POTATO PRODUCTION THROUGH TRUE POTATO SEED (TPS) TECHNOLOGY IN NEPAL: A GENERAL REVIEW

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ABSTRACT

References are conflicting whether, TPS technology is advantageous or not to the farmers in poor countries like Nepal. However, the use of TPS which is easier to store, transport and is free of major tuber-borne diseases, offers an alternative to costly seed tubers. Extensive research works in the last two decades brought the fact that the use of TPS for ware potato production reduces the production cost. Neverthless, some reservations are expressed against it, such as requirement of skillful management and lack of uniformity for plant and tuber characteristics in the crop grown. So far, after several years of on-station and on-farm research and development activities carried out on TPS in the country, Potato Programme Nepal has been able to recommend some suitable TPS progenies and agronomic practices for the cultivation in the mid-hills and terai of Nepal. This paper is a critical review of such activities in Nepal.

Key words: True potato seed, segregation, clonal tubers and tuber yield.

INTRODUCTION

Background

Potato (*Solanum tubersoum* L.) is tremendously an important crop in Nepal. It is the fourth most important food crop after rice, maize and wheat and one of the most important commodities for food security (Khatri and Rai, 2000). Considering its importance in the country, His Majesty's Government of Nepal prioritized it as one of the important food crops. The twenty years' Agriculture Perspective Plan (APP) has also clearly considered potato as a highly potential commodity for achieving food security (APP, 1995). Despite the importance, the average productivity of this crop (10.2 t/ha) is not satisfactory (APSD, 2001). It is among the lowest productivity in the world (Hidalgo *et al.*, 2001). The main constraint to cause lower yield is the unavailability of seed in adequate quantity (Khatri, 2000). In addition, seed is often of low quality (Wells and Schultz, 1997).

TPS has been considered as one of the alternatives to solve the problem (Lama and Khatri, 1997; Warrit and Pongphen, 1990). It can be used to produce consumption tubers directly after the first generation (F1) or as a source of planting material for consecutive clonal generations (Martin, 1995). As viruses are not generally transmitted in TPS, it is an alternate source of clean planting material in many countries. However, the adoption of TPS based potato production has been slow in most countries (Gaur *et al.*, 1999).

Research on TPS was initiated at the International Potato Center (CIP) in 1977 and since then it has rapidly extended to many countries throughout the developing world (Allen *et al.*, 1992). In Bangladesh, two families, HPS II/67 and HPS 7/67 have been released for commercial cultivation. But sustained use of the technology depends on the rate of degeneration and the resistance to late blight (*Phytopthora insfestans*) disease (Rashid, 1991).

In China TPS was introduced from United Kingdom in 1906 (Geddes, 1988). TPS thereafter spread to 26,700 hectares in 1976. Then, the use of TPS declined in subsequent years. TPS production dropped from 1000 kg in 1976 and 1978 to 100 kg in late 1980's (Bofu *et al.*, 1987). This sharp reduction in TPS production was due to the incidence of potato spindle tuber viroid disease (PSTVd) and varietal mixtures in the parental stocks.

In India, TPS technology was started in 1976. By 1984, TPS families were identified and package of practices for raising potato crop from TPS was established. As a result, India is currently the main producer of hybrid TPS in Asia. At present, the utilization of hybrid TPS for crop production has been slow resulting in the declining trend (Gaur *et al.*, 1999).

What is TPS?

TPS is the tiny sexually produced botanical seed found in the small, tomato like fruits of the potato plant (Fuglie et al., 2001). It is a small seed with a thousand seed weight of less than one gram. These seeds are more viable, high yielder and have greater resistance to pest and diseases (Wiersema, 1984). However, there are some disadvantages as well.

Advantages of TPS

1. ***Low disease pressure:*** As most of the diseases get filtered out during TPS production, TPS does not carry major diseases (Nayar, 1992). Spread of tuber-borne diseases can be minimized considerably (Wiersema, 1984). The crop raised through TPS is almost disease-free.

