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Effects of physiological age of seed tubers on seed yield and regrowth of progeny tubers in potatoes

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SUMMARY

Four experiments are reported in which the effects of a range of physiological ages of seed tubers on growth and yield in seed crops and regrowth of the progeny seed were studied. Increasing the age of seed in Home Guard, Arran Comet, Pentland Javelin and Désirée advanced emergence, tuber initiation and early growth but restricted leaf area index and reduced the number of tubers and seed tuber yield. In these varieties increasing the physiological age of seed shortened the dormancy of the progeny seed and slightly increased sprout lengths at replanting but in Home Guard had no effects on field growth and tuber yield.

In a further series of experiments at Tenby seed of five varieties (Home Guard, Red Craigs Royal, Désirée, Maris Piper and Stormont Enterprise) was multiplied over 2 years using husbandry methods designed to produce seed of contrasting ages. Once-grown seed from Tenby which had been planted and harvested early in the season was stored at either 4 or 12 °C and grown again at Tenby before being stored again at either 4 or 12 °C. The seed resulting from this multiplication over 2 years was compared with seed imported from seed-growing areas stored at the two temperatures. The seasons for the two multiplications at Tenby (1975 and 1976) were hot and were followed by an especially cold and late spring yet few differences between seed from Tenby and other areas could be detected. Where seed from different areas entered sprouting temperatures at different times and therefore produced different ages of seed at replanting large effects on yield were found. Storage temperature had large effects on regrowth of tubers in Home Guard, Red Craigs Royal and Stormont Enterprise for storage at 12 °C produced 'little potato disorder' in the majority of plants in one storage phase while storage at lower temperature produced full plant stands and yields. The results provided no support for the suggestion that repeated multiplication in warm lowland areas may lead to cumulative deterioration in the performance of seed.

INTRODUCTION

Published reports of the effects of physiological age are mainly restricted to ware crops in which large effects on tuber yield have been found (Allen & O'Brien, 1978; O'Brien *et al.* 1983; Wurr, 1978). Increasing age has been reported to reduce the number of tubers and this effect has important implications for seed production where upper and lower size limits apply and changes in number of tubers may affect seed yield where little or no effect on total yield can be detected. As physiological age of seed tubers affects the timing of tuber initiation it may affect the duration of dormancy (post-harvest) of the progeny tubers. The further possibility exists that such effects may be cumulative over successive multiplications and thereby create changes in the growth pattern of a variety. Thus, the age of the seed tuber may affect both yield and physiological quality of the seed produced. This paper reports the results of several experiments in which the effects of physiological age on seed yield and subsequent regrowth were studied in a range of varieties. In two experiments the effect of a range of physiological ages was studied in seed crops of the early variety Home Guard, grown in mid-Wales and the progeny seed was grown in ware experiments in

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Table 1. *Durations of controlled-temperature storage for treatments in Home Guard (Expts 1 and 2)*

Physiological age (number of day-degrees > 4 °C)	Storage temperature (°C)		
	4	8	12
0	28. x–20. iv	—	—
336	8. xii–20. iv	—	28. x–8. xii
672	19. i–20. iv	—	28. x–19. i
700	—	28. x–20. iv	—
868	—	8. xii–20. iv	28. x–8. xii
1036	—	19. i–20. iv	28. x–19. i
1064	9. iii–20. iv	—	28. x–9. iii
1232	—	9. iii–20. iv	28. x–9. iii
1400	—	—	28. x–20. iv

Pembrokeshire. The remaining experiments were carried out in Pembrokeshire. In two experiments the effects of physiological age on seed tuber yields and dormancy of Home Guard, Arran Comet, Pentland Javelin and Désirée were studied and in the other experiments seed of different ages of five contrasting varieties was multiplied for two generations to assess the longer-term effects.

THE EXPERIMENTS

Two experiments were carried out on the farm of Mr A. Lewis, Cefnceido, Rhayader, Powys on slaty mudstone and siltstone soils of the Denbigh Association (Soil Survey of England and Wales, 1984). Each experiment followed grazed grass which was not ploughed until April. The only cultivation was one pass of a rotary cultivator 2–3 weeks after ploughing. Soil conditions were very good in both years. Both experiments used 76 cm rows and received fertilizer applications of 151 kg N/ha, 65 kg P/ha and 159 kg K/ha applied by hand over the opened ridges. Ridges were opened and closed using rear-mounted ridging bodies.

Experiment 1, 1976–7

Using the early variety Home Guard, nine physiological ages were achieved using the combinations of controlled-temperature storage shown in Table 1. Seed tubers were from a Scottish FS2 stock and all weighed 50–65 g. The nine treatments were replicated three times in a randomized-block design. Plots were five rows wide and 9·1 m long. Seed tubers were spaced 30 cm apart in the row and the experiment planted by hand on 6 May.

The experiment was sampled intensively to record early growth and tuber initiation and two plants per plot were harvested for growth analysis on 25, 27, 30 May, 3, 8, 11, 18, 22, 26, 30 June and 7 and 20 July from the outside rows of each plot. The remainder of the plots was used for two harvests from which seed for the ware experiment was retained. Approximately half the remaining plants were defoliated with diquat on 28 July and other plants defoliated in the same way on 18 August. The plots were harvested by hand approximately 14 days after defoliation, 10 August and 6 September, respectively. On the first occasion ten plants per plot were retained for hand grading to determine yields while the tubers from the remaining plants of each age were bulked. On 6 September 26 plants were used to determine yields and the remainder bulked. The sampling, recording and grading techniques were essentially as described by Allen (1977).

Seed tubers were selected and placed in trays for sprouting as described by O'Brien *et al.* (1983). An application of a trietazine-linuron herbicide controlled weeds satisfactorily. No foliage blight or virus symptoms were observed.

For the ware part of Expt 1, treatments were all combinations of nine physiological ages in the seed crop (as in Table 1), two dates of harvesting, 10 August and 6 September and two storage temperatures, 12 °C from 12 October to 5 December then 8 °C until 9 March and 8 and 6 °C for the same periods, arranged in three blocks. Seed of 50–65, 65–80 and 80–100 g were selected for the three blocks in early October and moved into illuminated controlled-temperature cabinets on 12 October. At this time bud growth was apparent in the eyes of tubers of some treatments but none had reached 3 mm in length. Ten tubers per treatment in each replicate were numbered, inspected every 2–3 days and the date of production of 3 mm sprouts recorded. In all experiments the date of dormancy break of each plot was calculated as the mean of the dates for all ten tubers. Number and length of sprouts were recorded on the numbered tubers just prior to planting. The experiment was planted on 6 April 1978 at University College of Wales' Field Station, Trefloyne on Devonian Sandstone soil of the Milford Association (Soil Survey of England and Wales, 1984).

The plots were single rows of 24 tubers spaced 30 cm apart. General husbandry was as previously described for experiments at Trefloyne by Allen (1977) and O'Brien *et al.* (1983). The experiment received a fertilizer application of 151 kg N/ha, 65 kg P/ha and 159 kg K/ha. Emergence was recorded using the whole row and three harvests taken on 13, 26 June and 13 July using eight plants per plot. In some plots there were insufficient tubers but only data from the first harvest (13 June) are presented and all plots were complete.

Experiment 2, 1977–8

The experiment was essentially the same as Expt 1 and was carried out in a similar way. Seed tubers were 50–65 g and were the progeny of the same stock used in Expt 1 which had been grown in the University College of Wales' seed multiplication field on the Rhayader farm. Plots were again 9·1 m long but only four rows wide. The experiment was planted on 24 April.

Intensive sampling was again carried out and two plants per plot removed for growth analysis on 16, 19, 23, 26, 30 May, 2, 6, 9 June and 3 July using the outside rows. Yields were determined on two occasions; on 14 July half of the plants in all rows were defoliated by hand using a sickle and the remaining plants were similarly defoliated on 3 August. The tubers were harvested on 8 and 30 August using ten plants per plot for grading while other tubers from each treatment were bulked over replicates.

A trietazine-linuron herbicide was again used and controlled weeds well. No foliage blight or virus symptoms were observed.

For the ware phase of the experiment all tubers were stored at 12 °C and ten numbered tubers of each seed size in all treatments were observed frequently to record the end of dormancy. As effects on dormancy were small the experiment was not continued into the ware crop.

Experiments 3 *and* 4, 1979–80

Eight physiological ages in Home Guard, Arran Comet and Pentland Javelin (Expt 3) and ten ages in Désirée (Expt 4) were produced using the combinations of controlled-temperature storage shown in Table 2. Both experiments used once-grown seed and studied ware crop growth at Trefloyne and as no virus symptoms were observed in the crops samples of tubers from each age were used to study effects on dormancy. Progeny tubers used to study effects on dormancy of Home Guard, Arran Comet, Pentland Javelin and Désirée were harvested on 21, 22, 25 and 26 June, respectively. Ten tubers of three weights in all treatments were observed frequently to record the end of dormancy. The observed effects were small and the experiments were terminated during sprouting.

From 1975 to 1977 six further experiments were carried out in which the longer-term effects of age of seed tuber on regrowth of progeny tubers were studied. These experiments were carried out at the University College of Wales' Field Station at Trefloyne near Tenby in Pembrokeshire.

Experiment 5, 1976

There were ten treatments comprising all combinations of five varieties, Home Guard, Red Craigs Royal (early), Désirée, Stormont Enterprise and Maris Piper (maincrop) and two seed storage temperatures, 4 and 12 °C, arranged in three blocks. The plots were 4·5 m long and six rows wide. The seed had been produced at Trefloyne, Tenby (80 m above sea level) in 1975 from Scottish FS or AA stocks delivered to Aberystwyth in early January and planted in March. The early varieties and Désirée and Maris Piper were 'burnt off' on 1 July and Stormont Enterprise on 11 July and all were harvested on 28 July. Thus, husbandry methods for the first multiplication of certified seed were chosen to achieve an early end to dormancy and old seed at replanting after storage at 12 °C. Following grading and boxing the seed was transferred to Aberystwyth and from mid-September half of the seed of each variety was stored in illuminated, controlled-temperature rooms at either 4 or 12 °C. The seed of all varieties that was surplus to the requirements of the experiment was also divided between the two storage temperatures. Sprout growth was recorded on ten tubers of each seed weight of each treatment just before planting. Seed weighing 40–50, 50–60 and 60–75 g was used for each of the three blocks and spaced 30·5 cm apart in the row. A fertilizer dressing of 170 kg N, 74 kg P and 196 kg K/ha was applied at planting on 18 March. Two adjacent plants from each plot were removed for growth analysis on 3 and 13 May. Yield estimates were made on 28 May, 16 June, 8 July and 24 August by harvesting a 2·44 m length of row and a foliage analysis of two plants carried out for dry-weight determination and calculation of leaf area index on the first three dates. The produce of each plot was graded over 25 and 38 mm riddles.

The surplus seed of each variety from both storage temperatures was further multiplied at Trefloyne in 1976 on a site adjacent to Expt 5 for use in Expts 6–10. The fertilizer application and date of planting were the same as in Expt 5. Home Guard and Red Craigs Royal were desiccated with diquat on 22 June and the maincrop varieties 3 days later and all the seed harvested on 29 July. Thus, the husbandry of the second seed multiplication was also chosen so as to produce an early end to dormancy. The crops of Home Guard, Red Craigs

Table 2. *Duration of controlled-temperature storage for treatments in Home Guard, Arran Comet and Pentland Javelin (Expt 3) and Désirée (Expt 4)*

Physiological age of seed (number of day-degrees > 4 °C)	Storage temperature (°C)			
	4	12	4	12
	Home Guard		Arran Comet	
0	23. x–26. ii	—	23. x–3. iii	—
144	10. xi–26. ii	23. x–10. xi	10. xi–3. iii	23. x–10. xi
288	28. xi–26. ii	23. x–28. xi	28. xi–3. iii	23. x–28. xi
432	16. xii–26. ii	23. x–16. xii	16. xii–3. iii	23. x–16. xii
576	3. i–26. ii	23. x–3. i	3. i–3. iii	23. x–3. i
720	2. ii–26. i	23. x–2. ii	—	—
760	—	—	26. i–3. iii	23. x–26. i
864	8. ii–26. ii	23. x–8. ii	—	—
904	—	—	13. ii–3. iii	23. x–13. ii
1008	—	23. x–26. ii	—	
1048	—	—	—	23. x–3. iii
	Pentland Javelin		Désirée	
0	10. xii–22. iii	—	8. i–4. iv	—
80	—	—	18. i–4. iv	8. i–18. i
112	24. xii–22. iii	10. xii–24. xii	—	—
144	—	—	26. i–4. iv	8. i–26. i
208	—	—	3. ii–4. iv	8. i–3. ii
224	7. i–22. iii	10. xii–7. i	—	—
288	—	—	13. ii–4. iv	8. i–13. ii
336	21. i–22. iii	10. xii–21. i	—	—
368	—	—	23. ii–4. iv	8. i–23. ii
448	4. ii–22. iii	10. xii–4. ii	5. iii–4. iv	8. i–5. iii
528	—	—	15. iii–4. iv	8. i–15. iii
560	18. ii–22. iii	10. xii–18. ii	—	—
608	—	—	25. iii–4. iv	8. i–25. iii
688	—	—	—	8. i–4. iv
704	8. iii–22. iii	10. xii–8. iii	—	—
864	—	10. xii–22. iii	—	—

Table 3. *Source of seed of each variety (Expts 6–10)*

Home Guard (Expt 6)	Tenby (twice-grown) stored at 4 °C 1975–6 Rhayader (once-grown) Scotland (FS)
Red Craigs Royal (Expt 7)	Tenby (twice-grown) stored at 4 °C 1975–6 Rhayader (once-grown) Scotland (FS)
Désirée (Expt 8)	Tenby (twice-grown) stored at 4 °C 1975–6 Tenby (twice-grown) stored at 12 °C 1975–6 Rhayader (once-grown) Scotland (FS)
Maris Piper (Expt 9)	Tenby (twice-grown) stored at 4 °C 1975–6 Rhayader (once-grown) Scotland (FS)
Stormont Enterprise (Expt 10)	Tenby (twice-grown) stored at 4 °C 1975–6 Rhayader (once-grown) Scotland (FS)

Table 4. *Dates of arrival of Scottish seed in Aberystwyth* (*Expts* 6–10)

Variety	Time of arrival
Home Guard	Mid-October
Red Craigs Royal	Mid-October
Désirée	Mid-November
Maris Piper	Late-November
Stormont Enterprise	Mid-February

Royal and to a lesser extent Stormont Enterprise which had been stored at 12 °C during the winter of 1975–6 were so severely affected by 'little potato disorder' that no seed of these treatments was available for use in Expts 6–10.

Experiments 6–10, 1977

Separate experiments were carried out for each variety and the seed produced at Tenby in 1976 was compared with imported seed. There were six treatments in Home Guard, Red Craigs Royal, Stormont Enterprise and Maris Piper and eight in Désirée, comprising the seed sources shown in Table 3 and two seed storage temperatures, 4 and 12 °C, arranged in four blocks. The plots were 3·66 m long and six rows wide. At Tenby, the seed was graded and boxed and transferred to the controlled-temperature stores at Aberystwyth on 15 September. The Rhayader (once-grown) seed was produced from FS or AA stocks in 1976, planted in mid-April, desiccated in late July and harvested in early September. This seed was also transferred to the controlled-temperature stores at Aberystwyth in September after grading and boxing. The Scottish seed of each variety arrived at Aberystwyth at different times (Table 4) and consequently the length of time during which the storage temperatures could be imposed varied considerably. Sprout growth in these experiments was recorded on ten tubers of each seed weight of each treatment periodically throughout storage. The seed weights shown in Table 5 were used for the four blocks and spaced 30·5 cm apart in the row. The fertilizer dressing was the same as in Expt 1 and was applied at planting, the dates of which are shown in Table 6. The procedure for growth analysis, foliage analysis and yield estimates were identical to those of Expt 1. The dates of these operations in each experiment are also shown in Table 6.

All experiments followed spring barley, the stubbles of which were ploughed in September or October. The land for Expts 6–10 was prepared by the combined use of spring-tine harrows and power-driven rotary harrows and ridged just prior to planting. For Expt 5, however, as the autumn of 1975 was exceptionally dry, ridges were drawn from the ploughing in early November and left undisturbed until the following spring when the land was power-harrowed and re-ridged. Ridges were 71 cm apart in all experiments, were drawn with 3-row rear-mounted bodies and closed with a similar front-mounted implement. Fertilizer was applied by hand over open ridges just prior to planting. Within 10 days of planting, the experiments were sprayed with a trietazine-linuron residual herbicide. All experiments (including the area of seed in 1975 and 1976) were sprayed periodically after mid-June with a fungicide–aphicide mixture. Initial applications were with mancozeb with a change to a tin-based fungicide later in the season. The aphicide was dimethoate throughout. No symptoms of blight or virus diseases were observed. Growth analysis and harvesting techniques were essentially the same as those described by Allen (1977).

In Expts 3–10 and in the ware phase of Expts 1 and 2 seed size was confounded with blocks which contained all other combinations. There were few interactions between seed size and any other factor in any experiment but the 'error' term in the analysis of variance is likely to be greater than that in the analysis of an orthodox randomized-block design of the same seed size. Methods of analysis of the data were as described by O'Brien & Allen (1986).

RESULTS

Experiments 1 *and* 2

Seed crop growth

Meteorological data for the nearest recording site (Pant-y-dwr 8 km north-east of Rhayader) are

Table 5. *Seed weight* (*g*) *for each variety* (*Expts* 6–10)

	Block			
	I	II	III	IV
Home Guard (Expt 6)	40–50	50–60	60–75	75–90
Red Craigs Royal (Expt 7)	40–50	50–60	60–75	75–90
Désirée (Expt 8)	40–50	50–60	60–75	75–90
Stormont Enterprise (Expt 9)	30–40	40–50	50–60	60–75
Maris Piper (Expt 10)	40–50	50–60	60–75	75–90

Table 6. *Dates of planting, growth analysis, leaf analysis and yield estimate for each variety* (*Expts* 6–10)

	Date of planting	Growth analysis	Leaf analysis	Yield estimate
Expt 6 (Home Guard)	29. iii	12. v	22. vi 12. viii	22. vi 12. viii 10. viii
Expt 7 (Red Craigs Royal)	29. iii	27. v	23. vi 11. vii	23. vi 11. vii 11. viii
Expt 8 (Désirée)	7. iv	23. v	13. vi 4. vii 12. viii	13. vi 4. vii *12. viii 7. ix
Expt 9 (Maris Piper)	7. iv	24. v	16. vi 5. vii 12. viii	16. vi 5. vii *12. viii 13. ix
Expt 10 (Stormont Enterprise)	7. iv	—	16. vi 7. vii 18. viii	16. vi 7. vii *18. viii 18. ix

* Two-plant sample.

Table 7. *Meteorological data for Pant-y-dwr in* 1977 *and* 1978

1977				1978			
Date (week ending)	Temp. (°C) Max.	Temp. (°C) Min.	Rainfall (mm)	Date (week ending)	Temp. (°C) Max.	Temp. (°C) Min.	Rainfall (mm)
12. v	11·9	5·1	18·7	26. iv	9·8	3·5	28·7
19	11·9	1·3	7·5	3. v	8·0	2·7	4·6
26	17·6	6·7	4·5	10	14·2	5·1	10·2
2. vi	17·5	3·9	0	17	12·6	4·4	10·0
9	17·1	4·5	10·5	24	15·0	3·7	0
16	12·6	7·7	5·1	31	21·2	7·1	0
23	15·7	6·3	Trace	7. vi	19·4	9·0	6·9
30	16·0	8·5	0	14	14·2	4·4	1·6
7. vii	22·5	10·0	Trace	21	16·3	6·5	31·6
14	18·5	11·5	0·9	28	12·9	7·5	17·3
21	16·0	9·8	13·3	5. vii	14·0	9·6	20·2
28	16·6	10·6	6·4	12	16·6	9·7	6·4
4. viii	19·4	7·2	0	19	18·8	8·0	0·5
11	18·2	8·4	10·8	26	16·2	10·1	12·7
18	18·4	10·8	35·2	2. viii	17·3	11·6	14·5
25	16·5	10·0	48·4	9	15·5	10·1	9·0
1. ix	15·8	7·0	0	16	17·0	9·7	16·0
8	15·5	6·8	22·0	23	18·2	9·0	3·1
15	15·6	6·3	8·0	30	17·3	7·9	0·3
22	10·8	5·7	0·4				
29	14·7	10·5	17·2				

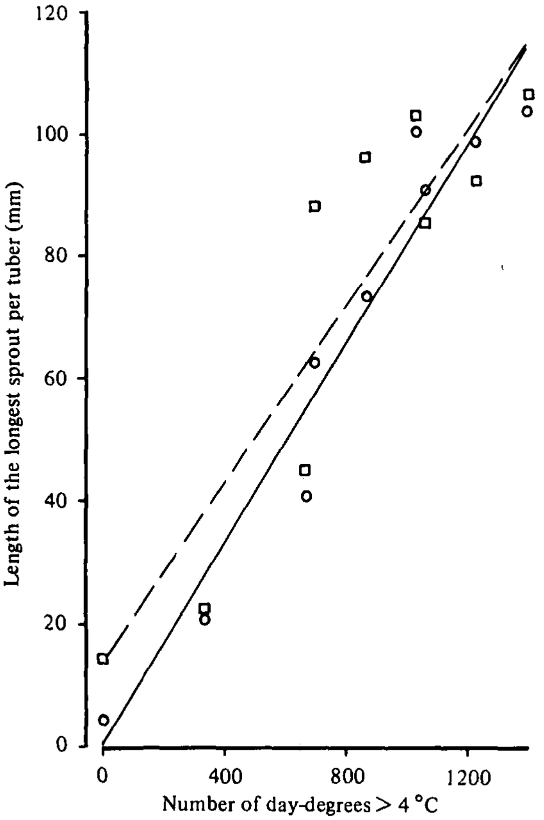

Fig. 1. The relationship between the length of the longest sprout per tuber of Home Guard at planting and the number of day-degrees > 4 °C in 2 years. ○, ——, 1977 (Expt 1), $y = 0{\cdot}50 + 0{\cdot}081x$, $r^2 = 0{\cdot}94$; □, — —, 1978 (Expt 2), $y = 13{\cdot}9 + 0{\cdot}072x$, $r^2 = 0{\cdot}72$.

shown in Table 7. 1978 was a much wetter year than 1977 but in neither seed year was any sign of water stress observed.

Length of the longest sprout per tuber at planting was linearly related to accumulated day-degrees experienced by the seed post-dormancy break (Fig. 1) in both years and the slope of the overall relationship was similar to that found in Home Guard in other experiments (see Fig. 1, O'Brien *et al.* 1983). In both years increasing the age of seed hastened emergence and the oldest seed reached 90% of complete emergence about 2 weeks before the youngest seed. Some 'little potato disorder' occurred with seed ages above 700 day-degrees.

Leaf area indices were slightly increased initially by increasing age of seed but peak values were higher from the youngest seed (Table 8). Leaf areas were similar in the two experiments and no treatments produced complete ground cover. Although age of seed affected the peak leaf area index there were no marked effects on the onset of senescence.

Tubers were initiated earlier with increasing age of seed; the range in mean date of tuber initiation from the seed of different physiological ages was 4 weeks in Expt 1 and 3·5 weeks in Expt 2 (Table 9). Plant dry weights at mean date of tuber initiation decreased with increasing age of seed and the oldest seed initiated tubers when plants were very small (Table 9).

Once tuber initiation was complete the total number of tubers decreased linearly with increasing age of seed in both years at all harvests (Fig. 2). The total number of tubers was higher in 1978 than in 1977 but in both years the range was approximately three-fold. The number of seed-size tubers (32–57 mm) decreased with increasing age of seed at all harvests (Fig. 2) and significant linear or quadratic regressions were found in both years.

As a consequence of earlier initiation of tubers, total tuber yield increased with increasing age of seed for the first few weeks of growth in both experiments. At the first commercial harvest in both experiments total yield was little affected by age of seed for only the oldest seed reduced tuber yield; however, as a consequence of effects on

Table 8. *Effect of physiological age of seed tubers on leaf area indices in Home Guard (Expts 1 and 2)*

Physiological age (number of day-degrees > 4 °C)	Experiment 1			Experiment 2	
	26. vi	20. vii	18. viii	14. vi	3. viii
0	0·6	2·2	2·6	2·2	2·6
336	1·0	3·0	2·2	2·4	2·4
672	0·6	2·0	2·0	2·2	2·2
700	0·6	2·0	2·0	3·0	1·8
868	0·4	2·4	1·8	1·8	2·2
1036	0·6	1·8	2·4	1·6	2·2
1064	0·6	1·8	1·6	2·2	2·0
1232	0·8	1·8	1·4	1·4	1·8
1400	0·4	1·4	1·8	1·8	2·2
S.E.	0·13	0·27	0·34	0·20	0·21

Table 9. *Effect of physiological age of seed tubers on mean dates of tuber initiation and plant dry weights at initiation (g) (Expts 1 and 2)*

Physiological age (number of day-degrees > 4 °C)	Mean date of initiation		Mean plant dry weight	
	Expt 1	Expt 2	Expt 1	Expt 2
0	3. vii	19. vi	14·7	15·3
336	26. vi	19. vi	15·8	16·0
672	23. vi	6. vi	8·0	5·4
700	18. vi	26. v	3·5	2·0
868	14. vi	23. v	2·9	1·9
1036	30. v	26. v	1·6	1·6
1064	15. vi	30. v	3·3	3·0
1232	8. vi	23. v	2·0	2·3
1400	4. vi	26. v	1·5	1·6

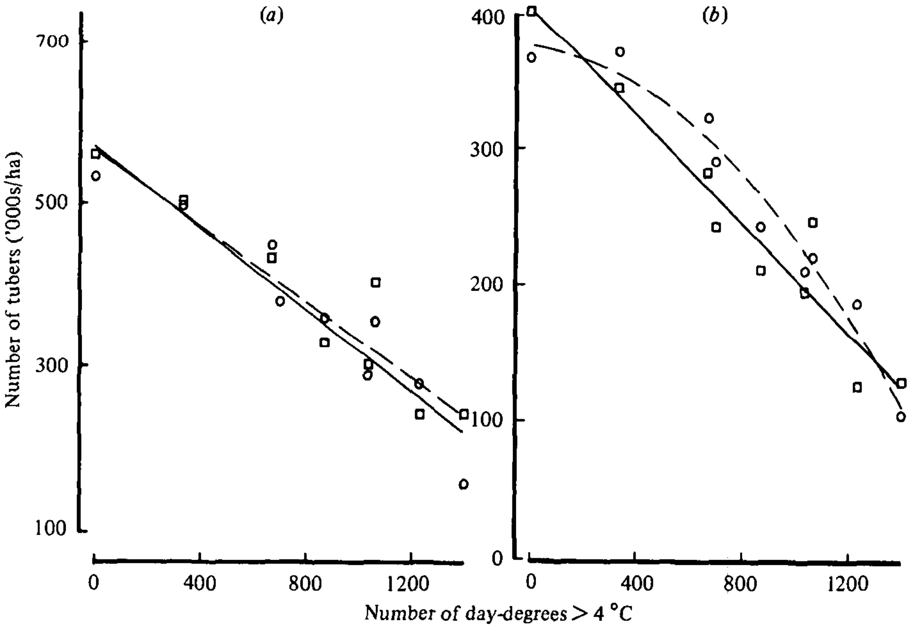

Fig. 2. Relationships between (*a*) total number of tubers and (*b*) number of tubers 32–57 mm of Home Guard at two dates of harvesting of the seed crop and number of day-degrees > 4 °C in Expt 1 (1977). (*a*) ○, ——, 10. viii. 77, $y = 569{\cdot}4 - 0{\cdot}25x$, $r^2 = 0{\cdot}90$; □, — —, 6. ix. 77, $y = 566{\cdot}2 - 0{\cdot}233x$, $r^2 = 0{\cdot}87$; (*b*) ○, ——, 10. viii. 77, $y = 374{\cdot}6 - 0{\cdot}0023x - 1{\cdot}19 \times 10^{-4}x^2$, $R^2 = 0{\cdot}96$; □, — —, 6. ix. 77, $y = 405{\cdot}3 - 0{\cdot}301x$, $r^2 = 0{\cdot}91$.

number of tubers a close negatively quadratic relationship was found between yield of seed-size tubers and increasing age (Fig. 3). At the final harvest in Expt 1 total yield and yield of seed-size tubers decreased linearly with increasing age (Fig. 3).

Dormancy, sprout and ware crop growth

Although there were significant effects of age of seed on duration of dormancy in both experiments the range in time was small (Table 10). The latest ending of dormancy occurred with the progeny of youngest seed but this delayed sprout growth by only 11 days in Expt 1. Length of longest sprout per tuber at planting was reduced from seed ages below 868 day-degrees (Table 10). No detailed recordings of emergence were made in Expt 1 but no obvious effects were observed and Table 10 shows that age of seed in the crop had no effects on yield or number of tubers in the ware crop.

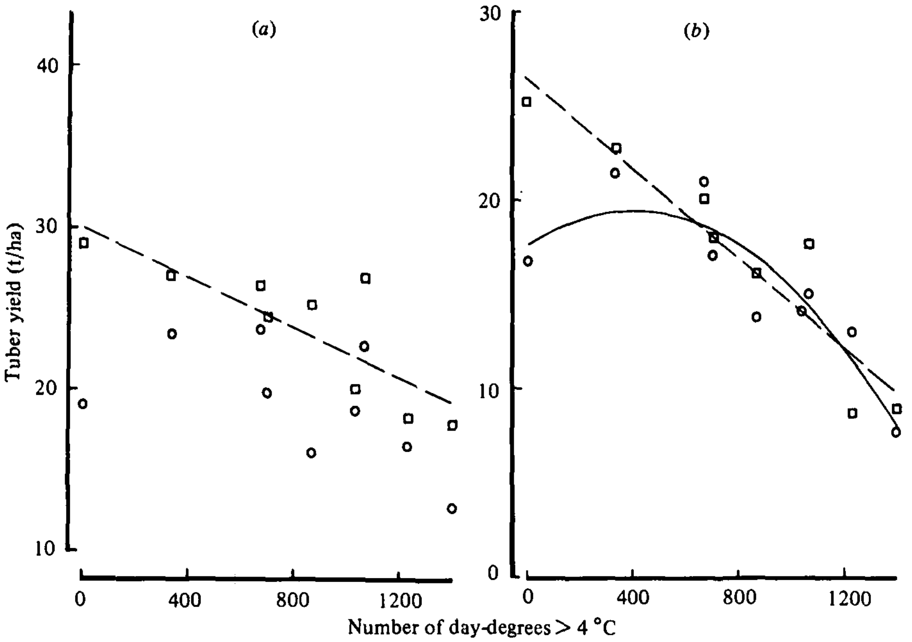

Fig. 3. Relationships between (*a*) total tuber yield and (*b*) tuber yield 32–57 mm of Home Guard at two dates of harvesting of the seed crop and number of day-degrees > 4 °C in Expt 1 (1977). (*a*) ○, 10. viii. 77; □,— —, 6. ix. 77, $y = 30{\cdot}2 - 0{\cdot}0078x$, $r^2 = 0{\cdot}64$; (*b*) ○, ——, 10. viii. 77, $y = 17{\cdot}8 + 0{\cdot}009x - 1{\cdot}14 \times 10^{-5}x^2$, $R^2 = 0{\cdot}76$; □,— —, 6. ix. 77, $y = 26{\cdot}6 - 0{\cdot}012x$, $r^2 = 0{\cdot}87$.

Table 10. *Effect of physiological age of seed tubers on date of onset of sprout growth, length of the longest sprout per tuber at planting, number of tubers* > 25 *mm and tuber yields* > 25 *mm in the progeny crop of Home Guard in* 1978 (*Expt* 1)

Physiological age (number of day-degrees > 4 °C)	Date of onset of sprout growth	Length of the longest sprout per tuber (mm) on 4. iii. 1978	No. of tubers > 25 mm ('000s/ha) on 13. vi	Tuber yield > 25 mm (t/ha) on 13. vi
0	14. ix	32·1	375·6	10·5
336	10. ix	34·6	395·6	10·8
672	9. ix	35·3	361·8	10·4
700	8. ix	37·8	420·1	11·7
868	5. ix	45·2	411·8	10·7
1036	8. ix	39·0	396·7	10·8
1064	3. ix	43·8	339·8	9·6
1232	5. ix	42·0	400·0	10·7
1400	6. ix	45·1	378·4	10·3
S.E.	1·47	2·4	15.24	0·38

Experiments 3 *and* 4

Seed crop yields

In Expt 3 effects of physiological age on number and yield of tubers of Home Guard were generally similar to those found in Expts 1 and 2 but there were no effects of age on final total tuber yield of Home Guard in Expt 3 (Figs 4 and 5). In Arran Comet and Pentland Javelin both total number and number of seed-size tubers decreased linearly with increasing age of seed; decreases were substantial in both varieties (Figs 4 and 6). Negatively quadratic relationships fitted the data best for total tuber yield in Arran Comet and for yield of seed-size tubers of both varieties (Figs 5 and 6). Optimum ages of 196 and 226 day-degrees > 4 °C for yield of seed-size tubers were found for Arran Comet and Pentland Javelin, respectively.

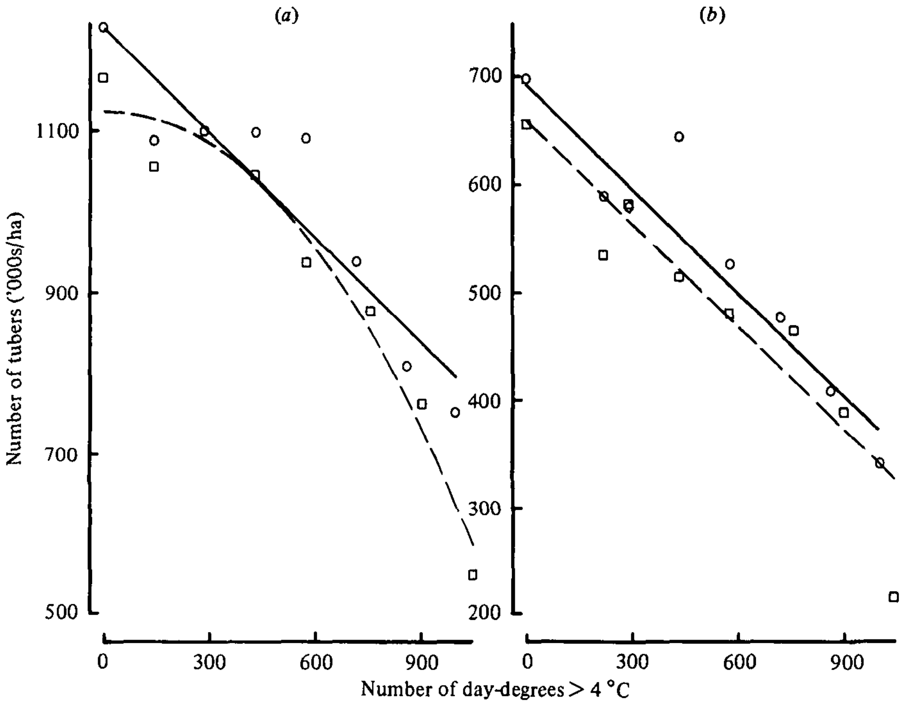

Fig. 4. Relationships between (*a*) total number of tubers and (*b*) number of tubers 32–50 mm of Home Guard and Arran Comet harvested on 14. viii. 79 and number of day-degrees > 4 °C (Expt 3). (*a*) ○, ——, Home Guard, $y = 1229{\cdot}9 - 0{\cdot}4323x$, $r^2 = 0{\cdot}86$; □, — —, Arran Comet, $y = 1122{\cdot}7 + 0{\cdot}021x - 5{\cdot}095 \times 10^{-4}x^2$, $R^2 = 0{\cdot}96$; (*b*) ○, ——, Home Guard, $y = 692{\cdot}9 - 0{\cdot}317x$, $r^2 = 0{\cdot}85$; □, — —, Arran Comet, $y = 659{\cdot}9 - 0{\cdot}341x$, $r^2 = 0{\cdot}85$.

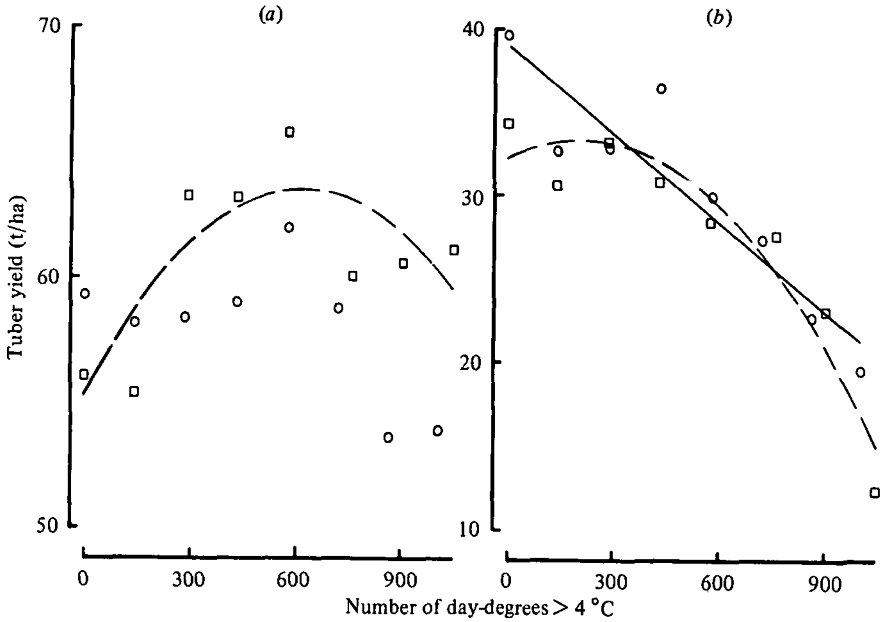

Fig. 5. Relationships between (*a*) total tuber yield and (*b*) tuber yield 32–50 mm of Home Guard and Arran Comet harvested on 14. viii. 79 and number of day-degrees > 4 °C (Expt 3). (*a*) ○, Home Guard; □, — —, Arran Comet, $y = 55{\cdot}2 + 0{\cdot}0026x - 2{\cdot}16 \times 10^{-5}x^2$, $r^2 = 0{\cdot}62$; (*b*) ○, ——, Home Guard, $y = 39{\cdot}0 - 0{\cdot}00175x$, $r^2 = 0{\cdot}82$; □, — —, Arran Comet, $y = 32{\cdot}2 + 0{\cdot}010x - 2{\cdot}55 \times 10^{-5}x^2$, $r^2 = 0{\cdot}87$.

Table 11. *Effect of physiological age of seed on date of end of dormancy of progeny seed (measured as mean date of 1 or 3 mm sprout length/tuber)*

Physiological age of seed (no. of day-degrees > 4 °C)	Date of production of 1 mm sprout	Date of production of 3 mm sprout
Home Guard (Expt 3)		
0	8. ix	27. ix
144	8. ix	28. ix
288	10. ix	28. ix
432	8. ix	28. ix
576	6. ix	26. ix
720	5. ix	25. ix
864	2. ix	25. ix
1008	2. ix	21. ix
S.E. (days)	2·3	2·5
Arran Comet (Expt 3)		
0	4. ix	28. ix
144	8. ix	3. x
288	4. ix	4. x
432	31. viii	29. ix
576	2. ix	28. ix
760	25. viii	21. ix
904	26. viii	23. ix
1048	23. viii	20. ix
S.E. (days)	2·4	2·7
Pentland Javelin (Expt 3)		
0	27. x	18. xi
112	28. x	16. xi
244	28. x	14. xi
336	29. x	20. xi
448	22. x	11. xi
560	29. x	17. xi
704	27. x	10. xi
816	23. x	13. xi
S.E. (days)	2·5	3·1
Désirée		
0	—	13. xii
80	—	8. xii
144	—	10. xii
208	—	13. xii
288	—	8. xii
368	—	14. xii
448	—	12. xii
528	—	8. xii
608	—	6. xii
688	—	12. xii
S.E. (days)	—	2·1

Sprout growth

In all four varieties, irrespective of whether dormancy was taken to have ended on the mean of the dates when longest sprout length exceeded 1 or 3 mm, there were significant effects of physiological age of parent tubers. Seed from the oldest seed tubers of the three early varieties generally ended their dormancy earliest and the ending of dormancy became progressively later with decreasing age of parent seed (Table 11). There was no consistent direction of effects of age on dormancy in Désirée. The range in the ending of dormancy was quite small in all varieties, not exceeding 15 days for any variety. Thus, in relation to the period available for sprout growth, the effects were of little significance in influencing sprout lengths at time of replanting.

Table 12. *Effect of storage temperature on length of the longest sprout per tuber (mm) at planting in five varieties (Expt 5)*

	Storage temperature (°C) 4	12
Home Guard	32·1	116·0
Red Craigs Royal	21·5	49·7
Désirée	8·4	20·8
Maris Piper	9·8	16·8
Stormont Enterprise	3·2	26·4
S.E.	3·71	

Table 13. *Effect of storage temperature and seed source on the mean date of ending of dormancy in Home Guard (Expt 6)*

Seed source	Storage temperature (°C) 4	12
Tenby (twice grown, stored at 4 °C, 1975–6)	4. ix	2. ix
Rhayader	10. xii	9. x
Scotland (FS)	14. i	13. xi

Experiment 5

This experiment may be regarded as the second seed multiplication in the lowlands which used seed of extreme physiological ages.

Storage at the higher temperature increased total and individual sprout lengths in all varieties (Table 12) and considerable sprout growth occurred at 4 °C in the two early varieties. Storage at 12 °C resulted in almost all plants of Home Guard and Red Craigs Royal and half the plants of Stormont Enterprise failing to emerge due to 'little potato disorder'. This also occurred in the adjacent seed multiplication area and insufficient seed was obtained to continue in the experiments. In Désirée and Maris Piper storage at 12 °C hastened emergence and complete plant stands were produced from both

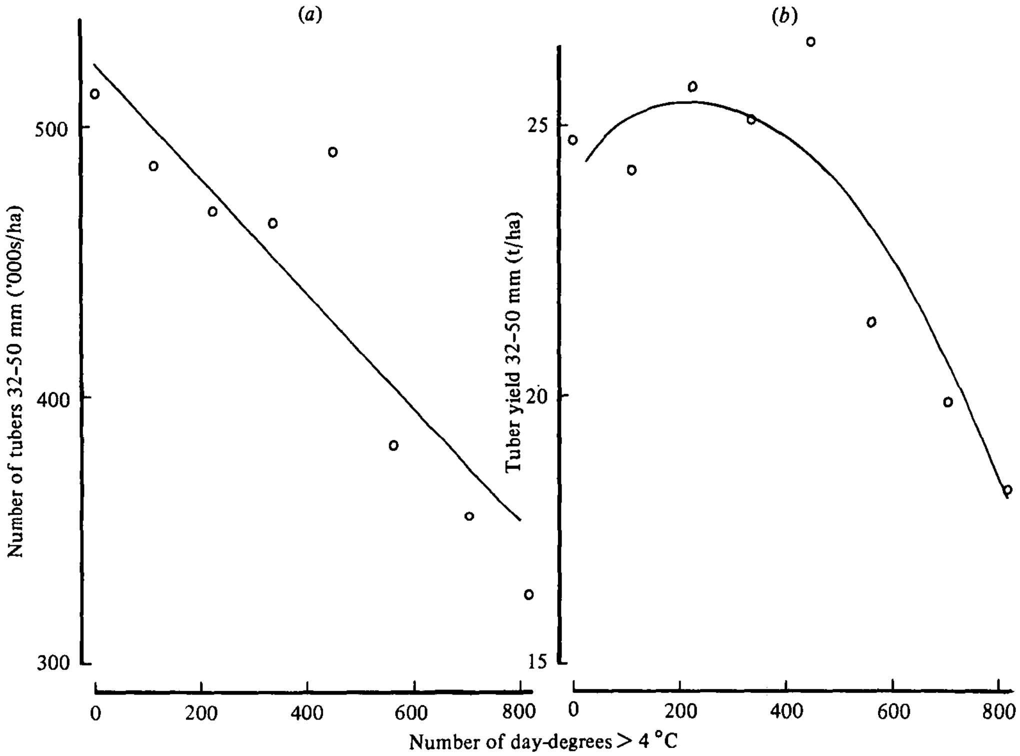

Fig. 6. The relationship between (*a*) number of tubers 32–50 mm and (*b*) tuber yield 32–50 mm of Pentland Javelin harvested on 6. vii. 79 and number of day-degrees > 4 °C (Expt 3). (*a*) $y = 523{\cdot}5 - 0{\cdot}2136x$, $r^2 = 0{\cdot}80$; (*b*) $y = 24{\cdot}4 + 0{\cdot}0096x - 2{\cdot}1 \times 10^{-5}x^2$, $R^2 = 0{\cdot}77$.

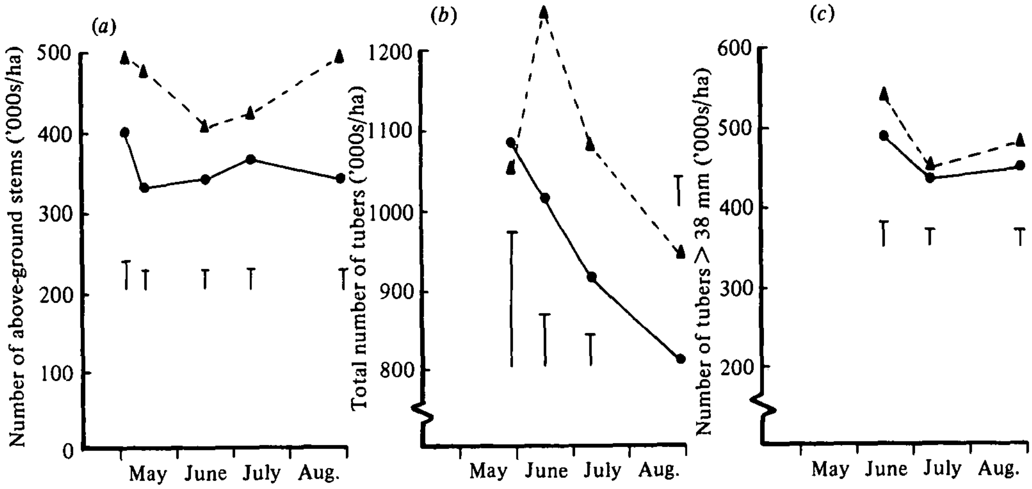

Fig. 7. Effect of storage temperature on (*a*) number of above-ground stems, (*b*) total number of tubers and (*c*) number of tubers > 38 mm in Maris Piper, Expt 5. ●——●, 4 °C; ▲ — — ▲, 12 °C. T, S.E.

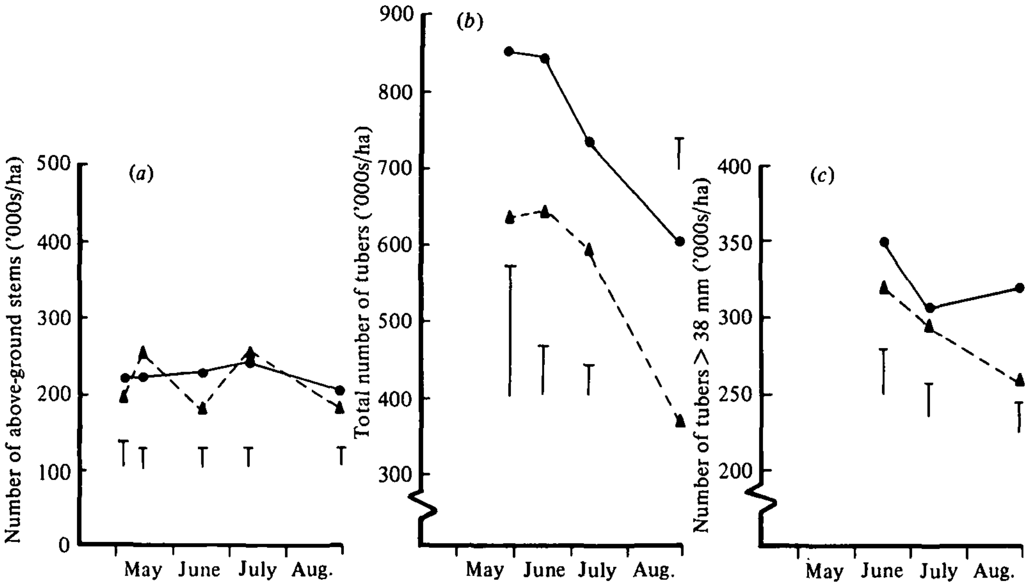

Fig. 8. Effect of storage temperature on (*a*) number of above-ground stems, (*b*) total number of tubers and (*c*) number of tubers > 38 mm in Désirée, Expt 5. ●——●, 4 °C; ▲ — — ▲, 12 °C. T, S.E.

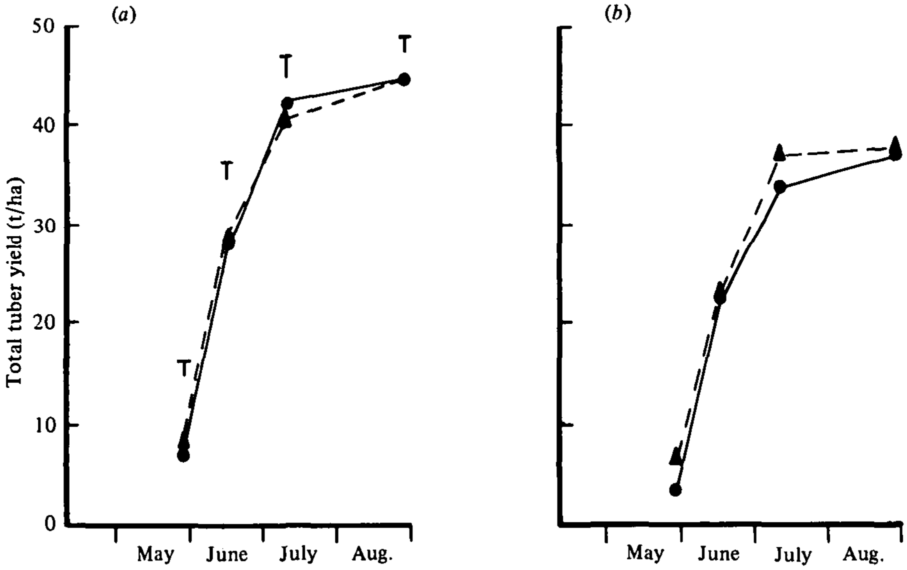

Fig. 9. Effect of storage temperature on total tuber yield in (*a*) Maris Piper and (*b*) Désirée, Expt 5. ●——●, 4 °C; ▲ — — ▲, 12 °C. T, S.E.

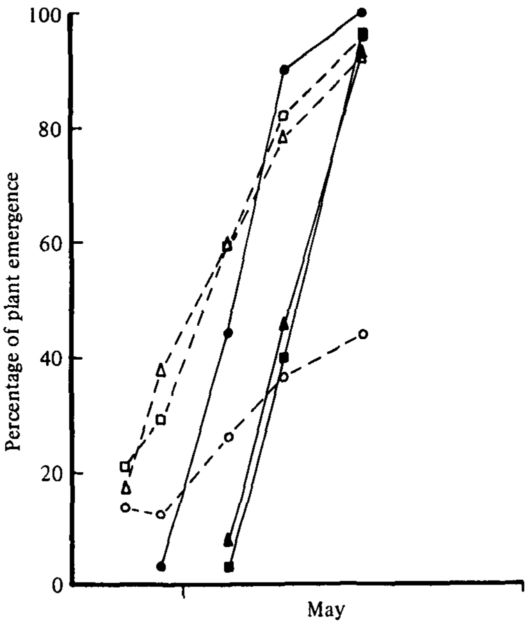

Fig. 10. Effect of storage temperature and seed source on percentage plant emergence in Home Guard, Expt. 6. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Rhayader 4 °C; ■——■, Scotland 4 °C; ○——○, Tenby (4 °C) 12 °C; △——△, Rhayader 12 °C; □——□, Scotland 12 °C.

storage temperatures. Storage at 12 °C increased number of above-ground stems and tubers in Maris Piper but had no effects on number of stems and reduced the number of tubers in Désirée (Figs 7 and 8). These effects on number of tubers were principally on the number of small tubers because numbers in the > 25 or > 38 mm grade were not affected by storage temperatures (Fig. 8). There were no effects of storage temperature on tuber yield at any harvest (Fig. 9).

Experiment 6 (*Home Guard*)

Tenby seed broke dormancy before transfer to controlled-temperature storage and Table 13 shows that in the other two seed sources dormancy ended earlier at 12 than at 4 °C. Sprout growth occurred at 4 °C in these two stocks and dormancy ended before the end of the storage period. Sprout lengths at both temperatures at the end of storage were principally determined by the ending of dormancy.

Emergence

Seed stored at 12 °C was the first to emerge, but storage temperature affected the time of complete emergence of seed only from Tenby (Fig. 10). Tenby seed stored at 12 °C was badly affected by 'little potato disorder' with over 50% of the plants failing to emerge and was the last to emerge following storage at 12 °C but the first after storage at 4 °C. The Scottish seed always emerged slightly later than the seed from Rhayader.

Although the effect was much smaller in the Scottish seed than in the seed from Rhayader and Tenby, storage at 12 °C always resulted in fewer tubers than storage at 4 °C. The effect of seed source varied with the temperature of storage. At 12 °C seed produced at Tenby had the fewest tubers and the Scottish seed the most. Following storage at 4 °C, however, there were no significant

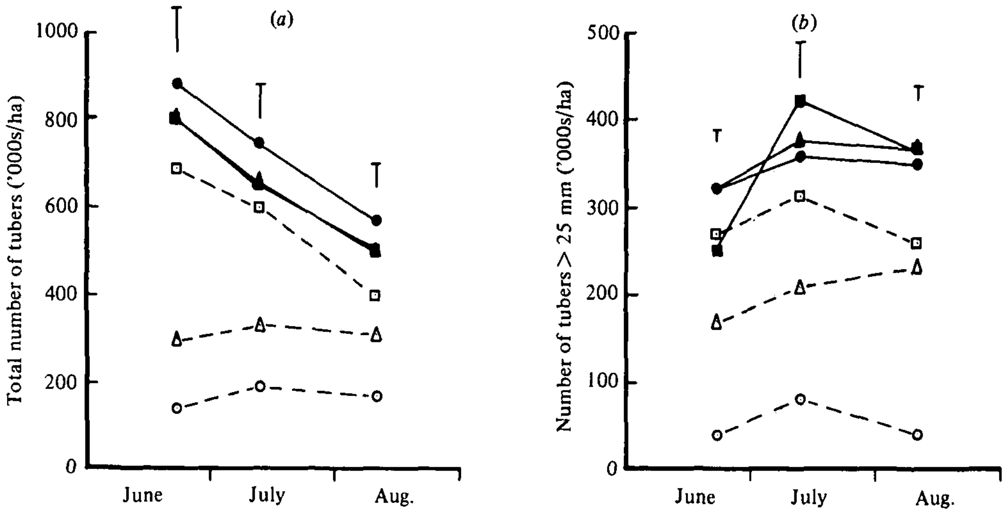

Fig. 11. Effect of storage temperature and seed source on (*a*) total number of tubers and (*b*) number of tubers > 25 mm in Home Guard, Expt 6. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Rhayader 4 °C; ■——■, Scotland 4 °C; ○——○, Tenby (4 °C) 12 °C; △——△, Rhayader 12 °C; □——□, Scotland 12 °C. T, S.E.

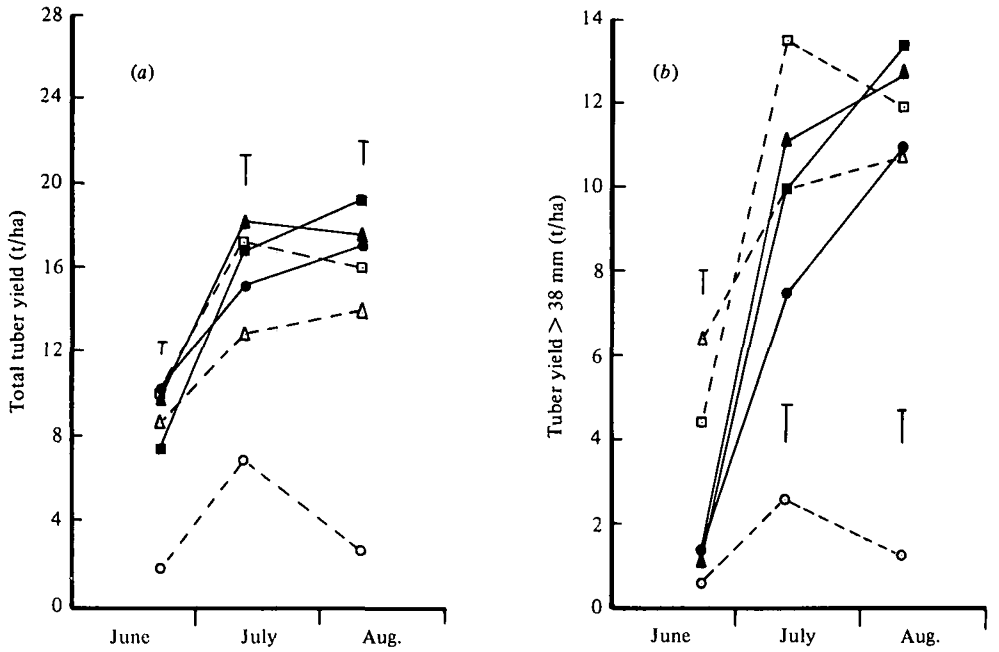

Fig. 12. Effect of storage temperature and seed source on (*a*) total tuber yield and (*b*) yield > 38 mm in Home Guard, Expt 6. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Rhayader 4 °C; ■——■, Scotland 4 °C; ○ — — ○, Tenby (4 °C) 12 °C; △ — — △, Rhayader 12 °C; □ — — □, Scotland 12 °C. T, S.E.

Table 14. *Effect of storage temperatures and seed source on mean date of ending of dormancy and proportion of plants with 'little potato disorder' (11 August) in Red Craigs Royal (Expt 7)*

	Mean date of end of dormancy		Proportion of plants with 'little potato disorder'	
Storage temperature (°C) ...	4	12	4	12
Seed source				
Tenby				
(twice-grown, stored at 4 °C, 1975–6)	12. i	8. x	0	81
Rhayader	—	29. x	0	50
Scotland (FS)	—	20. xi	0	0

differences (Fig. 11). The effect of seed source and storage temperature on the number of tubers > 25 mm were similar to the effects on total number (Fig. 11).

After storage at 12 °C Tenby seed produced the lowest yields and Scottish seed produced the highest yields throughout harvesting (Fig. 12). After storage at 4 °C, seed from Scotland produced the lowest total yields at the first harvest and there were no significant differences at the later harvests.

Experiment 7 (*Red Craigs Royal*)

Effects on ending of dormancy and sprout growth at planting were similar to those found in Home Guard (Table 14); the imported seed remained dormant at 4 °C. Higher temperature storage hastened emergence but as Table 14 shows incidence of 'little potato disorder' was severe after storage at 12 °C especially in seed from Tenby and, to a smaller extent, Rhayader. The disorder was generally absent from Scottish seed and may be attributed to this seed's later end to dormancy and younger physiological age at planting. Scottish seed generally differed from the other sources after storage at 12 °C producing more stems and tubers, larger leaf areas and higher yield (Fig. 13). After 4 °C there were no effects of seed source until the final harvest when seed from Tenby produced lower yield.

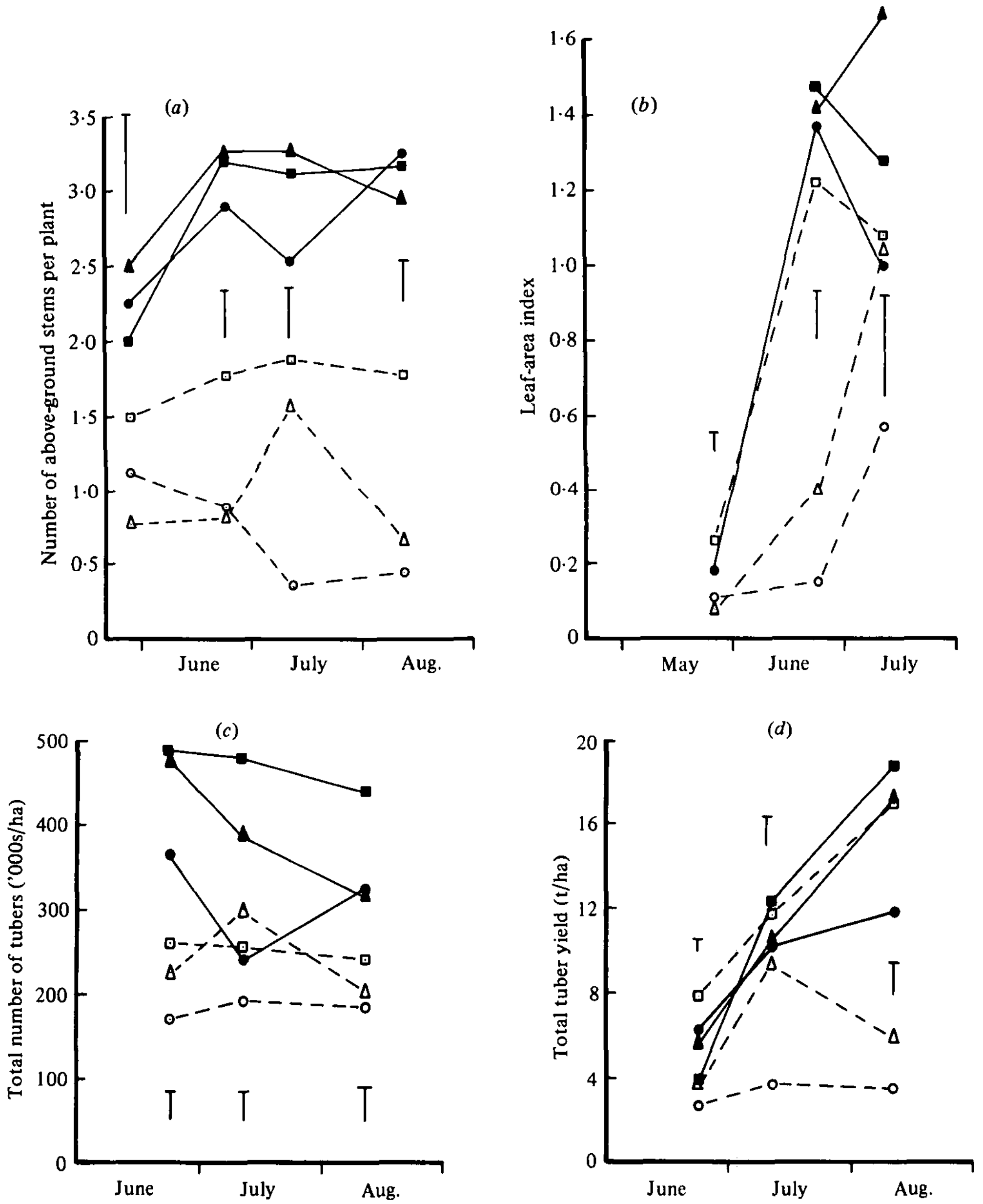

Fig. 13. Effect of storage temperature and seed source on (*a*) number of above-ground stems; (*b*) leaf area index; (*c*) total number of tubers and (*d*) total tuber yield in Red Craigs Royal, Expt 7. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Rhayader 4 °C; ■——■, Scotland 4 °C; ○ — — ○, Tenby (4 °C)12 °C; △ — — △, Rhayader 12 °C; □ — — □, Scotland 12 °C. T, S.E.

Experiment 8 (*Désirée*)

The effects on the timing of the end of dormancy were reflected in sprout length at planting. