Paper 8

POTATO PRODUCTION FROM TRUE SEED: IS THERE A FUTURE?

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INTRODUCTION

Potato cultivars are clones, maintained by vegetative production from planted seed tubers. In recent years, however, there has been an interest in the sowing of true potato seed (TPS) for crop production, both in New Zealand (Bedi *et al.*, 1979) and overseas (CIP, 1979).

This paper describes work carried out by Crop Research Division of DSIR, and discusses the potential of TPS in commercial potato production.

If potatoes could be grown satisfactorily from true seed, the advantages would be considerable. These include:

- Reductions in the cost of growing and transporting seed tubers, a major item in potato production costs.
- TPS may be more easily stored than tubers. Sufficient true seed to sow large areas can be stored in a very small volume for several years. A major problem in storing seed tubers is ensuring that they will be in sound physiological condition at the time of planting. In many environments, expensive controlled storage conditions are needed to maintain tubers in good physiological condition so that high yields can be attained.
- The absence of tuber-borne bacterial, fungal and virus diseases in true seed is a major advantage over vegetative seed. Some tuber-borne diseases can greatly reduce both yield and quality in potato crops, and many cultivars are infected with one or more virus.
- There are advantages in reducing the risk of losing part or all of the following season's seed tubers in times of shortage (high prices) or famine. This would be particularly important in less developed countries.

However, there are also serious problems to be overcome if TPS is to become significant in potato production. The disadvantages include:

- The longer period from sowing to maturity.
- The relative weakness of seedlings. They are vulnerable to difficult climatic and soil conditions until well after emergence or transplanting.
- Weed control is more difficult with TPS crop, particularly in the early stages when seedling growth is slow.
- TPS crops set their tubers close to the soil surface, which leads to increased greening and tuber moth infection unless they receive extra moulding.
- The high level of heterozygosity of all potatoes means that a high degree of segregation in plant types is likely within any TPS line. Furthermore, the potato shows a considerable inbreeding depression, and if parent lines are inbred to produce more uniform strains there is inevitably a reduction in vigour and yield potential. Such a reduction is also to be expected when selfed (open-pollinated) seed is grown from any potato cultivar. Hybrid F1 seed is less easily produced, and likely to be less uniform unless produced from specially inbred parent lines.

Hermsen (1980) discussed the potential advantage of growing uniform potatoes from TPS produced asexually by apomixis. However, he pointed out a need for considerable research before apomictic TPS could be seriously considered.

TPS TRIALS AT PUKEKOHE

Field trials with TPS lines were carried out at Pukekohe in three recent seasons, using latin square designs with one replicate. A trial sown in 1979-80 was abandoned because of poor germination.

1978-79

Six lines of TPS were direct-drilled in early October. Emergence was slow and erratic, leading to weed control problems. Spraying with Sencor (metribuzin) was largely ineffective, and the trial was then hand weeded. A regular fungicide and insecticide programme was maintained until late January and the trial was harvested in mid-April. Performance of the lines is shown in Table 1.

There were large differences between TPS lines but none gave a satisfactory yield. No seed tuber control was planted in the trial, but an adjacent maincrop hybrid trial yielded a mean 30 t/ha of table size, and more than 40 t/ha in total.

1981-82

Three TPS lines were grown in paper pots and vigorous plants were transplanted into the field in stale moulds in

Table 1. True potato seed trial, Pukekohe 1978-79

TPS line	Tuber yield t/ha	Table yield t/ha	Plants /m²	SG
440.22	11.3	2.2	5.6	1.080
524.4	7.2	3.9	2.9	—
796.55	4.8	1.7	2.7	1.082
866.24	12.0	5.2	5.4	1.084
V170.3	7.3	1.3	5.5	1.095
V170.6	10.8	1.0	7.9	1.070
LSD (0.05)	3.5	1.7	1.5	
CV%	32	56	25	

early November at 4.9 plants/m². At the same time, a tuber-planted control was planted, at 4.4 plants/m². Plant counts were made 9 weeks after transplanting; one true seed line had consistently poor survival. A regular fungicide and insecticide spray programme was maintained until mid-February. Weeds were controlled by one application of Sencor at 0.35 kg/ha a.i., three weeks after transplanting, followed by some hand weeding and by spot spraying with Preeglone (paraquat/diquat). The trial was harvested in late April. Performance is summarised in Table 2.

There were large differences between the TPS lines, the best two still gave less than half the total yield of the Rua standard, and a much lower proportion of table potatoes. The line repeated from the previous trial was poor in survival, but similar to the other TPS lines in total yield per plant.

Table 2. True potato seed trial, Pukekohe 1981-82

Line	Tuber yield t/ha	Table yield t/ha	Plants /m²	SG
Rua (tubers)	39.3	36.0	4.0	1.096
524.4 (TPS)	4.1	1.6	1.0	1.082
715.16 (TPS)	18.5	9.9	3.9	1.092
Iwa (TPS)	17.8	9.8	3.4	1.078
LSD	7.0	6.8	0.3	
CV%	20.2	35.4	5.0	

Table 3. True potato seed trial, Pukekohe 1982-83

Line	Tuber yield t/ha	Table yield t/ha	Plants /m²	SG
Rua (tubers)	35.4	31.8	2.7	1.087
ASB334 (TPS)	11.7	6.3	2.1	1.077
ASB556 (TPS)	21.0	11.6	4.1	1.068
ASB666 (TPS)	18.5	11.7	3.9	1.081
ASB887 (TPS)	23.0	10.8	3.3	1.066
LSD (0.05)	6.8	5.2	0.6	
CV%	23	26	13	

1982-83

This trial was treated in a similar way to the 1981-82 trial. Results are shown in Table 3.

Despite a more difficult season due to high winds and cooler temperatures, the TPS lines performed slightly better than in previous trials. The Rua seed tubers were physiologically advanced at planting and had only a 60% emergence. However, the TPS lines were much lower in yield than Rua, especially for table yield.

Tuber quality

In all trials there were clear differences between TPS lines in the acceptability of the tuber samples. In some lines, especially the Iwa TPS, the tuber samples were reasonably attractive, while others had faults, such as bad cracking, secondary growth, irregular shape, stolon attachment, and heavy russet, that clearly reduced the overall quality. The TPS lines had a lower specific gravity (dry matter) than the standard potato cultivars.

DISCUSSION

The direct-seeded TPS trial gave lower yields than the two transplanted TPS trials at Pukekohe. Alspach (pers. comm.) obtained slightly lower yields from direct-seeded TPS at Riwaka in a direct comparison between the two methods. Bedi *et al.* (1979) reported conflicting results, while at Lincoln transplanting has been the only reliable method of plant establishment (R.A. Genet, pers. comm.). Transplanting reduces the establishment losses, but it is expensive and in most situations it is unlikely to be cheaper than traditional potato production methods. At Pukekohe in 1982, 2.5 tonnes/ha of Rua tuber seed were planted at $450/tonne and $100/ha planting costs; a total cost of planting maincrop potatoes, excluding the cost of fertilisers of $1225/ha. By comparison, the estimated cost of producing and transplanting tomatoes was $58.30 per thousand plants, or $990 for 17,000 plants/ha, plus costs of extra irrigation after transplanting (NZ Commercial Grower, 1982); TPS potato plants would need to be transplanted at around 50,000 plants/ha, and even allowing for a lower unit cost this would be likely to cost well over $2000/ha. Therefore, if potato production from TPS is to be commercially viable in New Zealand, techniques of direct drilling and seed lines which give even and rapid emergence must be developed. Martin (1982) has achieved some success in this direction.

The yields of TPS reported in these trials are unacceptably low, especially the saleable fraction of the crop. Considerably higher yields have been reported by CIP (1979), Bedi *et al.* (1979), Martin (1982), and Alspach (pers. comm.), but some trials, especially direct-drilled trials, have been very poor or failed completely. Even in the highest yielding trials, where TPS yields have sometimes approached yields from tuber seed, the TPS lines invariably have a much lower proportion of yield of table-sized tubers.

It is unfortunate that all lines grown in the TPS trials at Pukekohe have been open-pollinated selfed lines. Although

some open pollinated TPS lines have given good tuber yields, hybrid seed has usually been higher yielding (Bedi *et al.*, 1979; Martin, 1982). Some lines freely produce self-pollinated seed in large quantities; seed from these is likely to be relatively cheap to produce on a large scale.

In 1982, an experiment was carried out at Pukekohe on the production of hybrid seed in the field using an Ilam Hardy male-sterile line. A previously untrained worker was able to produce 126 large berries, which would yield at least 25,000 viable seeds, from 162 flowers crossed in five hours. Clearly there is scope for improving the efficiency of pollination with experience and economies of scale, but this simple experiment indicates that commercial quantities of hybrid TPS could be economically produced in the field.

Approximately 0.4 ha of hybrid TPS potatoes are grown at Pukekohe each year as part of the breeding programme. There are very large differences between families in yield and the attractiveness of seedlings. The best families have looked reasonably promising and up to 25 percent of the seedlings transplanted have been selected and retained for further evaluation. There are hybrid TPS parents amongst the breeding material which show better potential for commercial production than those currently available.

CONCLUSION

High yields have not been obtained in the TPS trials at Pukekohe, but other reported trials appear to be more promising. There is little doubt that better TPS lines, probably hybrids, will become available and that higher yields can be reasonably expected. There are many practical and breeding problems to be solved before TPS could make an impact on the commercial potato industry. However, considerable international research on TPS is being undertaken (White and Sadik, 1983) and TPS may become an important method of producing potato crops in the future.

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