2. ***Low-cost planting material:*** Use of TPS reduces total production cost by 50-70 percent (Accantino and Malagamba, 1983). By using TPS about 18 percentage of the total production of edible potatoes in developing countries used as seed can be saved for food (CIP, 1982). Only about 50 g TPS is required for sowing in about 375 m^2 area for producing seedling tubers enough for planting one hectare next year and about 150 g TPS per hectare is required if the commercial crop is to be raised in the first year itself by transplanting seedling in the field (CPRI, 1999).

3. ***Reduction in storage costs/elimination of storage losses:*** Without cooling system, generally TPS can be stored for many years at room temperature, which is in favor to reduce storage cost of seed tuber and losses occurred due to rottage during storage and transportation. Since, there is no aging process like in seed tuber in storage, farmers can use readily available TPS for raising the crop, and therefore, TPS is easy to expand in such areas where seed tubers are not possible to produce or store.

4. ***Easy to transport and distribute:*** Due to very small size TPS is easy to transport and distribute.

5. ***Seedling tubers give considerably higher tuber yield than seed tubers:*** TPS seedlings are clean planting materials with high genetic diversity. Hence, the risk of entire crop being wiped-out by some diseases like late blight is minimum.

6. *Can be produced in all potato growing regions of the country:* TPS can be grown in all regions of the country. At present, nucleus Seed Potato Production Farm at Nigaley, Sindhupalchok and Horticulture Farm at Nawalpur, Sarlahi district under Department of Agriculture are producing TPS from identified parental lines and distributing to the farmers in the country (PDS, 2001). Parental materials are identified, maintained and multiplied at Potato Research Programme Khumaltar, Lalitpur.

8. *TPS avoids major pathogen transmission.*

9. *TPS breaks dependency on tuber-seed systems.*

Disadvantages of TPS

1. *Identification of a superior progeny:* The major limitation for the rapid adoption of TPS appears to be the identification of a superior progeny (Sussana and Vander Zaag, 1985). For example, Most of Nepalese farmers/consumers are found preferring red-skinned varieties and TPS progenies with such quality are not available at present.

2. *TPS technology requires comparatively higher technical skill.*

3. *Segregation problem.*

4. *Lack of uniformity.*

5. *TPS requires intensive care and high labour requirement.*

6. *Longer growing period:* TPS being late maturing types, it has less flexibility in planting, rotation and a fear of attack by pests and diseases, such as nematode enforces early harvests which reduces yield and quality (Basuki and Gunadi, 1991).

7. *Seedlings, highly sensitive to biotic and abiotic factors:* Seedlings from TPS are more sensitive to environmental stress, insects, pests and pathogens. For example, in China, TPS has been commented as the spread of Potato Spindle Tuber Viroid (PSTV) that possibly resulted from the large-scale use of TPS by the farmers.

8. *Seedling tubers need cooling storage:* In the hot humid and sub-humid conditions of tropical and sub-tropical areas, seedling tubers also need cooling storage, as it requires for clonal tuber.

9. *Quality assurance:* It has been difficult to achieve quality and efficiency in both the production and handling of TPS, consequently, the cost of TPS to farmers is not insubstantial and the seed itself is sometimes of uncertain quality (Fuglie *et.al.*, 2001).

TPS WORK IN NEPAL: A REVIEW

The then National Potato Development Programme (NPDP) was the first institute involved in Nepal for the research and development of TPS technology in the past. Since it was splitted into Potato Research Programme (PRP) and Potato Development Section (PDS) in 1991, as the successor of NPDP, PRP is responsible at present to conduct and coordinate all TPS research and PDS for technology transfer.

