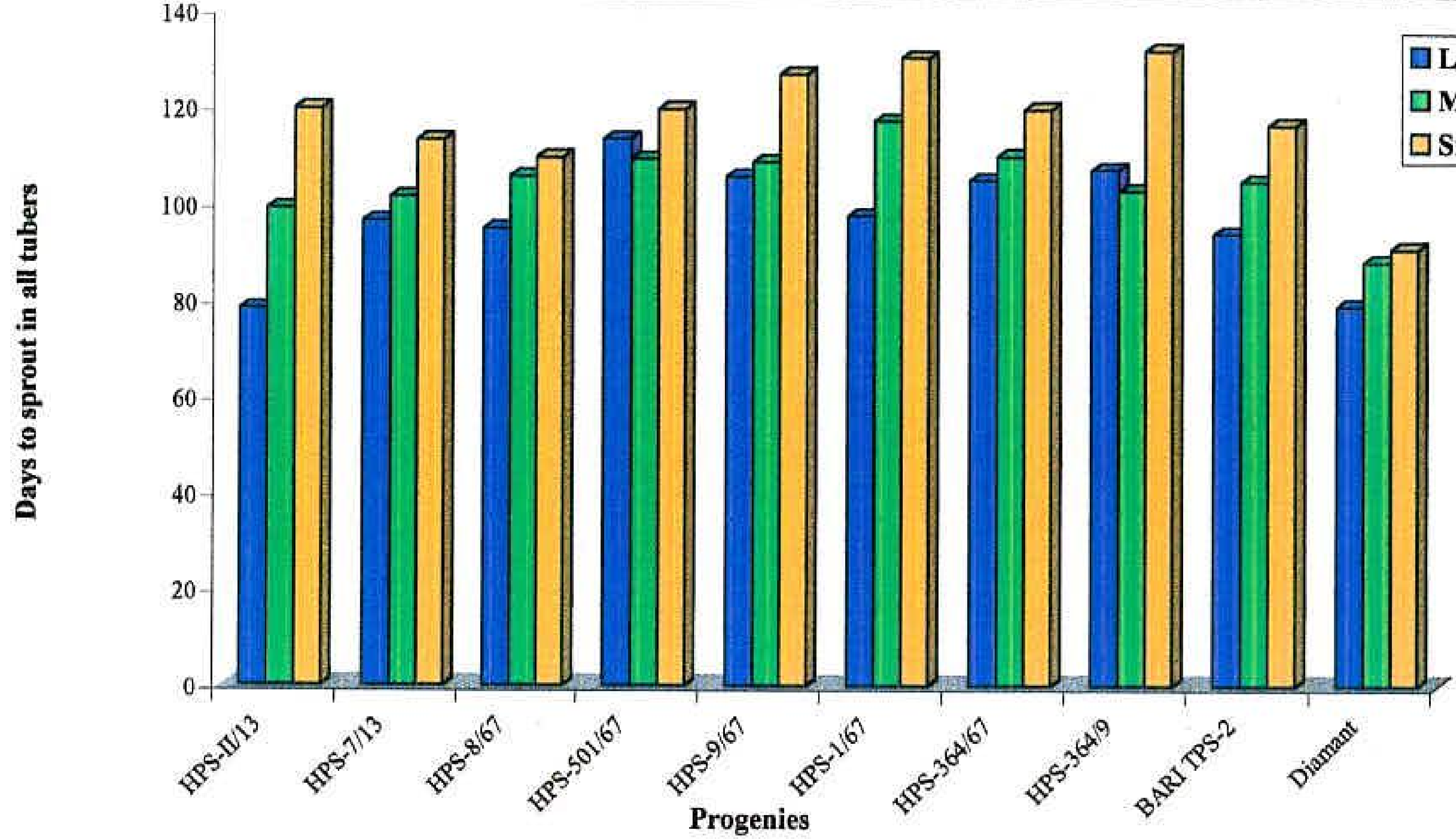

Fig. 2. Effect of tuber size on days to sprout in all tubers in different TPS progenies

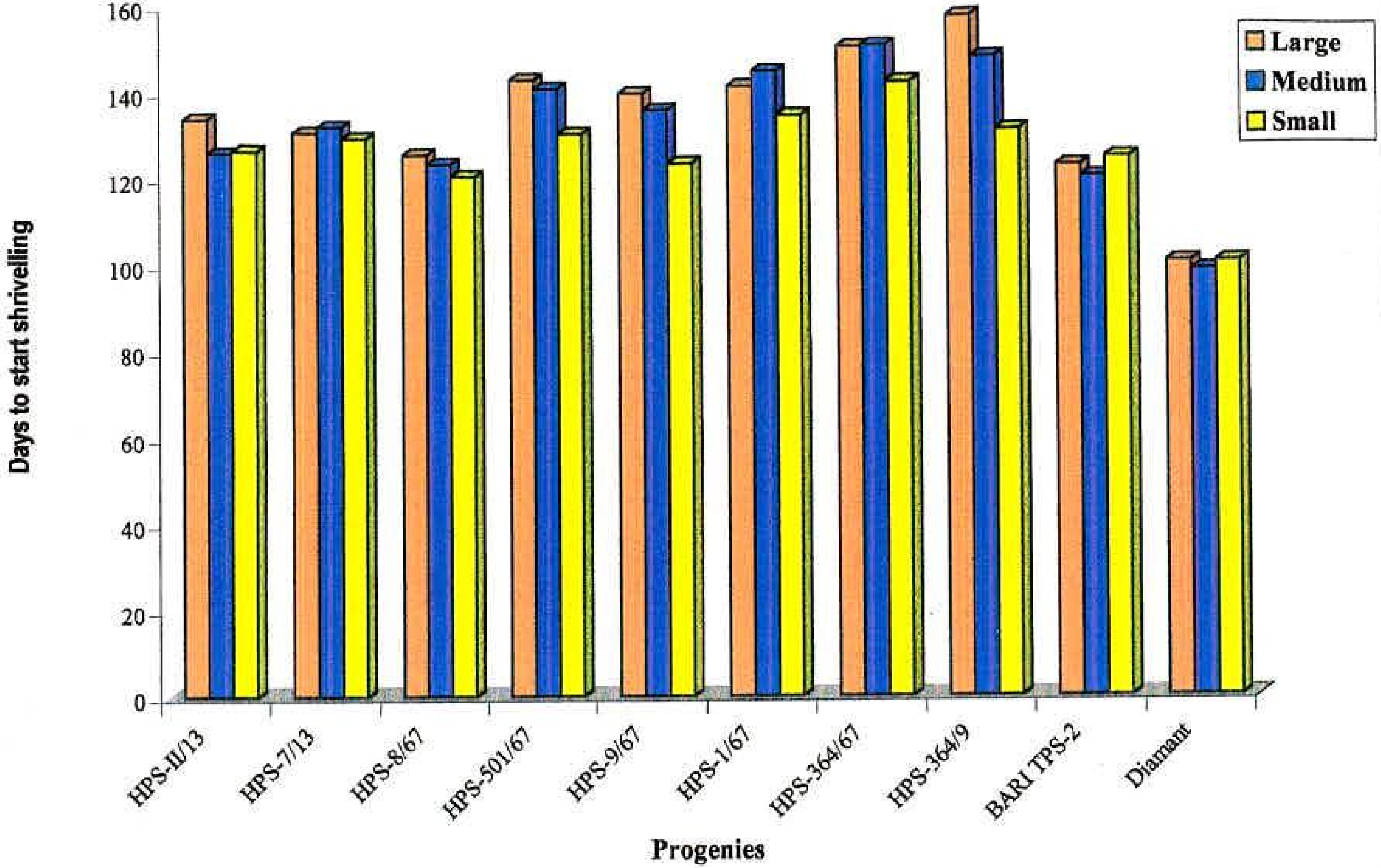

Fig. 3. Effect of tuber size on days to start shrivelling in different TPS progenies

