

Growing techniques of potato from true seed in Finland

SEIJA AHONEN and HELENA LAMMINSIVU

*Department of Horticulture, University of Helsinki,
SF-00710 Helsinki, Finland*

Abstract. The suitability of three production methods for potato (*Solanum tuberosum* L.) from true seed (TPS) were studied in field conditions at the University of Helsinki, Department of Horticulture. The production methods were direct field sowing, planting 4-week-old seedlings raised in peat pots and planting seedlings and covering them with floating polypropylene mulch. The cultivars were Explorer and Pan American Seed Company varieties numbers 2928 and 4000. Also tested were the cultivars 2909, 2928, 3018, 4000, 4016, 4048 and 4147.

Floating mulch promoted vegetative growth, but also promoted the propagation and spreading of *Phytophthora infestans* spores. The best yield was obtained with pot-raised seedlings without mulching (3.38 kg/m²), the second best yield with mulching (2.69 kg/m²) and the lowest yield with field-sowing (2.33 kg/m²). More small tubers were obtained under floating mulch than without mulching.

Of the seven Pan American Seed Company cultivars tested, 4047 and 4016 gave the best yield, 4.1 and 4.0 kg/m². In sensory tests none of the three cultivars (3018, 4047 and Explorer) proved to be better than or equal to the taste of the common vegetatively propagated Finnish potato variety called Pito.

Index words: floating mulches, mulching, potato, pot raising, TPS, true seed potato

Introduction

Growing potatoes from true seed has some advantages over vegetative potato production. True seed is easy to produce and store, and fewer diseases are spread by seed than by vegetative potato production (SADIK 1983). The TSP method can be used to obtain healthy seed potato. In Finland, experiments on potato production from true seed have previously only been made by Finska hushåll-

ningsällskapet, a local extension service unit in Southwest Finland (ANON. 1983 and 1984).

Potato production from true seed is limited by our short growing period, which exceeds 175 days only in South Finland. A study was planned and carried out in 1986 at the University of Helsinki, Department of Horticulture, to ensure the growth of potato from true seed in our circumstances. In addition, some American cultivars were compared to find cultivars suitable for our climate.

Material and methods

In the experiment comparing American TPS cultivars, seedlings from seven Pan American Seed Company varieties numbers 2909, 2928, 3018, 4016, 4047, 4048 and 4000 as well as the control cultivar, Explorer, were raised in a greenhouse until four weeks old and then planted outdoors. Temperature in the greenhouse was 18–20°C at night and 20–25°C by day. The peat pots used were 4 cm × 4 cm in size, and they were filled with light Sphagnum-peat. The soil type of the experimental field was fine sand, and the field was fertilized with 800 kg/ha of mixed fertilizer (N:P:K = 6:7:17). The raised seedlings were planted outdoors on 12th June, on ridges in rows, 30 cm × 70 cm apart. After planting a floating mulch was kept on the vegetation for one week, to protect from frost.

Three cultivars, 2928, 4000 and Explorer, were used in the production method experiment. The three production methods were: 1. direct field sowing; 2. planting 4-week-old seedlings as in the cultivar experiment; 3. as in method 2, but covering the planted seedlings with floating mulch. Field sowing took place on 23rd May, and after sowing the rows were covered with a PE film (0.01 mm), which was removed after 25 days. After the emergence of seedlings the stand was thinned to a plant distance similar to that in the cultivar experiment.

In methods 2 and 3, the seedlings were raised as in the first experiment. The floating mulch used in method 3 was Agryl P-17, a polypropylene mulch weighing 17 g/m². The mulch was removed 67 days after planting, and harvesting occurred on 23rd September. Thus the total growth time of the plants in the cultivar experiment and in the planted plots of the production method experiment was 144 days (31 + 113). It was 124 days in the field-sown ones.

A randomized block design was used in the cultivar experiment, a split-plot design in the production method experiment. There were four replicates in both of them, and each ex-

perimental plot comprised 18 plants. The following observations were made: the width of plant foliage throughout the field period; insects and plant diseases; tuber yield and its quality (colour, taste, starch contents, texture). The width of plant foliage was determined by measuring the shortest and longest foliage diameter of ten plants per plot and then calculating the average. Insects and plant diseases were observed visually. The tuber crop harvested was sized, and the marketable yield calculated.

The data were analysed with analyses of variance, and F-values were tested with the Tukey-test. Correlation coefficients were calculated between plant diameter and yield, plant diameter and plant virosy, and plant virosy and yield.

Flesh colour and taste testing of cooked potato tubers was carried out by a 12 person sensory panel at the Laboratory of Sensory Science, University of Helsinki, Department of Food Chemistry and Technology. The methods used were triangle test and quantitative descriptive analysis (STONE *et al.* 1974). The pleasantness of the taste and colour of the samples was evaluated using graphic 10-cm scale anchored verbally at both ends (unpleasant — pleasant). After converting the graphic ratings to numerical values (1–10), means were calculated for the pleasantness scores, and analysis of variance was performed.

Tuber flesh texture was evaluated visually, by fork and by tasting, and 1–9 point scores were given (1 = watery, wet and loose and 9 = very mealy and dry), a method recommended by the European Association for Potato Research. Starch contents, as the percentage of fresh weight, was approximated according to the Hals-Buchholz method.

Climatic conditions

The month of June was warmer than usual (mean temperature 17°C; usual mean 14.5°C), and there was less rainfall than normal in South Finland (29 mm as opposed to the usual 47 mm). The months of July and August were

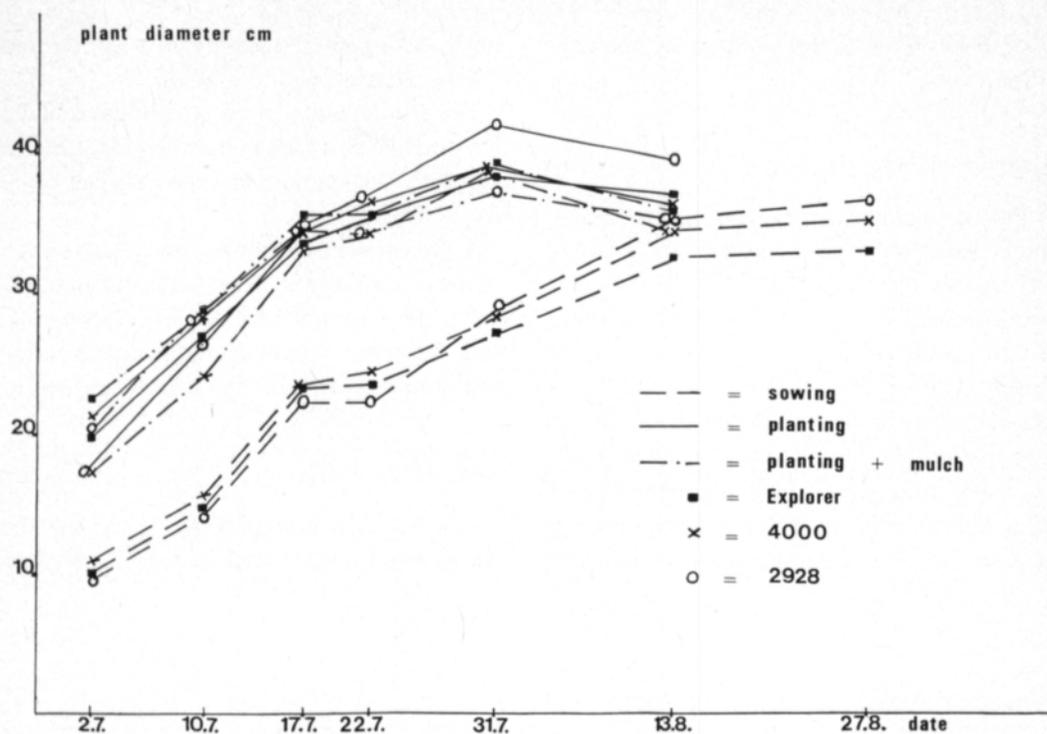


Fig. 1. Effect of the production method of the development of plant diameter of three TPS-cultivars.

exceptionally rainy, and the mean temperatures were lower than usual.

Results

Growth

By the end of July, the diameter of the

direct-seeded plants was around 10 cm less than that of pot-raised plants; by the middle of August it was only 3—5 cm less than that of covered vegetation. In the covered plots, the plants of all three varieties were equally large, and of direct-seeded plants the cul-

Table 1. Effect of the production method on TPS tuber yield.

method	cultivar	total yield		marketable yield kg/m ²	small tubers kg-%
		kg/m ²	number of tubers/m ²		
sowing	2928	2.5	59.9	2.3	11.6
»	4000	2.3	43.1	2.0	10.3
»	Explorer	2.1	40.2	1.7	10.4
		\bar{X} 2.3 b	47.7 a	2.0 b	10.7 b
planting	2928	3.3	78.1	2.9	9.6
»	4000	3.5	66.4	2.7	13.4
»	Explorer	3.4	53.0	2.3	8.1
		\bar{X} 3.4 a	65.8 b	2.6 a	10.4 b
planting + mulch	2928	2.6	64.3	2.0	18.9
»	»	2.9	61.0	2.4	20.4
»	»	2.7	54.9	2.0	14.5
		\bar{X} 2.7 b	60.1 (b)	2.1 (b)	17.9 a

tivar Explorer was the smallest in diameter (Figure 1).

Tuber yield

Pot raising increased tuber yield. In the production method experiment, the highest yield average of the three cultivars, 3.38 kg/m², was obtained with planted seedlings without floating mulch and lowest, 2.33 kg/m², with direct-seeding (table 1). The number of tubers per plant for seedlings planted without mulch was greater than for direct-seeding. The greatest marketable yield, tuber diameter 35–65 mm, was obtained with planted seedlings without mulch. The greatest proportion of small

tubers, as kg-% of total yield, was detected for the floating mulch method.

The production method experiment resulted in a positive correlation between plant diameter and yield, the correlation coefficient being $r = 0.6393$ (0.1 %).

In the variety experiment total yields varied between 2.85 and 4.13 kg/m², and marketable yields between 2.13 and 3.10. No significant differences were found in marketable yield and number of small tubers (Table 2).

Insects and diseases

Peach-potato aphids were found for the first time in the third week of June. They were

Table 2. Effect of the cultivar of TPS tuber yield.

cultivar	total yield		marketable yield kg/m ²	small tubers kg-%
	kg/m ²	number of tubers/m ²		
2909	2.8 (b)	60.8	2.2	15.7
2928	3.3	78.1 a	2.9	9.6
3018	3.1	57.3 (b)	2.1 (b)	8.9
4000	3.5	66.4	2.7	13.4
4016	4.0	61.1	2.4	5.9
4047	4.1 a	70.1	2.8	9.8
4048	3.6	58.6 (b)	3.1 a	5.6
Explorer	3.4	53.0 b	2.3	8.1

Table 3. Effect of the production method on the quantity of diseased tubers (kg/m²).

method	fungi + bacteria	source of infection		Streptomyces scabies
		PLR-virus		
sowing	cultivar			
»	2928	0.0	0.3	0.1
»	4000	0.2	0.4	0.0
»	Explorer	0.2	1.1	0.0
		\bar{X} 0.1	\bar{X} 0.6 b	\bar{X} 0.0
planting	2928	0.0	1.0	0.1
»	4000	0.4	1.8	0.0
»	Explorer	0.2	1.5	0.0
		\bar{X} 0.2	\bar{X} 1.4 a	\bar{X} 0.0
planting + mulch	2928	0.1	0.0	0.1
»	4000	0.2	0.1	0.0
»	Explorer	0.1	0.5	0.0
		\bar{X} 0.1	\bar{X} 0.2	\bar{X} 0.0

Table 4. Effect of the cultivar on tuber quality. Taste and colour: 1—10 points (0 = least pleasant and 10 = most pleasant). Starch contents as % of FW, Hals & Buchholz -method. Texture: 1—9 points (1 = watery, wet and loose and 9 = very mealy and dry).

	taste	colour	starch % of FW	texture
cultivar				
3018	6.5	6.5	13.0	3.8
4047	4.0	8.2	16.7	4.0
Explorer	5.4	5.2	11.4	6.8
Pito	7.4	8.2	17.7	7.0

most abundant in planted seedlings without mulch, and fewest in direct-seeded vegetation. In the planted, non-covered seedlings, potato leaf roll virus (PLRV) symptoms were also common. Tubers from plants that had visibly been evaluated as strongly virotic were graded separately, and the planted, non-covered seedlings gave the greatest amount of these tubers. Very few scabbed tubers (*Streptomyces scabies*) were found in any plot (Table 3).

In the production method experiment there was a negative correlation between virosy and yield, $r = -0.1264$ (5 %). There was also a negative correlation between the width and virosy of plants, $r = -0.1446$ (5 %). The tuber yield of visibly virotic plants was 29—95 % of that of non-virotic plants.

Mulching increased leaf symptoms of *Phytophthora infestans*. Tubers from the three production methods, however, did not differ as to visible infection by *Phytophthora infestans* and *Erwinia carotovora* (Table 3).

Tuber quality

The varieties evaluated were 4047, 3018, visibly healthy Explorer and visibly virotic Explorer, and Pito, a common Finnish variety used as a control. In the triangle test, all the varieties differed from each other either by colour or by taste. No differences were found in the virotic and non-virotic tubers of Explorer. In the descriptive analysis Pito, a yellow-fleshed variety was best by colour and taste

(Table 4). The red-fleshed variety 3018 was second best. There was a statistical difference in taste only between Pito and 4047. No differences were found between the members of the panel.

Pito had the greatest starch contents, 17.7, and Explorer the lowest, 11.4 %. Pito also reached the highest scores in texture evaluation.

Discussion

The use of floating mulch did not increase tuber yield of true seed potato. Symptoms of *Phytophthora infestans* were found in the middle of August, when plant growth was still continuing. Leaves were destroyed and the photosynthesising leaf area was diminished, which must have had an effect on yield.

The monthly mean maximum temperatures under mulch in June-August were 3—6°C higher than in the open. Tuber formation must have been retarded by the high temperatures, as claimed by BURTON (1981) and MALAGAMBA (1983). This may also explain why the proportion of small tubers was much higher for the plants under floating mulch than for the non-covered plants.

Of the three methods, direct-seeding gave the lowest mean yield, 2.3 kg/m². MARTIN (1983) in Washington achieved a yield of 58 tonnes per hectare with this method. In his experiment, the growth period was much longer than in ours, 195 days versus 124 days.

The good yield results in these experiments cannot be generalized, because the climatic conditions in the beginning of the summer were more favourable than the long-term ones in Finland.

Mulching gave a good growing environment for *Phytophthora infestans*, but treating potato vegetation with fungicides (mankozebe and metalaxyle) prevented the disease from spreading into the tubers. Apparently the mulch should have been removed earlier.

PLRV is spread by the peach-potato aphid. One of the hosts of this virus is *Physalis alkekengi*, the plants of which were growing near the experimental field. The mulch apparently

protected the potato vegetation from the virus vector, as PLRV symptoms were much less frequent under mulch and later than in the open. According to MARCO (1987), white colour, in this case a white mulch, causes aphid repellancy and disturbs aphid behaviour, thus diminishing potato Y-virus and PLRV infection. On the other hand, the plants were taller under mulch, and thus could have stood aphid damage better than the non-covered plants.

In the official Finnish potato cultivar test of 1981 (MATTILA et al. 1981), Pito was given the best points, 7, for its appearance; in our test, too, it was found to be the best as to colour. In both experiments it was also found to be the best by taste. Both in our test, and in

earlier tests performed by Finska hushållningssällskapet (ANON 1984), the varieties 3018 and 4047 proved to be equally mealy.

Conclusions

It seems possible to grow potato from true seed in Finland, at least when the summer weather is favourable. Further experiments are needed to clarify more precisely the best possible growing techniques.

Acknowledgements. We are grateful to Aarre Kurppa from the Agricultural Research Centre, Department of Plant Pathology, for the virus determination and to Ulla Helleman, from the University of Helsinki, Department of Food Chemistry and Technology Laboratory of Sensory Science, for arranging sensory tests.

References

- ANON 1983. Sätids- och sortförsök med potatis från frön. Finska Hushållningssällskapet. Åbo. Unpublished.
- ANON 1984. Finska Hushållningssällskapet. Unpublished.
- BURTON, W.G. 1981. Challenges for stress physiology in potato. *Amer. Potato J.* 58: 3—14.
- MALAGAMBA, P. 1983. Reducing the effect of stress during the establishment and growth of potatoes from true seed in hot climates. p. 125—126. Res. for the potato in the year 2000. Lima, Peru.
- MARCO, S. 1987. Effect of whitewash sprays onto potato crop on aphid landing and virus incidence. EAPR. Abstr. of Conference Papers and Posters. p. 409. Aalborg, Denmark.
- MARTIN, M.V. 1983. Techniques for successful field seeding of true potato seed. *Amer. Potato J.* 60: 245—259.
- MATTILA, L., MUSTONEN, L., PULLI, S. & RANTANEN, O. 1981. Virallisten lajikekokeiden tulostyöselmiä 1981. *Kasvinviljelylaitoksen Tiedote* 20: 150 p.
- SADIK, S. 1983. Potato production from true seed — present and future. p. 18—25. Res. for the potato in the year 2000. Lima, Peru.
- STONE, H., SIDEL, J., OLIVER, S., WOOLSEY, A. & SINGLETON, R.C. 1974. Sensory evaluation by quantitative descriptive analysis. *Food Technology* 28: 24—34.
- VARIS, E. 1970. Variation in the quality of table potato and the factors influencing it in Finland. *Acta Agraria Fennica* 118: 1—99.

Ms received January 12, 1988

SELOSTUS

Perunan siemenlisäyksen viljelytekniikka Suomessa

Seija Ahonen ja Helena Lamminsivu

Helsingin yliopisto, Puutarhatieteen laitos,
00710 Helsinki

Kesällä 1986 Helsingin yliopiston puutarhatieteen laitoksella tutkittiin kenttäkokein kolmea perunan (*Solanum*

tuberosum L.) siemenlisäyksen viljelymenetelmää. Menetelmät olivat kylvö avomaalle, neljän viikon taimikas-

vatus sekä taimikasvatus ja kasvuston kattaminen polypropyleeniharsolla. Lajikkeet olivat Explorer sekä Pan American Seed Companyn numerolajikkeet 2928 ja 4000. Lisäksi vertailtiin erillisessä, taimista perustetussa kokeessa lajikkeita 2909, 2928, 3018, 4000, 4016, 4048 ja 4147.

Kasvuston kate lisäsi taimien vegetatiivista kasvua ja myös saastumista *Phytophthora infestans*-sienen aiheuttamaan lehtiruttoon. Paras sato, 3.38 kg/m², saatiin taimista perustetusta kasvustosta ja toiseksi paras istutetusta,

katetusta kasvustosta. Avomaalle kylvetty kasvusto tuotti satoa 2.33 kg/m². Katteen alla kasvaneet yksilöt tuottivat pieniä mukuloita enemmän kuin kattamattomat.

Seitsemästä Pan American Seed Companyn lajikkeesta 4047 ja 4016 tuottivat satoa eniten, 4.1 ja 4.0 kg/m². Aistinvaraisessa arvioinnissa Pito-verrannelajikkeen mukulat saivat paremman arvion kuin tutkittujen siemenlajikkeiden 3018, 4047 ja Explorer.