TPS was first tried in 1969 by growing seeds in the open fields. Hybrid seed was produced later in 1973 and again tried in 1978 and 1979 (Shakya, 1989). Research works on TPS was institutionalized in 1978. Considerable efforts were made after 1985 for progeny testing and technology generation (Bhomi and Aryal, 1985). From 1986 to 1991, TPS was a priority research and major emphasis was on evaluation of TPS families. Due to some managerial problems with the programme in 1991, number of experiments on TPS research got reduced. Several studies have shown that the open-pollinated (OP) progenies are inferior to hybrid progenies in any stage of their generations (Lama, 1998).

A preliminary observation on raising seedling of potato and their transplanting in the field was conducted at Khumaltar during 1978. The experiment was not very successful and for a long period no attempts were made to promote it in Nepal (Shakya, 1986). NPDP again started TPS work in 1985 with the collaboration of CIP Region VI in Kathmandu valley during spring 1985 (Bhomi and Aryal, 1985). Six genotypes namely MF-1, TPS-2, HPS-25, HPS-26, HPS-45 and HPS–95 were evaluated in the study. The families TPS-2 (OP), HPS-2/5 and HPS-19/5 were found most suitable ones for the spring season of Kathmandu condition (Aryal *et al.*, 1985).

To further verify the results, the trial was repeated in 1986 autumn season in Terai condition. Among the tested five hybrid lines, HPS-I/13, HPS-7/13, HPS-2/III and HPS-I/III yielded significantly higher than open pollinated one (MF I). Highest yield (29.2 t/ha) among all the tested families was obtained from HPS-I/13 (NPDP, 1987/88).

In spring 1986, an attempt was made to study the feasibility of TPS seed production in Kathmandu valley with clonal varieties Kufri Jyoti, NPI-106, Hybrid-14, Cruza-27 and BR 63/65. The time of flowering of all the tested varieties indicated that reciprocal crossing could be made successfully during April third week to May first week for this purpose in Kathmandu valley (Shakya and Rai, 1986). In order to produce hybrid true potato seed, a crossing was made from cultivar P-4 and Kufri Jyoti, but the cross-pollination practice for hybrid true potato seed production was not successful that year at Khumaltar due to flower dropping problem (Shakya and Shrestha 1986).

In same year, Shakya and Rai (1986) undertook an experiment to study the effect of GA_3 on dormancy breaking and percentage germination of TPS. The study showed that GA_3 one of the growth regulators in 2000-ppm concentration was optimum for both of the purpose within short period.

In autumn 1987, twenty-six different hybrid progenies were evaluated by transplanting at Khumaltar. Since, heavy water logging problem damaged the plots, the results obtained were not satisfactory. The yields obtained were 14.8 t/ha from family Maine-28 x 575049, followed by from the crosses of 377830.2 x 377250.7 (NPDP, 1988/89).

Research on true seed was further extended in 1987/88 in four developmental regions of the country from east to west of the Terai and in Kathmandu valley. This year's seedling tuber production trials were more successful and highly impressive in the farmers' field. (Shakya, 1988).

The average yields from the six CIP hybrid progenies remained lower (4.9 to 7.9 t/ha). However, the highest yielding hybrid progenies were AT-LAB, AT-7, HPS I/13, HPS II/13 and HPS 24/III respectively (Shakya, 1988). In progeny evaluation, HPS 7/67, HPS 7/13 and HPS II/67 were identified as highest yielder among the tested ones (NPDP, 1989/90).

In farmers' field, TPS was introduced in 1987/88 through on-farm research system. Continuty was given with 14 on-farm and on-station trials in 1988/89. However, progenies, which did well in the terai, tended to be late maturing with lower yields in Kathmandu valley. All tested families, Ser- 33, Ser - 7, AT LAB, AT - 7 and Ser- 28 had equal or more yields than check variety Kufri Jyoti in Kathmandu valley. TPS tuberlets (F1C1) showed good adoption, good yield than the check varieties in terai also.

During 1989/90 research work on TPS was concentrated on progeny testing and hybrid seed production in Nepal. Several superior parents for true potato producing up to 400 tuberlets/m^2 were identified through it. HPS-7/67, HPS-25/67, HPS-7/13 and HPS-II/67 were identified as highest yielding progenies and were observed far superior to the open pollinated progenies and had equal or better yield and the better resistance to late blight disease (NPDP, 1990/91).

Potato Research Programme (PRP) under Nepal Agricultural Research Council (NARC) was started from 1991. TPS evaluation was carried out with main focus for production of true seed of promising lines identified earlier from hybridization project during monsoon season (NPRP, 1991/92). F1 generations from different crosses showed superior yield potential than the variety developed from the clonal selection. In the trials, progeny HPS-7/13, CIP 985001, CIP 98001, HPS-2/67 and CIP 985003 had better performance with greater yield potential in terai and HPS-7/67 and HPS-I/13 had greater in the hills of Nepal (NPRP, 1991/92). Different sets of farmer's field trials were evaluated in terai and hills of Nepal. Some hybrid progenies were identified promising with respect to the yield, however, without farmers' reaction on a tested progeny it became difficult to identify the better ones for the recommendation.

In 1990/1991, several TPS progenies received from CIP Lima and CIP India were evaluated in different parts of the country. F1 progenies namely CIP 978001 and CIP 985001 were observed highly promising in yield characteristics (NPRP, 1990/91).

In 1991/92, PRP continued its research projects on TPS. F1 seedling production and evaluation of progenies received from CIP Lima were evaluated in the research stations and in the farmers' fields. Again it was proven that HPS-I/67, HPS-II/13 and HPS-II/67 were better in Khumaltar condition (NPRP, 1991/92).

TPS tuberlets density trial and time of sowing and transplant density trials were conducted at Khumaltar. Although no clear conclusion was derived for small tubers, results obtained from the trial suggested that 20 cm plant to plant spacing was better for 20 - 40 g size seed tuber. Results obtained from date of transplanting trials showed that the first transplanting of 22nd July with closer spacing (60 x 10 cm) had also better yield performance (NPRP, 1991/92).

With the help of CIP Southwest Asia region, technology transferring activities were re-started in 1993/94 crop season through conventional extension methods (Lama, 1999) in the terai through the network of DOA. As a result, DOA conducted 34 demonstrations in five districts. In the following year, the programme was launched in 22 districts but due to insufficient training to the farmers and field technicians, the results were disappointing (Wells *et al.*, 1996).

Research conducted in 1992/93 and 1993/94 on TPS, F1C1 tuberlet trial revealed the results that all tested TPS families had no significant differences with check variety Kufri Jyoti although yield level was recorded higher upto 32.2 t/ha with progeny IP-88004 (HPS-II/67). Farmers field trials conducted in terai proved that HPS-II/13 and HPS-7/13 are good for eastern and central Terai region of Nepal (NPRP, 1992/93 and 1993/94). All tested progenies had good yield and highest farmers' rating in comparison to Kufri Sindhuri, one of the clonal varieties.

In 1994/95, TPS F1C1 tuberlet evaluation trial was conducted at Khumaltar condition with TPS families received from CIP, Lima. Twenty-four TPS families were compared with widely adopted clonal varieties Kufri Jyoti, Desiree and Kathmandu Local (NPRP, 1994/95). No significant difference was observed in yield among the tested families. However, progeny IP 991006 was the highest yielder producing 36.3 tons per hectare followed by IP 88004 (35.2 t/ha), 991002 (34.7 t/ha) and check progeny HPS II/67 (34.5 t/ha), respectively. All tested families had the higher percentage of seed size tubers ranging from 72 to 92 per cent.

In 1995/96, most of the TPS trials were dropped due to the manpower shortage with the potato programme and only tuber family evaluation trial was continued at RARS Parwanipur. In the trial, among the 13 tuber families tested, only five (388573.1D, 385505.10, 388577.5, 388578.4 and 388576.3D) were selected and recommended for further evaluation in varietal evaluation scheme on the basis of their yield and other characteristics (PRP, 1995/96).

