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Research Note

The effect of storage ageing and spring sprouting of seed tubers on the yield of three potato varieties in the Finnish Lapland

Antti Hannukkala

MTT Agrifood Research Finland, Lapland Research Station, Tutkijantie 28, FIN-96900 Saarenkylä, Finland, e-mail: antti.hannukkala@mtt.fi

The objective of this study was to investigate the effects of storage ageing on the emergence, stem and tuber number and yield of potato grown at the MTT Lapland Research Station in Rovaniemi in the Arctic Circle (66°35'N). Three varieties, Puikula, Tanu and van Gogh, differing in earliness and storing properties, were used. Two sprouting treatments in the spring, i.e. varietal optimum and control with no sprouting, and four storage treatments, i.e. autumn, mid-winter, autumn and winter and control, were applied. A split-split-plot design was used. The emergence, stem and tuber numbers and yield were determined. Storage ageing enhanced the emergence up to 6 days depending on the cultivar and spring sprouting treatment. The tuber yield also increased by approx. 8 tn ha^{-1}. The stem and tuber numbers were not affected by winter ageing. However, the enhancement in emergence and increase in tuber yield were not high enough to compensate for the need for proper spring sprouting. According to this study, storage ageing cannot replace proper sprouting.

Key words: potato, sprouting, yield, yield component

Introduction

The growing season in the Finnish Lapland in the Arctic Circle is about 136 days and the average effective temperature sum above +5°C is about 870 degree days. Thus, at harvest potato tubers are immature (Hannukkala 1991). To sprout the seed tubers in the spring is the method used to obtain more mature tubers (Varis 1972). Furthermore, in the North the photoperiod is less favourable for potato growth because originally potato was, and largely remains, a short-day species (Burton 1989).

In the autumn, weather conditions are often unfavourable during harvesting and tubers must be dried prior to storage. Drying requires warming and this increases the tuber age. In addition, tubers are processed several times during the storing period before marketing or use as seed. For instance, tubers must be sorted according to size and health. If this is done at a storage temperature of +4°C, quality problems are likely to occur. Thus, the tubers must be warmed to a tem-

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perature of +12°C (Maaseutukeskusten liitto 1992) before handling. Also cultivars differ in storing properties. For instance, their earliness and dormancy status vary during the storing period (Maaseutukeskusten liitto 1997). In autumn ageing of tubers in northern growing conditions has been tested previously on the Muddusjärvi Experimental Farm of the University of Helsinki. It had some effect on the tuber yield, and the impact was greater in an early maturing cultivar (Hannukkala and Varis 1993). The importance of spring sprouting has been studied previously in Northern Finland (Hannukkala 1991). However, the ageing behaviour of seed tubers of different cultivars during storage has not been studied in the North. This kind of ageing can take place unintentionally when the yield is processed for marketing or intentionally when the dormancy of seed tubers is weakened or broken to compensate for the need for spring sprouting.

Material and methods

The experiment was carried out at the MTT Agrifood Research Finland, Lapland Research Station (66°35'N, 26°01'E) in 1996–1997. Three cultivars were used: van Gogh, a Dutch medium early maturing cultivar with weak dormancy and poor storing properties, Tanu, a Finnish early maturing cultivar with average storing properties, and Puikula, a very late landrace type of cultivar from northern Finland with prolonged dormancy (Maaseutukeskusten liitto 1997). The seed material was first grown from healthy seed potatoes for one year in the research area in order to obtain a similar physiological status for the tubers. Four ageing treatments were applied: immediately after harvest from the end of October to the second week of November (autumn), in January (winter), both in autumn and winter and a non-aged control for three weeks at 12°C. Half of the tubers in each of the four ageing treatments were sprouted again in the spring at 12°C in light using the recommended sprouting times for each cultivar which is four weeks for van Gogh and Tanu and eight weeks for Puikula. The other half was not spring sprouted. The tubers were planted on 5 June in 1996 and on 6 of June in 1997. These are average planting dates in the Arctic Circle. The stands were harvested in early September.

The potatoes were planted according to a $3 \times 2 \times 4$ split-split-plot design, where cultivar was the main plot, spring sprouting the sub-plot and storage ageing the sub-sub-plot factor. The trial was repeated four times. A row distance of 75 cm and a planting distance of 30 cm were used. The plot size was 7.5 m^2. The soil was sandy moraine, pH 5.8 in 1996 and 6.4 in 1997. The figures for Ca were 1400 units and 1340, Mg 203 and 289, P 14 and 13 and for K 56, respectively (Viljavuuspalvelu 1995, 1996). The trials were fertilized with a chloride-free fertilizer in both years at a rate of N 64, P 80 and K 96 kg ha^{-1}. The weeds were controlled with Senkor 0.5 kg ha^{-1} (metribuzin 700 g kg^{-1}, Bayer). No other plant protection measures were taken. Stem emergence on 50% of the plot area in days from planting, stem and tuber numbers per plant and total yields (tn ha^{-1}) were determined. Statistical analysis was done using MSTATC, version 1.2 (Michigan State University 1990).

The beginning of the growing period in 1996 was average, July was rather cool but wet, rainfall was 40 mm higher than average (103 mm vs. 63 mm) and August was warm and dry. June 1997 was very dry and little warmer than average, July and August were warmer and somewhat drier than average (Table 1).

Results and discussion

The ageing during the storage period enhanced the emergence in all cultivars slightly when treatment was carried out in the middle of the storing period (Table 2). Combined with spring sprouting this effect was of minor importance. Stem and tuber numbers per plant were not or

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Table 1. Summer weather conditions at the MTT Agrifood Research Finland Lapland Research Station in 1996–1997. Data provided by the Finnish Meteorological Institute.

Month	Mean temperature °C			Rainfall mm		
	1996	1997	average 1961–90	1996	1997	average 1961–90
May	3.6	3.9	5.8	30	14	34
June	11.0	13.2	12.5	85	12	54
July	13.4	17.1	14.7	103	45	63
August	14.7	14	12	29	44	69
September	5.7	7.8	6.7	8	59	59

Table 2. The effect of storage ageing on the emergence, stem and tuber number and tuber yield of potato at the MTT Lapland Research Station in Rovaniemi 1996–1997.

Variety	Sprouting	Storage ageing	Emergence 50 % in days		Stem number/ plant		Tuber number/ plant		Yield tn/ha	
			1996	1997	1996	1997	1996	1997	1996	1997
Puikula	yes	autumn	22	20	4.7	6.0	8.8	10.1	20.8	16.1
	yes	winter	23	19	4.7	4.7	9.4	9.8	22.7	18.0
	yes	autumn+winter	22	18	4.7	5.2	7.2	13.7	20.9	17.3
	yes	control	23	21	5.7	4.5	34.1	9.9	22.3	17.9
	no	autumn	34	35	4.3	4.1	0.0	6.3	7.5	7.2
	no	winter	30	34	4.5	4.8	0.4	11.6	15.7	9.8
	no	autumn+winter	32	34	3.9	4.8	0.2	9.1	9.3	9.3
	no	control	33	34	3.5	5.1	0.4	10.0	9.1	9.6
Tanu	yes	autumn	22	21	3.1	3.0	10.5	9.8	32.1	30.6
	yes	winter	20	18	3.6	3.3	13.3	17.1	32.7	33.4
	yes	autumn+winter	20	18	3.0	3.2	14.6	11.3	34.4	32.6
	yes	control	21	23	3.6	3.4	13.0	16.6	35.6	32.4
	no	autumn	28	32	4.4	2.6	6.4	10.4	27.0	22.5
	no	winter	25	28	3.4	3.3	11.1	11.7	30.1	26.0
	no	autumn+winter	25	25	3.9	2.6	13.0	13.4	29.8	28.6
	no	control	33	34	3.4	3.0	5.4	11.0	21.6	20.2
van Gogh	yes	autumn	20	19	3.7	2.9	15.3	12.9	38.9	37.6
	yes	winter	20	18	3.5	2.3	13.3	11.5	31.1	35.6
	yes	autumn+winter	20	18	2.9	2.2	11.1	11.9	35.6	30.8
	yes	control	21	18	4.2	2.8	14.6	11.0	37.2	31.3
	no	autumn	23	25	4.1	2.3	13.6	10.3	33.5	28.1
	no	winter	21	21	3.1	2.1	12.0	11.3	36.8	28.8
	no	autumn+winter	23	22	2.9	1.7	13.1	9.0	35.0	31.4
	no	control	24	27	4.4	2.6	12.3	9.5	31.0	26.5
LSD			1.816	2.351	1.135	0.8156	14.00	3.081	4.144	3.620
Significance		Variety A	***	***	**	***	ns	*	***	***
		Sprouting B	***	***	ns	**	**	**	***	**
		Storage ageing C	***	***	ns	ns	ns	*	**	**
		A*B	***	***	***	ns	*	ns	***	ns
		A*C	**	***	ns	ns	ns	*	ns	**
		B*C	***	ns	ns	**	ns	ns	***	**
		A*B*C	**	*	ns	ns	ns	***	ns	ns

*** 99.9 % significance
** 99 % significance
* 95 % significance
ns not significant

very little affected by storage ageing. The differences in these yield factors were mainly due to the variety and spring sprouting.

In the case of total yield, all three varieties reacted as expected to spring ageing in both years, sprouting increased the yields. Also winter ageing had a significant effect on the yield, especially when the seed tubers were not sprouted in the spring.

Rapid early development of stands is essential in northern growing conditions, as seen before in many studies (Varis 1972, Hannukkala 1991, Hannukkala and Varis 1993). The rapid emergence of stems is easily achieved by proper spring sprouting. Concerning stem and tuber number, the response of cultivars and the effect of sprouting varied between the years, but winter ageing did not have any significant influence on these traits. Storage ageing increased the yields, but the yield increase of 1–4 tonnes was negligible compared with that caused by choice of cultivar and sprouting treatment.

In general, the effects of storage ageing on the performance of seed tubers are minor. It may, however, improve the maturity and stability of seed tubers during the storage and, subsequently, the growth vigour in the spring (Hannukkala and Varis 1993). The results of this study indicate that in the northern growing conditions, in particular, choice of cultivar and sprouting the tubers in spring are important factors of yield formation. According to this study, ageing of seed tubers during storage does not eliminate the need for spring sprouting.

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SELOSTUS

Siemenmukuloiden varastointiaikaisen lämpökäsittelyn ja kevätidätyksen vaikutus kolmen perunalajikkeen satoon Lapissa

Antti Hannukkala
MTT (Maa- ja elintarviketalouden tutkimuskeskus)

MTT:n Lapin tutkimusasemalla tutkittiin vuosina 1996–1997 varastointiaikaisen siemenmukuloiden lämpökäsittelyn vaikutusta kolmen perunalajikkeen, satoon, taimettumiseen sekä verso- ja mukulalukuun. Lajikkeet olivat aikaisuudeltaan ja varastointikestävyydeltään erilaiset Puikula, Tanu ja van Gogh. Keväällä siemenmukuloita ei idätetty tai idätettiin lajikeoptimin mukaisesti. Varastointiaikana perunoita lämpökäsiteltiin loka-marraskuussa, tammikuussa, molempina aikoina tai ei ollenkaan. Keskitalvella tehty varastointiaikainen lämpökäsittely nopeutti taimettumista ja lisäsi satoa. Se ei sen sijaan vaikuttanut versojen ja mukuloiden määriin. Varastointiaikaisilla käsittelyillä ei voitu kuitenkaan kompensoida kevätidätyksen vaikutusta perunan kasvuun ja satoon Lapin lyhyen kasvukauden aikana.