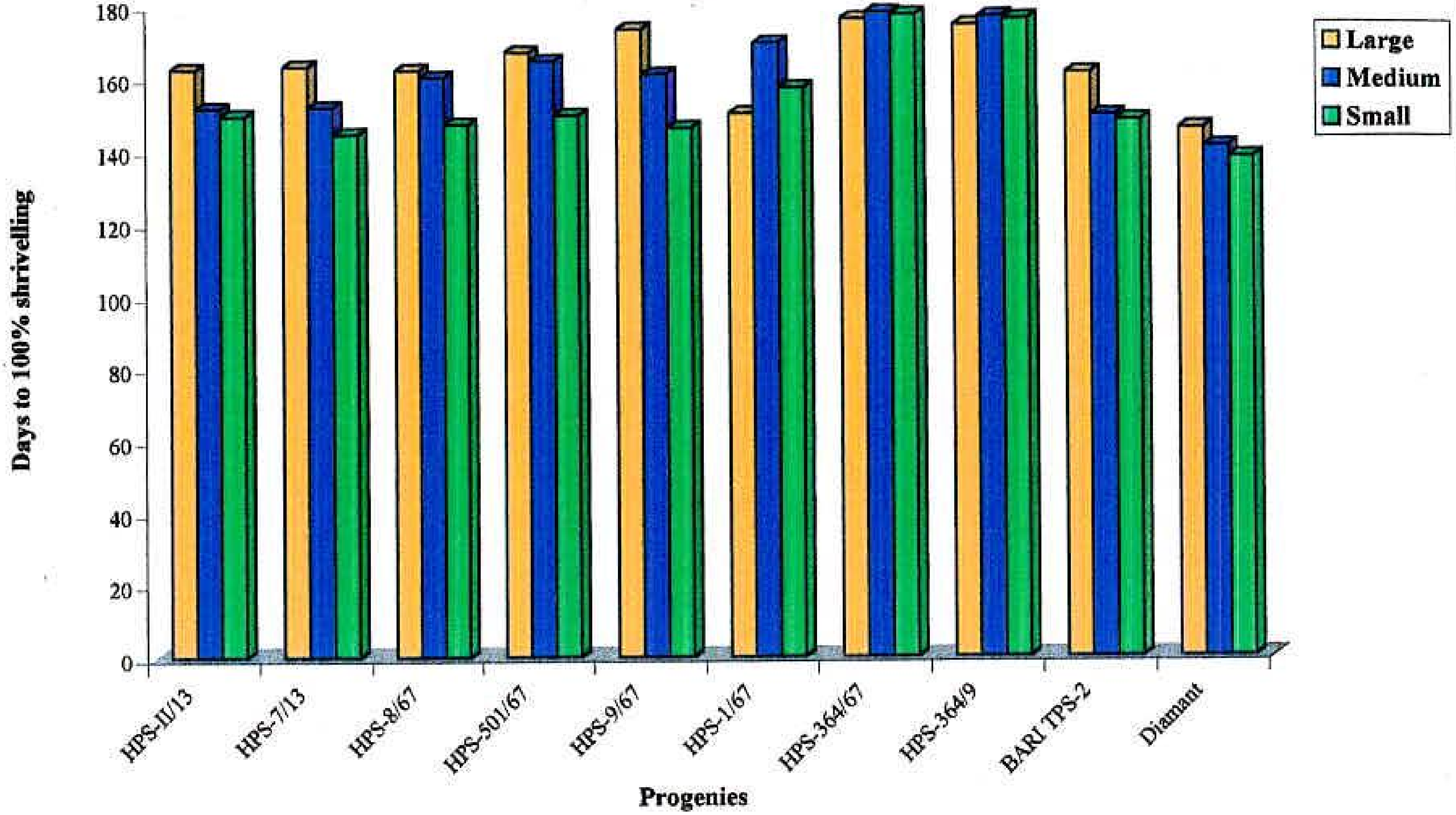

Fig. 4. Effect of tuber size on days to 100% shrivelling in different TPS progenies

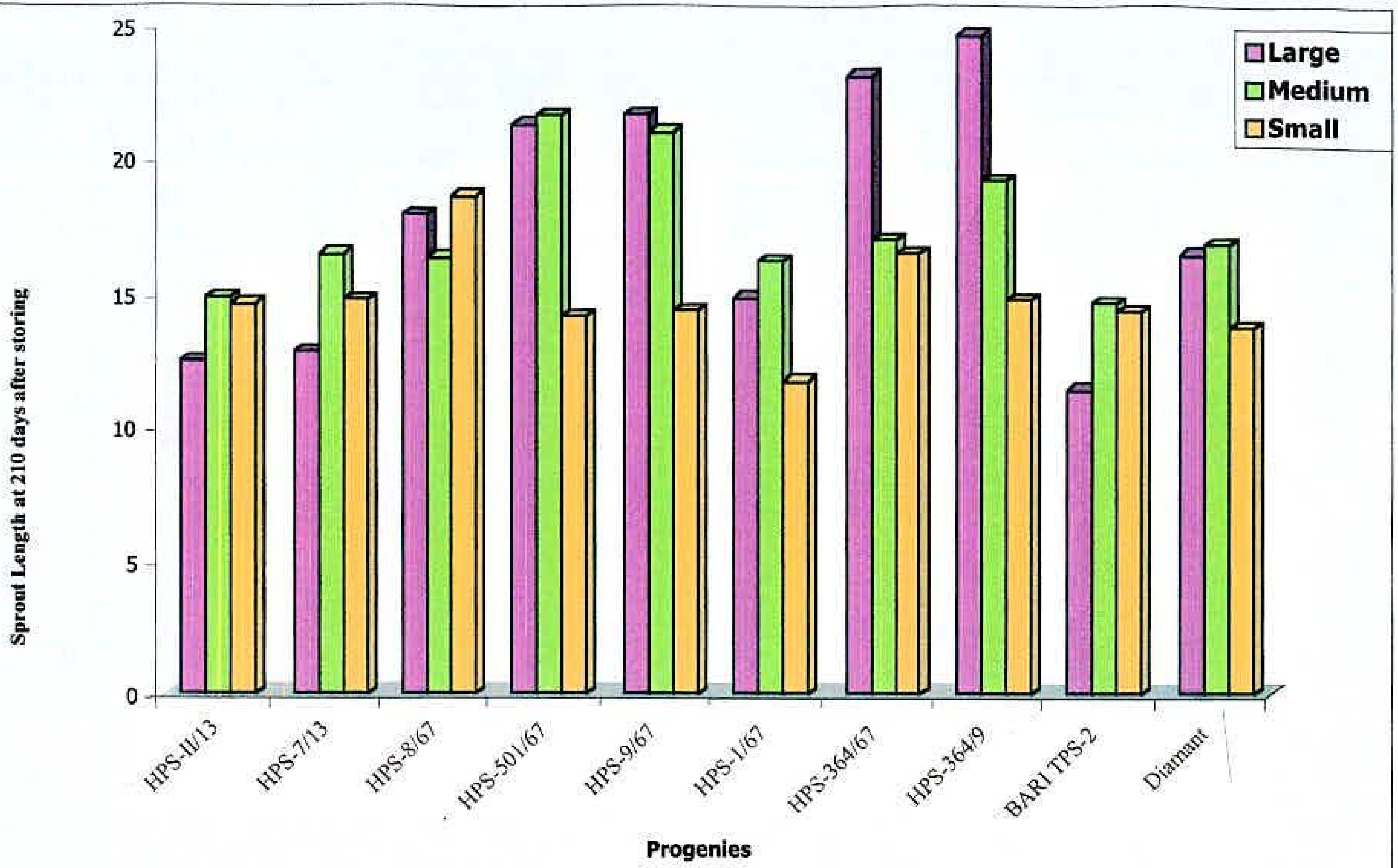

Fig. 5. Effect of tuber size on sprout length in different TPS progenies

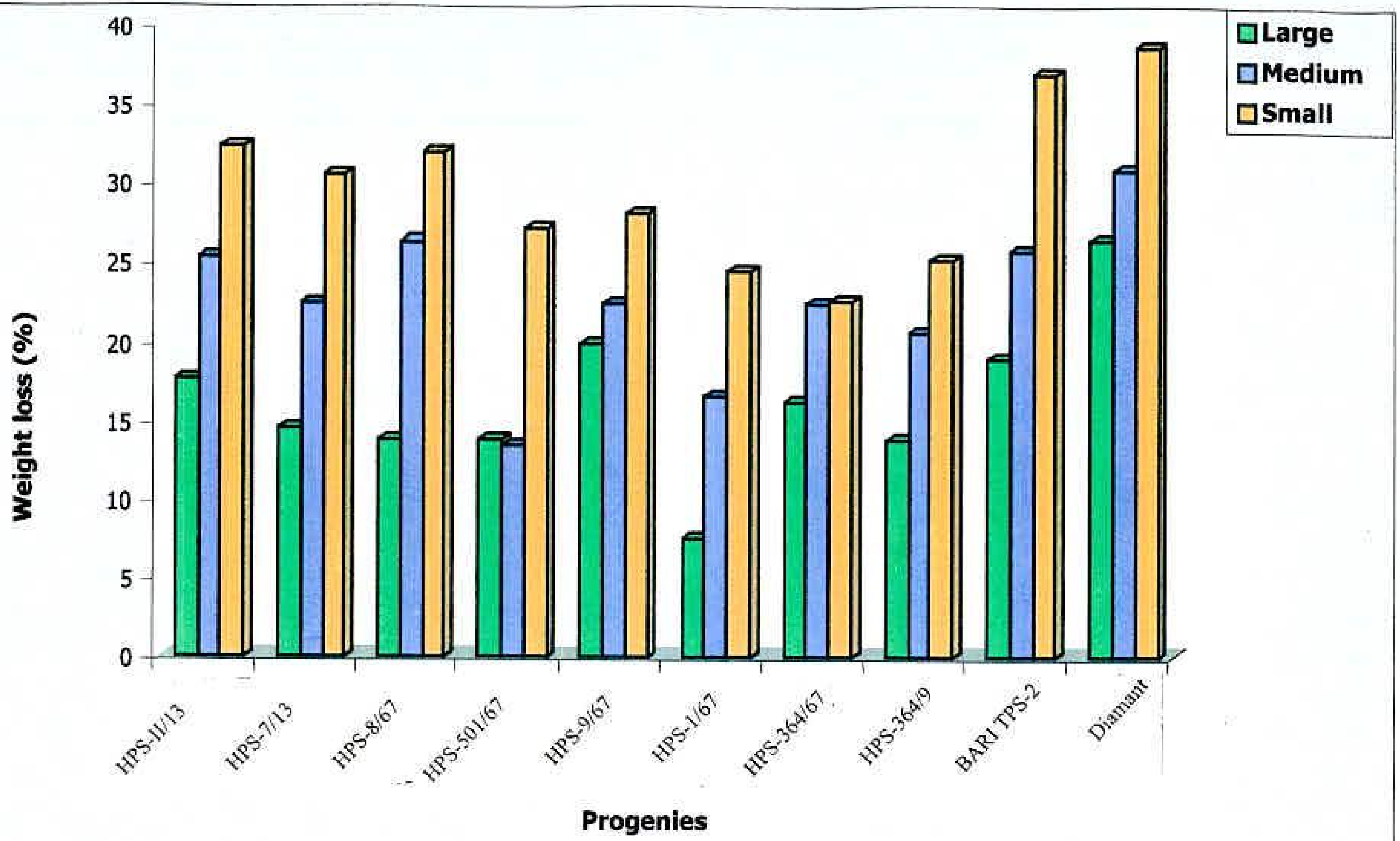

Fig. 6. Effect of tuber size on weight loss (%) in different TPS progenies

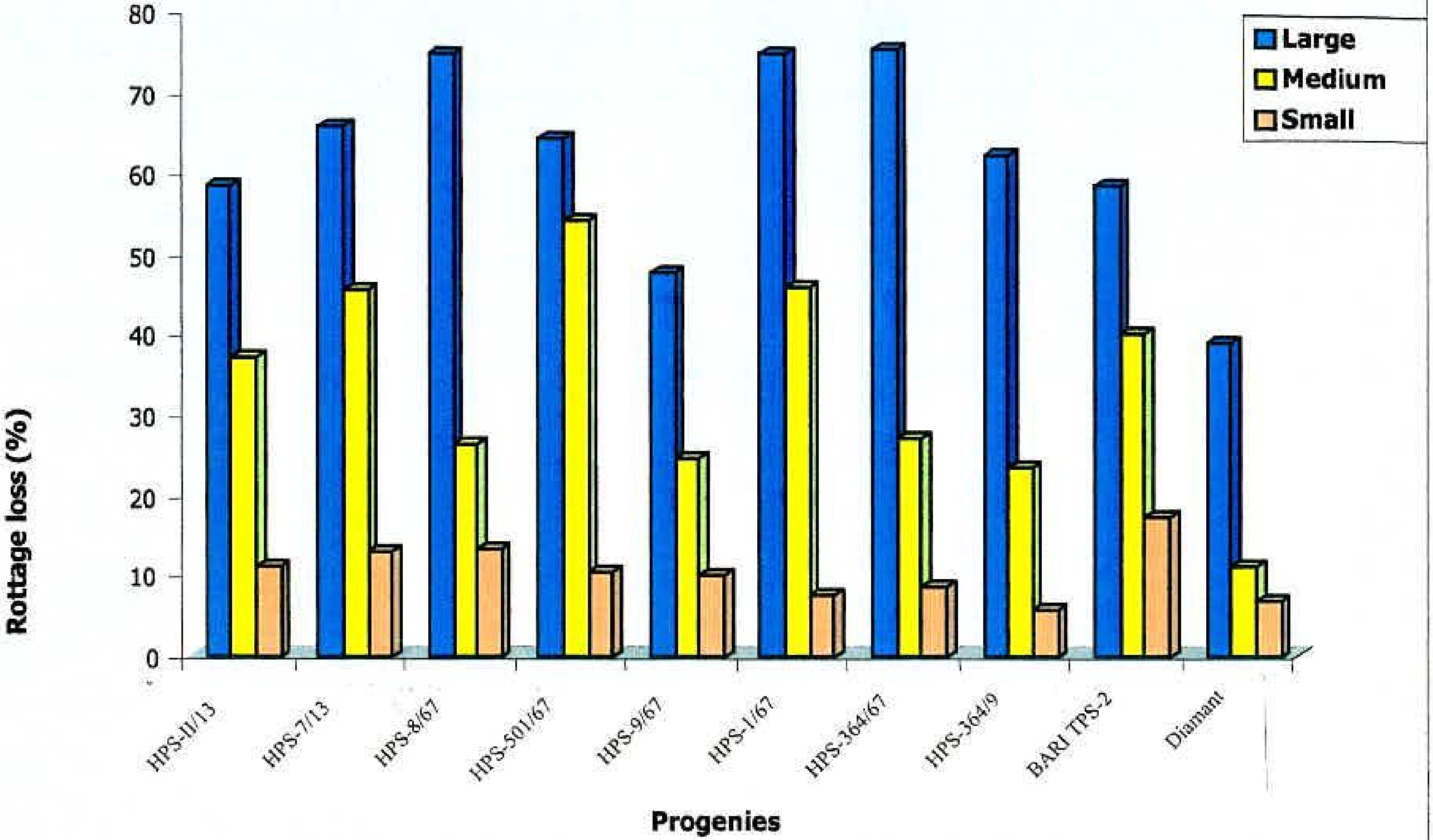

Fig. 7. Effect of tuber size on rottage loss in different TPS progenies

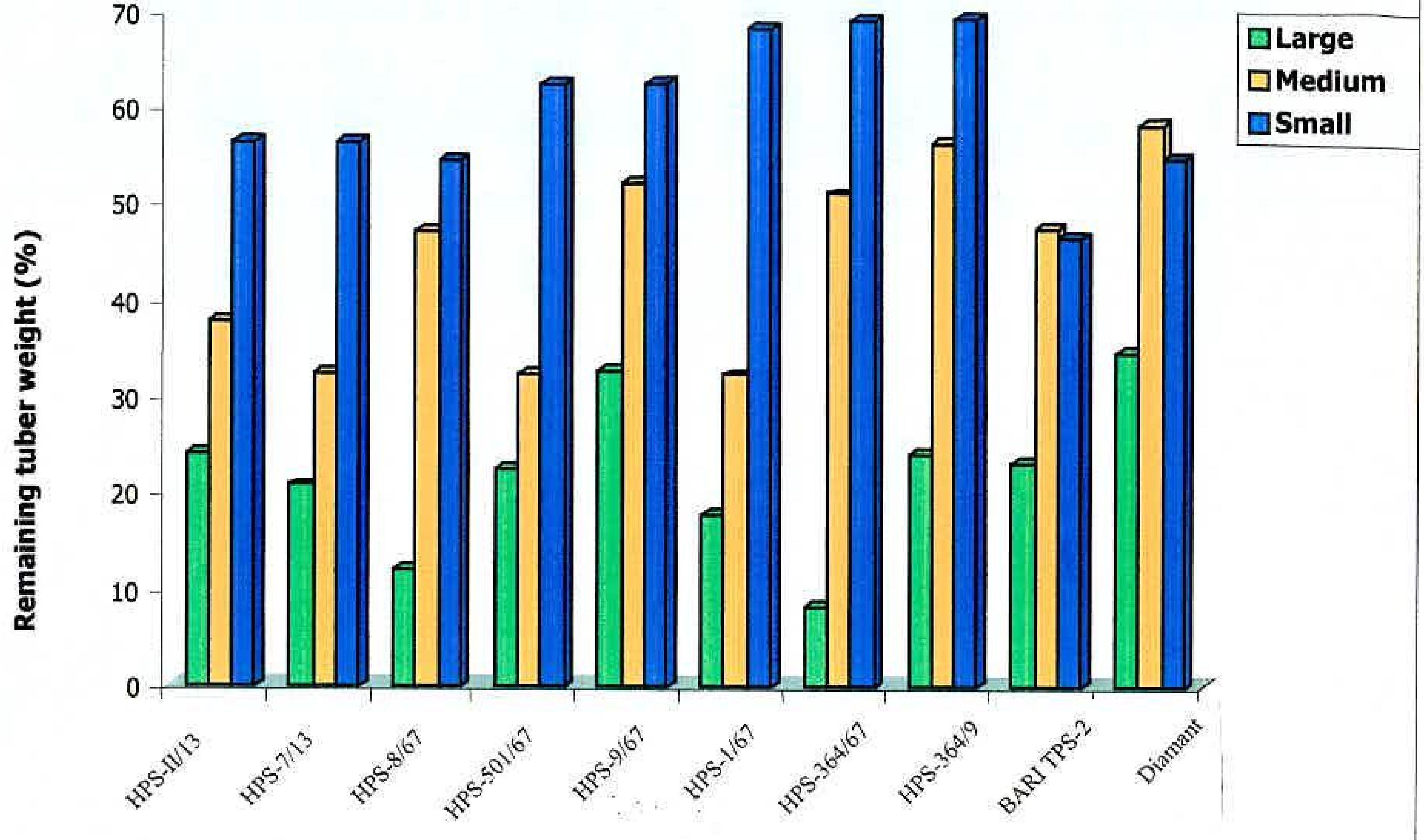

Fig. 8. Effects of tuber size on remaining tuber weight in different TPS progenies

4.2.2.9 Analysis of correlation coefficient

Correlation coefficient analysis between different characters of storage was estimated in all possible combination, which is shown in Table 10. Rottage loss (%) showed significant negative (-0.661* and -0.636*) correlation to remaining tuber weight and weight loss, respectively. The non-significant positive correlation of rottage loss with days to sprouts in all tubers, days to start shrivelling and days to 100% shrivelling was also observed (Table 10).

Days to sprout initiation showed significant positive (0.758*) correlation with days to start shrivelling followed by days to sprout in all tubers (0.697*) but non-significant negative correlation (-0.576) with weight loss.

Days to sprout in all tubers showed highly significant positive correlation with days to start shrivelling (0.782**). The highly significant negative correlation was observed between weight loss with days to sprout in all tubers and days to start shrivelling (-0.879**).

The highly significant positive correlation was found between days to start shrivelling and days to 100% shrivelling (0.903**) and the highly significant negative correlation with weight loss (-0.879**). The positive non-significant association was obtained with longest length of sprout and remaining tuber weight (Table 10).

Days to 100% shrivelling showed significant positive correlation (0.733*) with longest sprout length at 210 days after storing and significant negative correlation with weight loss (-0.745*) and non-significant positive correlation with remaining tuber weight (Table 10).

Correlation of length of longest sprout at 210 days with weight loss was nonsignificant and negative (-0.467) but it was positive (0.467) with remaining tuber weight.

The correlation of weight loss with remaining tuber weight was non-significant and negative (-0.079).

Based on above discussion, it may be concluded that among the nine promising TPS progenies, only three (HPS-9/67, HPS-364/67 and HPS-364/9) have performed excellent in respect of post-harvest behaviour under natural storage condition. Different sizes of tubers behaved differently in storage, though small tubers performed comparatively better than the other two sizes.

Table 10. Correlation coefficient of different storage characters in their first clonal generation (F_1C_1)

Parameters	Rottage loss 210 days (%)	Days to sprout initiation	Days to sprout in all tubers	Days to start shrivelling	Days to 100% shrivelling	Longest sprout length at 210 days after storing	Weight loss after 210 days (%)	Remaining tuber weight after 210 days (%)
Rottage loss after 210 days (%)	1.00	**-0.018**	0.467	0.285	0.224	-0.067	-0.636*	-0.661*
Days to sprout initiation			**0.697***	0.758*	0.612	0.382	-0.576	0.479
Days to sprout in all tubers				**0.782****	0.685*	0.418	-0.879**	0.188
Days to start shrivelling					**0.903****	0.588	-0.879**	0.370
Days to 100% shrivelling						**0.733***	-0.745*	0.358
Longest sprout length at 210 days after storing							**-0.467**	0.467
Weight loss after 210 days (%)								**-0.079**
Remaining tuber weight after 210 days (%)								1.00

* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

4.3 Experiment 3. Field performance of 9 promising True Potato Seed progenies in their first clonal generation (F_1C_1)

Results of the study are presented and discussed below:

4.3.1 Growth parameters

4.3.1.1 Days to first emergence

The analysis of variance showed significant differences among the progenies for days to first emergence (Appendix V). The longest duration (10.00 days) for first emergence in F_1C_1 was needed by the progeny HPS-I/67 that followed by HPS-501/67 (9.33 days) with statistically similar durations (Table 11). The minimum duration (6.67 days) was taken by the check variety, Diamant.

4.3.1.2 Days to 50% emergence

Significant differences were observed among the progenies for days to 50% emergence (Appendix V). The longest duration for 50% emergence was recorded from the progeny HPS-7/13 (15.00 days) that was followed by the progenies HPS-I/67 (14.67), HPS-501/67 (14.33), HPS-II/13 (13.33), BARI TPS-2 (13.33), HPS-8/67 (13.00), HPS-9/67 (12.33) and HPS-364/9 (12.33) which were statistically similar. The minimum duration was required by the check variety, Diamant (10.67 days) (Table 11). Non-significant differences among the progenies in first clonal generation (F_1C_1) were also reported (Anon., 1992).

4.3.1.3 Days to tuber initiation

The days to tuber initiation from the analysis of variance was found statistically significant (Appendix V). The lowest duration for tuber initiation in F_1C_1 was required by the progeny HPS-8/67 (33.67 days) (Table 11). The duration of tuberization was highest in HPS-501/67 (41.00 days) which was statistically similar to Diamant (40.33 days), HPS-9/67 (39.67 days), HPS-364/67 (39.67days), HPS-7/13 ((39.00 days), HPS-364/9 (37.33 days) and HPS-II/13 (37.33 days).

4.3.1.4 Number of stems hill^{-1}

The mean value of stems hill^{-1} showed significant differences among the progenies (Appendix V). The check variety, Diamant showed significantly highest number of stems hill^{-1} (4.57). The progenies HPS-7/13 and HPS-501/67 revealed the lowest number of stems hill^{-1} (2.33) (Table 11). The result is in agreement with the result described earlier by Sharma *et al.* (1998).

4.3.1.5 Plant height (cm) at 60 DAS

The mean value for plant height showed significant variations among the progenies of F_1C_1 (Appendix V). The progeny HPS-364/9 (70.67 cm) showed significantly tallest plant which was at par with the progenies HPS-364/67 (68 cm), HPS-8/67 (64.5 cm), HPS-7/13 (64.00 cm) and HPS-501/67

(63.13 cm). On the other hand, the progeny HPS-II/13 showed the significantly the shortest plant (56.5 cm).

4.3.1.6 Foliage coverage at 60 DAS (%)

Good foliage coverage indicates higher growth and development of potato crop are directly related to yield of seedling tubers. The more the foliage coverage, the more the photosynthetic pool area and thereby higher tuber yield (Roy *et al.*, 1999). In the present study, the foliage coverage was recorded at 60 DAS. The progenies differed significantly for foliage coverage (Appendix V). The highest foliage coverage was obtained from HPS-I/67 (94.00%) which was statistically similar to all others except HPS-9/67 (85.33%) and Diamant (78.00%). The check variety Diamant showed the lowest foliage coverage at 60 days after sowing (Table 11).

4.3.1.7 Days to maturity

Significant variations among the progenies were observed in respect of days to maturity (Appendix V). The progeny HPS-9/67 took 96.00 days while Diamant took 90.67 days to mature. The progeny HPS-7/13, HPS-8/67, HPS-364/9 HPS-501/67, HPS-364/67 and BARI TPS-2 were statistically similar in maturity date (Table 12). Similar variations for maturity dates were also reported by Anon, (1995).

4.3.1.8 Number of tubers hill^{-1}

Non-significant difference among the progenies (F_1C_1) was observed in respect of number of tubers hill^{-1} (Appendix V). The number of tubers hill^{-1} ranged from 8.8 (Diamant) to 11.6 (HPS-364/67) (Table 12). The present findings on the number of tubers hill^{-1} are in agreement with the findings of Kamal (1964), Siddique *et al.* (1987), Anon, (1991), Sultana and Siddique (1991) and Choudhury (1997).

4.3.1.9 Weight of tubers hill^{-1} (g)

Analysis of variance of tuber weight hill^{-1} showed no significant variations among the progenies (Appendix V). The weight of tubers ranged from 400.0g (HPS-II/13) to 454.7 g (HPS-364/9) (Table 12). The present findings are in agreement with the reports of Goma *et al.* (1970), Taleb *et al.* (1973), Rabbani and Siddique (1987), Siddique *et al.* (1987), Rahman and Gaffar (1991), Sultana and Siddique (1991) and Choudhury (1997).

4.3.1.10 Tuber yield (t ha^{-1})

Yield (t ha^{-1}) showed significant differences among the progenies. The yield ranged from 21.40 t ha^{-1} (HPS-501/67) to 30.13 t ha^{-1} (HPS-364/9) (Table 12). The progeny HPS-364/9 (30.13 t ha^{-1}) gave significantly the highest yield which was statistically similar to BARI TPS-2 (29.13 t ha^{-1}) and HPS-364/67 (28.30 t ha^{-1}). The lowest tuber yield (21.40 t ha^{-1}) was resulted in the progeny HPS-501/67. Significant differences were observed among the TPS progenies for yield in first clonal generation (F_1C_1) at Joydebpur as reported by Anon, (1991).

Table 11. Growth parameters of promising TPS progenies in their first clonal generation (F_1C_1)

Parameters / Progenies	Days to first emergence	Days to 50% emergence	Days to tuber initiation	No. of stem $hill^{-1}$	Plant height at 60 DAS (cm)	Foliage coverage at 60 DAS (%)
HPS-II/13	9.00bc	13.33a-c	37.33ab	2.67bc	56.50c	88.33ab
HPS-7/13	8.67b-d	15.00a	39.00a	2.33c	64.00a-c	88.33ab
HPS-8/67	8.33cd	13.00a-c	33.67c	3.00bc	64.50ab	88.33ab
HPS-501/67	9.33ab	14.33ab	41.00a	2.33c	63.13a-c	91.00ab
HPS-I/67	10.00a	14.67ab	35.33bc	3.00bc	62.33bc	94.00a
HPS-9/67	8.00de	12.33a-c	39.67a	3.00bc	60.33bc	85.33bc
HPS-364/67	8.67b-d	12.00bc	39.67a	3.33b	68.00ab	85.67a-c
HPS-364/9	7.33ef	12.33a-c	37.33ab	3.00bc	70.67a	90.67ab
BARI TPS-2	9.00bc	13.33a-c	34.33bc	3.00bc	60.67bc	89.67ab
Diamant (Check)	6.67f	10.67c	40.33a	4.57a	62.00bc	78.00c
Mean	8.5	13.10	37.77	3.03	63.21	87.93
CV (%)	5.68	10.84	5.08	13.16	6.46	4.94
$S\bar{x}$	0.2787	0.8196	1.108	0.2302	2.357	2.507
Level of significance	**	*	**	**	*	*

* Significant at 5 % level of probability
** Significant at 1 % level of probability
Value in each column followed by same latter (s) is not significantly different

Table 12. Yield attributes of promising TPS progenies in their first clonal generation (F_1C_1)

Parameters / Progenies	Days to maturity	Number of tubers $hill^{-1}$	Weight of tubers $hill^{-1}$ (g)	Tuber yield ($t\ ha^{-1}$)
HPS-II/13	92.00cd	10.2	400.0	21.90de
HPS-7/13	95.33ab	11.2	423.6	24.63c-e
HPS-8/67	94.67a-c	9.3	440.7	24.60c-e
HPS-501/67	95.00ab	10.3	435.7	21.40e
HPS-I/67	93.00b-d	10.6	412.3	24.27c-e
HPS-9/67	96.00a	10.8	432.7	25.40b-e
HPS-364/67	93.33a-d	11.6	432.7	28.30a-c
HPS-364/9	93.33a-d	11.4	454.7	30.13a
BARI TPS-2	96.33ab	10.7	444.6	29.13ab
Diamant (Check)	90.67d	8.8	420.3	25.93b-d
Mean	93.87	10.5	432.8	25.57
CV (%)	1.51	11.26	5.06	8.45
$S\bar{x}$	0.8179	-	-	1.247
Level of significance	**	NS	NS	**

* Significant at 5 % level of probability

** Significant at 1 % level of probability

NS= Non significant

Value in each column followed by same latter (s) is not significantly different

4.3.2 Analysis of correlation coefficient

4.3.2.1 First clonal generation

Correlation co-efficient between different characters were estimated in all possible combinations which are shown in Table 13. Positive and significant correlation was observed between days to first emergence and days to 50% emergence (0.755*) followed by days to first emergence and foliage coverage (0.685*), number of tubers hill^{-1} and yield (t ha^{-1}) (0.671*). The highly significant negative correlation was noticed between days to 50% emergence and number of stem hill^{-1} (-0.822**). Yield did not show any significant correlation with all the parameters except number of tubers hill^{-1}. Yield was found negatively correlated with days to first emergence, days to 50% emergence, days to tuber initiation and foliage coverage.

It was evident from the results, days to first emergence and days to 50% emergence followed by days to first emergence and foliage coverage, days to 50% emergence and foliage coverage, number of tubers hill^{-1} and yield (t ha^{-1}) were interrelated. So, selection on the basis of these characters should get preference for selection of progenies or parental lines for future True Potato Seed breeding programme.

From the results represented above discussion that performance of the 9 progenies were well. But 4 such as HPS-364/9, HPS-364/67, BARI TPS-2 and HPS-9/67 have been found to be best compared to others.

Table 13. Correlation coefficient of different characters for TPS progenies in their first clonal generation (F_1C_1)

Parameters	Days to first emergence	Days to 50% emergence	Days to tuber initiation	Number of stem hill^{-1}	Plant height at 60 DAS (cm)	Foliage coverage at 60 DAS (%)	Days to maturity	Number of tuber hill^{-1}	Weight of tuber hill^{-1} (g)	Yield (tha^{-1})
Days to first emergence	1.00	0.755*	-0.184	-0.519	-0.226	0.685*	0.125	-0.024	-0.254	-0.591
Days to 50% emergence			-0.273	-0.822**	-0.116	0.673*	0.315	0.000	-0.187	-0.573
Days to tuber initiation				0.007	-0.043	-0.352	-0.122	0.061	-0.214	-0.116
Number of stem hill^{-1}					0.117	-0.493	-0.371	-0.019	0.046	0.603
Plant height at 60 DAS (cm)						0.215	-0.024	0.455	0.511	0.321
Foliage coverage at 60 DAS (%)							-0.111	0.092	0.234	-0.276
Days to maturity								0.389	0.570	0.164
Number of tuber hill^{-1}									0.328	0.671*
Weight of tuber hill^{-1} (g)										0.529
Yield (tha^{-1})										1.00

* Correlation is significant at the 5% level and ** Correlation is significant at the 1% level

CHAPTER - V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

5.1 Experiment 1. Field performance of 20 True Potato Seed (TPS) progenies in their seedling tuber generation (F_1C_0)

The present experiment was undertaken to study the different yield and yield contributing characters in 20 TPS progenies in their seedling tuber generation. The experiment was conducted during November 2000 to March 2001. Progenies were sown in RCBD with 3 replications. Data collected on eight characters were subjected to statistical analysis. The salient findings of the present study have been summarized below:

The analysis of variance showed significant differences among the progenies for all characters studied. Maximum and minimum days to 80% seed germination were exhibited by the progenies HPS- Lalmadda/501 (15.00) and HPS-364/67 (9.67), respectively. The highest germination was observed in HPS-9/67 (96.33%) and the lowest in HPS-501/67 (71.67%). Most of the progenies showed good foliage coverage at 60 DAS ranging from 63.67% to 82.67% exhibited by HPS-Lalmadda/501, HPS-364/9 and BARI TPS 2, respectively. Plant height was highest in HPS-364/67 (88.00 cm) and lowest in HPS-501/Lalmadda (67.33 cm). The highest and lowest number of tuberlets plant^{-1} was obtained from HPS-364/9 (9.33) and HPS-501/Lalmadda (5.33), respectively. The highest and lowest number of tuberlets m^{-2} was obtained from HPS-364/67 (872.3) and 501/Lalmadda (541.7). The highest yield was observed in HPS-9/67 and HPS-364/67 (7.07 kg m^{-2} i.e. 44.88 t ha^{-1}) and the lowest in HPS-Lalmadda/501 (4.75 kg m^{-2} i.e. 30.18 t ha^{-1}). The progeny HPS-364/9 having second highest yield (6.93 kg m^{-2}), higher number of tuberlets m^{-2} (863.7) and highest foliage coverage (82.67%) might be considered as prospect one for commercial cultivation and also as prospective parent in hybridization programme.

Correlation coefficient among different characters revealed that days to 80% seed germination showed negative and significant correlation with germination, foliage coverage, plant height, tuberlets number $plant^{-1}$, tuberlets number m^{-2} and tuberlets yield (t ha^{-1}).

Tuberlets yield (t ha^{-1}) showed positive and highly significant correlation with foliage coverage, plant height, tuberlets number $plant^{-1}$, tuberlets number m^{-2} and tuberlets yield (kg m^{-2}).

Tuberlets number $plant^{-1}$ showed the highest positive direct effect on yield (t ha^{-1}).

5.2 Experiment 2. Natural storage behaviour of 9 promising True Potato Seed (TPS) progenies in their first clonal generation

The present experiment was undertaken to identify good TPS progenies having better keeping quality under ordinary storage conditions. The experiment was conducted in laboratory of the department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka under ordinary storage condition during March to October 2001. The experiment was conducted in 2 factors Completely Randomized Design (CRD) with 3 replications where one factor was TPS progenies and another factor was tuber size. Nine TPS progenies (selected from 20 TPS progenies) with three tuber sizes including Diamant as check were used for this study.

All the collected data of the present study were subjected for statistical analysis. The salient findings of the present study have been summarized below:

The analysis of variance for days to sprout initiation showed significance difference among the progenies. All TPS progenies had longer dormancy than Diamant except HPS-II/13 and HPS-8/67. Tuber size also varied significantly among them. The large size tuber sprouted earlier (43.17 days) compared the small tuber (55.63 days).

A close relationship occurred between days to sprout initiation and days to 100% sprouting, which differed significantly for tuber sizes. The small size tuber took 118.07 days for sprouting in all tubers compared to 97.30 days for large tuber.

Among the progenies, shrivelling was noticed in HPS-364/67 after 147.78 days while Diamant started shrivelling after 100 days. All progenies took longer days to start shrivelling over the check variety.

All the tubers of HPS-364/67 shrivelled most delayed. The highest days to 100% shrivelling were observed in HPS-364/67 (177.33 days) and earliest in the check, Diamant (141.67 days). The large size tuber most delayed to 100% shrivelling (163.67 days) and small size the earliest (153.47 days) . The large and medium size tuber took the longest time to 100% shrivelling and small size had the minimum.

The significant differences were found for the longest sprout length at 210 days among the progenies and tuber sizes. The large and medium size tuber of HPS-364/9, HPS-501/67, HPS-9/67 and HPS-364/67 gave longest sprout and short sprout was observed in small sized tuber.

Both progenies and tuber size showed significant difference for weight loss (%), rottage loss (%) and remaining tuber weight (%). The maximum weight loss was observed in the check, Diamant (31.97%) and maximum rottage loss was exhibited by HPS-501/67 (42.87%) and HPS-1/67(42.56%) and maximum remaining tuber weight found in HPS-364/9 (49.89%) and HPS-9/67 (49.16%). The small tuber experienced maximum weight loss (29.74 %) and minimum rottage loss (10.31%).

The interaction between tuber size and TPS progenies showed significant difference among the progenies for the days to sprout initiation, days to sprout in all tubers, days to start shrivelling, days to 100% shrivelling, length of sprout at 210 days, weight loss, rottage loss and remaining tuber weight. The maximum days to sprout initiation was taken by HPS-364/9 (60.33) with small tuber size. In same progeny, medium and large size tuber took 52.67 and 49.67 days to initiate sprout, respectively. The small tuber size always took higher days to sprouting by all progenies than medium and large tuber size which is indicated that small are long dormant tubers due to physiological immaturity. The progeny HPS-364/9 had relatively longer dormancy across all tuber sizes. Small tuber always took longer time to sprouting in all tubers than medium and large tuber in all progenies. The check, Diamant required relatively shorter time for spouting in all tubers for each size which is undesirable for breeding long dormant variety. Diamant took shorter time for days to start shrivelling for all sizes; large tuber required relatively longer time for start shrivelling than medium and small tuber which is desirable and accepted by growers as well as consumers. Diamant had maximum weight loss in all tuber sizes. Large tubers of all progenies always experienced with the maximum rottage loss for large size was in HPS-364/67 (75.43%) and minimum in Diamant (39.03%). Small tuber size had always maximum remaining tuber weight for most progenies.

The highly significant positive correlation was obtained from the relations of days to 100% shrivelling with days to start shrivelling. The relationship of days to sprout in all tubers with days to start shrivelling was also highly positive. The weight loss had highly significant negative correlation with days to sprout in all tubers and days to start shrivelling.

5.3 Experiment 3. Field performance of 9 promising TPS progenies in their first clonal generation (F_1C_1)

The experiment was undertaken to study the yield and yield contributing characters in TPS progenies in their first clonal generation. The experiment was conducted during November 2001 to March 2002. Tuberlets /seedling tubers of TPS progenies like HPS-II/13, HPS-7/13, HPS-8/67, HPS-501/67, HPS-1/67, HPS-9/67, HPS-364/67, HPS-364/9, BARI TPS-2 and check, Diamant were sown in RCBD with three replications. Data on days to first emergence, days to 50% emergence, days to tuber initiation, plant height at 60 DAS, foliage coverage at 60 DAS, number of stems hill^{-1}, number of tubers hill^{-1}, weight of tubers hill^{-1} and yield (t ha^{-1}) were recorded on plot basis. All the collected data of the present study were subjected for statistical analysis. The salient findings of the present study have been summarized below.

All the progenies in F_1C_1 varied significantly for all the characters studied except number and weight of tuber hill^{-1}. Maximum and minimum days to first emergence were exhibited by the progenies, HPS-I/67 (10.00) and Diamant (6.67). There were the maximum and minimum days required for 50% emergence by HPS-7/13 (15.00) and Diamant (10.67). The highest days to tuber initiation were observed in HPS-501/67 (41.00) followed by HPS-9/67 (39.67), HPS-364/67 (39.67), HPS-7/13 (39.00) and Diamant (40.33). The lowest duration was in HPS-8/67 (33.67). The number of stems hill^{-1} ranged from 4.57 (Diamant) to 2.33 (HPS-7/13 and HPS-501/67). The highest plant height was observed in HPS-364/9 (70.67) and the lowest in HPS-11/13 (56.50). Most of the progenies had good foliage coverage which indicates its considerable contribution towards higher yield. Foliage coverage ranged from 94.00% (HPS-1/67) to 78.00% (Diamant). Early maturity was observed in Diamant (90.67) while late in HPS-9/67 (96.00). The highest and lowest number of tubers hill^{-1} was obtained from HPS-364/67 (11.6) and Diamant (8.80), respectively. The highest weight of tubers hill^{-1} was obtained from HPS-364/9 (454.70 g) and lowest in HPS-11/13

(400.00 g). The highest yield was observed in HPS-364/9 (30.13 t ha^{-1}) and the lowest in HPS-501/67 (21.40 t ha^{-1}). The progeny HPS-364/9 having highest yield (30.13 t ha^{-1}), higher number of tubers $hill^{-1}$, higher foliage coverage, highest weight of tubers $hill^{-1}$ might be considered as suitable one for commercial cultivation and also as prospective parent in future breeding programme.

In first clonal generation, correlation study revealed that yield was not significantly correlated with any of the character except number of tubers $hill^{-1}$.

However, significant positive correlation was obtained from the relations of days to first emergence with days to 50% emergence and foliage coverage, days to 50% emergence and foliage coverage. The relationship of number tuber $hill^{-1}$ with yield was also positive. The days to 50% emergence had highly significant negative correlation with number of stem $hill^{-1}$.

Correlation study (correlation calculated based on mean value of seedling tuber and first clonal generation) revealed that in case of seedling tuber generation foliage coverage, plant height (cm), number of tuberlets $plant^{-1}$, number of tuberlets m^{-2}, tuberlets yield (kg m^{-2}) had good positive association with tuberlets yield (t ha^{-1}). Tuberlets yield (t ha^{-1}) showed significant negative correlation with days to 80% seed germination. In first clonal generation, yield showed significant positive correlation with number of tubers $hill^{-1}$. So, selection on the basis of these characters should get preference for selection a progeny or parental line for future True Potato Seed (TPS) breeding programme.

Results of the present studies indicated significant variation among the progenies for 8 characters studied in the seedling tuber generation. Again, significant variation was also present among the progenies for 10 characters in first clonal generation. Correlation studies of the seedling tuber generation showed positive correlation between yield and its most components, while in the first clonal generation, yield showed negative correlation with some of these cases. It was happened due to the environmental influences (fluctuation) and seed quality.

Based on the results on these studies of TPS progenies the following conclusion may be drawn:

i) The progenies HPS-364/9, HPS-9/67 and HPS-364/67 showed relatively better performance among the progenies under natural storage condition.

ii) Small (< 28 mm) sized tuber had high keeping quality under natural storage condition.

iii) Considering yield and other performance both at field and laboratory, progenies viz. HPS-364/9, HPS-364/67 and HPS-9/67 might be used for commercial cultivation and also to be used for the development of high yielding long dormant varieties. So, these varieties might be proceeded for regional yield trial.

The study should be conducted in their seedling tuber and first clonal generation for further confirmation taking additional parameters. Correlation coefficient calculated on mean value of different generations shall be done for precise reliable information.

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APPENDICES

Appendix I. Distribution of monthly temperature and rainfall of the experimental site during the period from November 2000 to March 2002

Month	**Air temperature (^0C)		*Rainfall (mm)
	Maximum	Minimum	
November 2000	30.30	18.20	Nil
December 2000	25.80	14.10	Nil
January 2001	25.30	12.30	Nil
February 2001	26.80	14.50	30.96
March 2001	31.30	22.10	56.02
April 2001	34.10	23.70	240.39
May 2001	34.80	24.90	289.40
June 2001	32.60	24.95	315.29
July 2001	32.30	27.05	238.60
August 2001	31.70	26.43	230.31
September 2001	33.20	26.67	259.60
October 2001	29.65	22.93	261.67
November 2001	29.40	22.90	5.50
December 2001	23.50	20.00	50.50
January 2002	23.20	13.50	30.40
February 2002	27.30	16.70	5.00
March 2002	28.60	18.90	70.80

**= Monthly average
*= Monthly total
Source: National Meteorological Department, Dhaka

Appendix II. Distribution of monthly relative humidity and sunshine during the period from November 2000 to March 2002

Month	**Relative humidity (%)		*Sunshine (hrs)
	Maximum	Minimum	
November 2000	89.40	65.20	224.8
December 2000	89.69	64.17	230.9
January 2001	82.67	53.49	201.7
February 2001	85.30	31.10	192.3
March 2001	86.30	35.49	253.6
April 2001	90.23	42.23	213.1
May 2001	89.93	64.43	208.0
June 2001	90.62	68.37	191.0
July 2001	90.57	77.16	175.3
August 2001	89.97	78.13	156.3
September 2001	88.80	69.40	152.7
October 2001	91.23	65.64	185.2
November 2001	81.60	70.00	221.7
December 2001	75.05	64.32	225.3
January 2002	85.02	58.04	203.3
February 2002	83.40	33.05	185.7
March 2002	77.90	35.02	247.6

**= Monthly average
*= Monthly total
Source: National Meteorological Department, Dhaka

Appendix III. Analysis of variance for 8 characters of twenty TPS progenies in their seedling tuber generation

Sources of variation	d.f.	Mean square							
		Days to 80% seed germination	Total Germination (%)	Foliage coverage at 60 DAS	Plant height (cm)	Number of tubers $plant^{-1}$	Number of tubers m^{-2}	Tuber yield (kgm^{-2})	Tuber yield (t/ha)
Replication	2	4.467	20.867	72.717	8.867	4.779	2007.200	0.086	3.626
Variety	19	8.536**	154.00**	86.522**	155.132**	3.853**	33531.319**	1.777**	71.753**
Error	38	1.975	19.761	25.296	19.235	1.349	921.340	0.298	12.189

** Significant at 1% level of probability

Appendix IV. Analysis of variance for eight different characters of nine TPS progenies

Sources of variation	d.f.	Mean square							
		Days to sprout initiation	Days to sprout in all tubers	Days to start shriveling	Days to 100% shrivelling	Sprout length at 210 days after storing	Weight loss (%)	Rottage loss (%)	Remaining tuber weight (%)
Factor A (tuber size)	2	1209.7**	3308.2**	518.6**	816.9**	79.0**	1375.897	19895.1**	10941.2**
Factor B (variety)	9	185.8**	766.7**	1722.7**	1019.8**	53.5**	190.1**	515.7**	241.6**
AB	18	25.933**	121.668*	67.868**	122.491**	21.263**	21.273**	237.073**	219.460**
Error	60	6.122	66.933	17.044	39.200	0.289	5.527	23.485	10.632

* Significant at 5% level of probability

** Significant at 1% level of probability

Appendix V. Analysis of variance for 10 characters of TPS progenies in 1st clonal germination

Sources of variation	d.f.	Mean square									
		Days to 1st emergence	Days to 50% emergence	Days to tuber initiation	Number of stem hill^{-1}	Plant height at 60 DAP	Foliage coverage at 60 DAP (%)	Days to maturity	Number of tuber hill^{-1}	Weight of tuber hill^{-1}	Yield (t/ha)
Replication	2	3.900	1.200	66.533	0.233	28.280	22.633	4.933	0.758	51.733	6.393
Factor A (variety)	9	2.833**	5.337*	20.226**	1.293**	47.613*	55.911*	8.607**	2.328 ns	1111.559ns	25.170**
Error	18	0.233	2.015	3.681	0.159	16.667	18.856	2.007	1.398	479.993	4.667

* Significant at 5% level of probability

** Significant at 1% level of probability

ns – Non Significant

Appendix VI. Exact fertilizer nutrient required for making the recommendation

$$\text{Fertilizer nutrient required for given soil test value} = \text{Upper limit of the recommended fertilizer nutrient for the respective STVI class} - \frac{\text{Units of class intervals used for fertilizer nutrient recommendation}}{\text{Units of class intervals used for STVI class}} \times \left(\text{Given soil test value} - \text{Lower limit of the soil test value within STVI class}\right)$$

Solution

$$N\ (kg\ ha^{-1}) = 135 - \frac{45}{0.09}(0.10 - 0.091) = 130.5\ kg\ N\ ha^{-1} = 283.69\ kg\ urea\ ha^{-1}$$

$$P\ (kg\ ha^{-1}) = 30 - \frac{10}{7.50}(14.9 - 7.51) = 20.15\ kg\ P\ ha^{-1} = 46.14\ kg\ P_2O_5\ ha^{-1} = 100.30\ kg\ TSP\ ha^{-1}$$

$$K\ (kg\ ha^{-1}) = 120 - \frac{40}{0.09}(0.10 - 0.091) = 116.00\ kg\ K\ ha^{-1} = 139.20\ kg\ K_2O\ ha^{-1} = 132\ kg\ MP\ ha^{-1}$$

$$S\ (kg\ ha^{-1}) = 18 - \frac{5}{7.5}(9.27 - 7.51) = 16.83\ kg\ S\ ha^{-1} = 93.48\ kg\ Gypsum\ ha^{-1}$$

$$Zn\ (kg\ ha^{-1}) = 20 - \frac{20}{0.45}(1.20 - 0.90) = 7.11\ kg\ Zn\ ha^{-1} = 90.55\ kg\ ZnSO_4\ ha^{-1}$$

Appendix VII. Nutritive value of potato (mg 100 gm^{-1}) edible portion (Lisinska and Leszezzynski, 1989)

Sl. No.	Elements	Quantity
1.	Mineral (g)	0.60
2.	Carbohydrate (g)	12.60
3.	Calorie	97.00
4.	Calcium (mg)	10.00
5.	Phosphorus (mg)	40.00
6.	Iron (mg)	0.70
7.	Carotene (mg)	24.00
8.	Vitamin B_1 (mg)	0.10
9.	Vitamin C (mg)	17.00

Appendix VIII. Chain of plates representing potato production through True Potato Seeds

Plate 2. Inflorescence of a potato plant

Plate 3. Bunches of berry (fruit) of potato

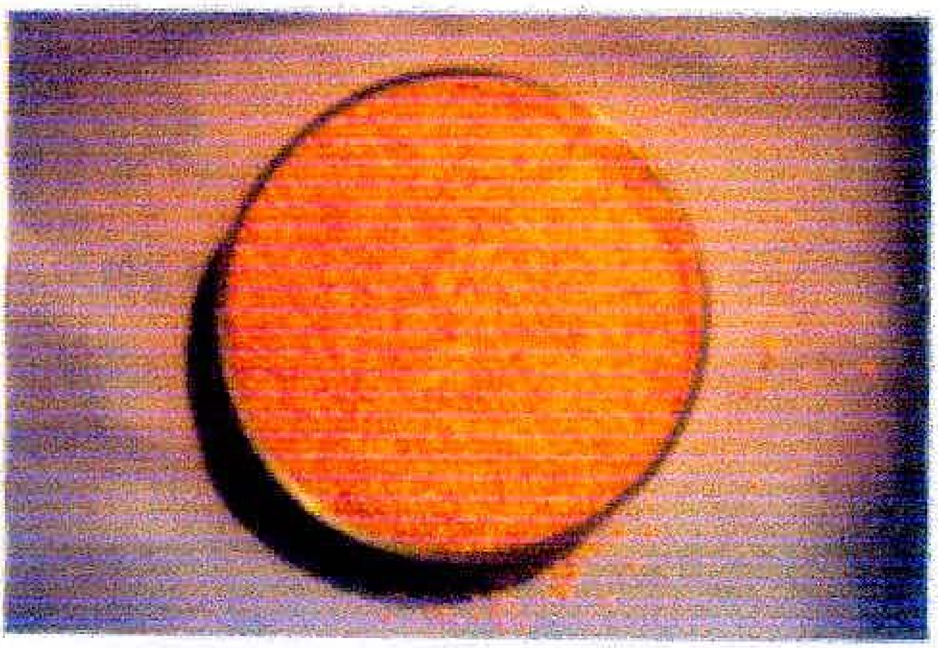

Plate 4. True Potato Seeds (TPS)

Plate 5. A general view of production of tuberlets in beds from TPS

Plate 6. Seedling tubers /tuberlets produced from TPS

Plate 7. Crop view of 1st clonal generation of TPS

Plate 8. Tubers of 1st clonal generation derived from tuberlets