In 1996/97, studies were continued to identify the suitable TPS progenies, which have high yield, good uniformity, desirable tuber color, good tuber shape and resistance to major pest and diseases at Hattiban farm of PRP Khumaltar. Sixteen TPS families received from CIP Lima, Peru were evaluated and compared with HPS 7/67 and HPS II/67. In the trials, number of tubers per plant varied from 3.5 with TS 5 x TPS 13 to 7.1 in LT 9 x TPS 67. Tuber grading data showed that highest percentage of medium sized tuberlets (20 - 40 g) were obtained from TS 5 x TPS 13 (44.2). Out of all tested progenies, high yielding families were LT 9 x TPS 67 (35.5 t/ha), TS 5 x TPS 13 (34.1 t/ha) and Atzimba x TPS 13 (30.7 t/ha), respectively.

In 1997/98, three different research activities were conducted as the continuation of TPS research activities in Nepal (PRP, 1997/98):

1. **Evaluation and adaptability of TPS progenies:** This experiment was conducted at RARS Tarahara and PRP Khumaltar. At Khumaltar, plant vigour of progenies LT 9 X

TPS 67 and Serrana x TPS 67 were very good. Families Atzimba x TPS 13, LT 9 x TPS 13, TS 5 x TPS 67 were found early maturing. Tuber grading results showed that the highest number of medium sized tuberlets (20 - 40 g) were obtained from LT 9 x TPS 67 (115.8) in one square metre area followed by Serrana x TPS 67 (102.5). With respect to the yield all the progenies were higher yielder than control, HPS II/67 (43.4 t/ha). Based on the results, all the progenies were recommended for further evaluation as F1 seedling tubers.

At RARS Tarahara, germination was counted highest in check progeny, HPS II/67 followed by Atzimba x TPS 67. Harvested tubers were not uniform in shape, size and color. Grading data showed that the highest number of 1-5 g tuber was recorded in progeny Serrana x TPS 67 and Atzimba x TPS 67 (361). More than 20 g tubers were harvested highest in control progeny HSP II/67 and obtained the highest yield kg per plot (5.12 kg) followed by MF I x TPS 67 (4.4 kg).

2. **Evaluation of optimum spacing for producing maximum economic yields:** Trials were conducted at DOA governed Horticulture Farm Sarlahi. Results showed that size of seed tubers had positive effects on percentage emergence, percentage ground cover, and plant height. Highest tuber yield was recorded in 60x10 cm spacing and 5-10 g seed size (28.4 t/ha) followed by 60x15 cm with 20 g sized Kufri Jyoti clonal variety (27.6 t/ha) and the least in 60x15 cm with less than 2 g sized tuberlets (17.5 t/ha). There was increasing trend in yield as the size of seed tubers increased. This result concluded that 10 cm spacing is the best upto 10 g seed tuber size.

3. **Response of TPS derived planting material (seedling tubers) to different fertilizer level:** Experiment was conducted at Khumaltar condition. NPK at 125:100:60 kg per hectare gave the highest yield (24.4 t/ha) followed by 75:100:60 kg NPK per hectare (22.8 t/ha) and 125:75:60 (21.5 t/ha), respectively. Whereas in 12-24 g sized tubers, the fertilizer dose of 125:125:60 gave the highest yield (29.0 t/ha) followed by 125:75:60 kg (29.2 t/ha) and 100:75:60 (29.01 t/ha), respectively. Results further showed that 5-12 g sized tubers which are not practiced for planting could be utilized for seed tubers but 12-24 g size tuberlets are the best.

Results from Regional Agriculture Research Station (RARS) Tarahara showed that, the highest number of 1-5 g tubers were recorded in progeny Serrana x TPS 67 (361 tubers) followed by Atzimba x TPS 67 (361) and least in I-1035 x TPS 13 (62). Highest number of < 20 g tubers were harvested in control HPS II/67 (54) followed by MF II x TPS 67 (52) another check and lowest in TS 5 x TPS 13 (13). No progeny gave better yield than check progeny HPS II/67 (45.3 t/ha) except MF II x TPS 67 (51.2 t/ha). However, both of these progenies were same but the seed sources were different.

From the trials, TPS progenies; Atzimba x TPS 67, Atzimba x TPS 13, LT 9 x TPS 67, I 1035 x TPS 67, Serrana x TPS 67 and MF I x TPS 67 were identified as promising for Mid – hills condition and MF I x TPS 67, Atzimba x TPS 67, Serrana x TPS 67 and LT 9 x TPS 13 for Terai. At Khumaltar, most of the tested progenies had early to medium maturity except MF II x TPS 67. If compared TPS 13 and TPS 67 as a male parent with different female parents, TPS 13 had the potentiality of giving better yield except with I 1035 as compare to TPS 67. However, a further testing is required by producing seedling tubers with these promising progenies at different locations in the country and performance of these seedling tubers at the different research stations as well as in farmer's fields.

TPS F1 progeny evaluation trial conducted at Khumaltar during 1998/99 showed the highest plant uniformity (4.0) and percentage ground cover on HPS II/67, one of the check progeny. Regarding the yield, Serrana x TPS 67 gave the highest yield (52.4 t/ha) followed by the check, HPS II/67 (48.4 t/ha) and Serrana x TPS 67 (45.7 t/ha). Results on tuber grading showed that Serrana x TPS 13 gave highest number of tubers with <40 g weight followed by TS 5 x TPS 67. Highest percentage of 21-40 g, graded tubers were recorded in Serrana x TSP 13 (39 per cent) followed by HPS II/67, the check progeny (37 per cent) and Serrana x TPS 67 (PRP, 1998/99).

In same year, TPS F1C1 tuberlet evaluation trials were carried out at PRP Khumaltar and RARS Tarahara, representative sites from mid-hills and terai, respectively. In TPS F1C1 tuberlet evaluation trial from Tarahara, there was no significant difference in the yield, however, all TPS families were superior to Kufri Sindhuri (clonal check), but numerically, TS 5 x TPS 67 gave the highest yield (19.5 t/ha) and I-1035 x TPS 67 the lowest (15.3 t/ha). At Khumaltar, family Serrana x TPS 13, LT 8 x TPS 13 and MFI x TPS 667 produced significantly higher yield (21.7 t/ha, 19.5 and 19.4 t/ha), respectively as compared to 14.2 t/ha yield of Desiree one of the clonal check variety. However, yield gain of TPS families did not differ significantly when compared with the yield of Kufri Jyoti (18.9 t/ha). Tuber grading in percentage by weight showed that I-1035x TPS 13, MF I x TPS 657, I-1035x TPS 67 and LT 9 x TPS 67 had higher percentage of seed sized tuber as compared with Kufri Jyoti (71.5 per cent) by giving 81.4 per cent, 75.4 per cent and 71.6 per cent, respectively, whereas tuber uniformity was at par to check varieties. From the studies, it is concluded that in the hills, Serrana x TPS 13, Serrana x TPS 67, Atzimba x TPS 67, I 935 x TPS 13, Atzimba x TPS 13 as well as HPS II x TPS 67 (check) were identified promising lines for seedling tuber production at Khumal condition. In comparison to TPS 67, TPS 13 had better performance with Serrana and TPS 67 with Atzimba (PRP, 1998/99). However, from TPS F1C1 tuberlet evaluation trial, it can be concluded that, in terai, TS 5 x TPS 67, HPS II/67, LT 9 x TPS 67, LT 8 x TPS 13 and MF I x TPS67 were identified as promising lines for ware potato production under Tarahara condition.

In Khumaltar condition, families, Serrana x TPS 13, LT 8 x TPS 13, MF1 x TPS 67, I 1035 x TPS 67, LT 9 x TPS 67, I 1035 x TPS 67, LT 9 x TPS 67 and I 1039 x Kufri Sindhuri were identified as superior for ware potato production since seedling tubers of these superior lines were comparative to basic seed tubers of Kufri Jyoti and Desiree on yield (PRP, 1998/99). Based on all on-station research results these superior lines were recommended to verify under multi-location farmers' field conditions.

The results compiled for 1996/97 to 1998/99 from Khumaltar and Tarahara showed that the crosses of Serrana, Atzimba, MFI and MFII with TPS67 and Serrana and Atzimba with TPS13, were the best in yields, tuber shape, sizes and color under Khumaltar (mid-hills), whereas crosses of Serrana, Atzimba TPS 25, MF I, MFII with TPS 67 were the best in Tarahara (Khatri and Shrestha, 2000). In the trials, performance of the seedling-tubers of best TPS families were comparable to the performance of widely adapted varieties, Kufri Jyoti, Kufri Sindhuri and Desiree, propagated with tubers of basic seed. Crosses of MF II and MF I with TPS 67, tested at RARS Tarahara produced 5.12 and 4.43 kg tuber yield per square meter of area, respectively on nursery beds whereas at Khumaltar, the crosses of Serrana and Atzimba with TPS 13 produced 4.17 and 4.07 kg tuber per square meter.

When seedling tubers were planted for potato production, the crosses of TPS 25, LT9 and MF II with TPS 67 yielded 19.5 and 19.0 tons per hectare at Tarahara, Serrana x TPS 13 and MFIxTPS67 produced 21.7 and 19.4 t/ha at Khumaltar (PRP, 1996/97). All selected TPS families were very promising and being tested at farmer's level.

In 1999/2000, two TPS F1C1 tuberlet evaluation trials with nine TPS families were conducted and compared with Desiree and Kufri Jyoti variety at PRP Khumaltar using tuberlets from previous year's nursery bed trial (PRP, 1999/2000). In the result, TPS families were not uniform. Ground cover of Kufri Jyoti was the highest (85 per cent) followed by LT 9 x TPS 67 (84) and MF II x TPS 67 (83 per cent). With respect to the yield, there was significant differences over the Desiree (32.2 t/ha) one of the clonal check variety. The highest percentage of over size (>50 g) tuberlets were recorded from TS 5 x TPS 67 (52 per cent) followed by Serrana x TPS 67 (48 per cent), Serrana x TPS 13 (43.5 per cent).

TPS F1 progeny evaluation trials were conducted in same year at PRP Khumaltar (PRP, 2000). In the results, progeny, MF II x TPS 67 gave the highest yield (35.0 t/ha) followed by Serrana x TPS 67 (30.1 t/ha). Results of tuber grading showed that MF II x TPS 67 gave highest (12.8 per cent) number of >40 g sized tubers followed by Serrana x TPS 13 (10.6 per cent). Likewise highest percentage of 20-40 g sized tuberlets were recorded in MF II x TPS 67 (30.4 per cent) followed by LT 8 x TPS 13 (23.8 per cent) and highest percentage of small sized tubers (1-10 g) was recorded from Serrana x TPS 67 (46.7 per cent) and Serrana x TPS 13 (42 per cent).

During 1999/2000, TPS progenies found promising from on-station conditions were tested under farmers' field conditions from Rupandehi, Chitawan and Sunsari districts representing terai sites from Western, Central and Eastern Developmental Regions (PRP, 1999/2000).

At Rupandehi, check progeny MF II x TPS 67 was the best with respect to yield, foliage, tuber shape and colour. Results on tuber grading showed that family LT x TPS 13 gave highest number (17.5per cent) of tubers with greater than 50 g weight category followed by Serrana x TPS 13 (15.6per cent). Highest percentage of small sized tubers of <10 g was recorded from Serrana x TPS 57 (30.1 per cent) and MF II x TPS 67 (14.1 per cent).

Four TPS progenies were evaluated in the different places of Chitawan district. Among all Serrana x TPS 67 was the highest yielder giving 29.9 t/ha tuber yield. Farmers' preference on foliage, yield, tuber shape and tuber colour was also scored highest with this progeny. Results of tuber grading showed that highest number and weight percentage of seed size tubers (20 to 40 g) were obtained from Serrana x TPS 67 followed by the check progeny, MF II x TPS 67. The size of 10 to 20 g tuberlets were produced highest from Serrana x TPS 13 (253.0) followed by Serrana x TPS 67 (249.0).

At Tarahara, eight TPS progenies were evaluated in the farmers' field conditions from Sunsari district. Since the progeny response to the late blight disease, plant uniformity, and number of main stems per plant was not significantly different in the trial, the analysis of variance showed a non-significant difference between the progenies. However, the highest tuber yield

(37.7 t/ha) was obtained from MF I x TPS 67 followed by TS 5 x TPS 67 (37.1 t/ha), LT 8 x TPS 13 (36.8 t/ha), respectively (PRP, 1999/2000).

During 2000/01, TPS F1 progeny evaluation trials were conducted at PRP Khumaltar and RARS Tarahara (PRP, 2000/01). Results from Khumaltar showed that TPS F1 progeny of MF II x TPS 67 gave the highest seedling tuber yield (7.15 kg/m2) followed by LT 8 x TPS 13 (6.4 kg/m2). LT 8 x TPS 13 gave highest percent (32.5 per cent) of seed size tubers (20-40 g) and > 40 g sized tubers (19.8 per cent). In Tarahara, Serrana x TPS 67 gave highest percentage by weight of the > 40 g tubers (24.8 per cent) followed by HPS II/67 (11.9 per cent). Regarding the yield, Atzimba x TPS 67 and MF II x TPS 67 gave the highest yield (49.5 t/ha) followed by Serrana x TPS 13 (47.3 t/ha).

TPS F1C1 tuberlets evaluation trial conducted during same year at Khumaltar showed that TPS families were not uniform (PRP, 2000/2001). The plant height and ground cover of family LT 8 x TPS 13 was highest in the results. Highest numbers of main stems per plant were counted highest in Kufri Jyoti, one of the clonal check variety (5.1) followed by Desiree (4.5) another check. With respect to the tuber yield, there was no significant difference over Kufri Jyoti and Desiree. Results on tuber grading showed that Serrana x TPS 13 gave highest percentage of weight (45.9 per cent) of the tuber with >50 g size followed by LT 8 x TPS 13 (4.3 per cent).

Highest percentage by weight of seed sized (25-50 g) tubers was recorded on Serrana x TPS 13 (43 per cent). With respect to tubers' dry matter content, there was a significant difference over the Desiree (17.7 per cent) and Kufri Jyoti (18.2 per cent). Progeny LT 8 x TPS 13 had highest tuber dry matter content (23.1 per cent) followed by Serrana x TPS 13 (22.3 per cent) and MF II x TPS 67 (22.0 per cent). There was positive relation between per cent tuber dry matter and taste value (PRP, 2000/01).

CONCLUSION AND RECOMMENDATIONS

On the basis of experiences and available references, following conclusion and recommendations are made:

- TPS research carried out in the past by potato programme revealed that much attention was given on progeny selection and as a result, progenies HPS I/13, HPS 7/67, were found superior in the hills, HPS I/67, HPS 7/13 for terai and HPS II/67, Serrana x TPS 67 and LT 8 x TPS 13 for both condition.

- Results and reports available so far had shown that the production by TPS is a promising alternative. Existing techniques of producing tuberlets in a high-density nursery bed need additional improvement to reduce the work requirement and increase the yield, so that it will be more attractive to the farmer.

- True potato seed technology, as a new approach shows great potentiality towards production and productivity increment, especially in areas where good quality seed tubers are expensive, inadequate and have limited storage facilities.

- Based upon the success of several on-station and on-farm trials conducted in the country for several years, it can be projected that the future role of TPS technology is increasing potato production at reduced cost.

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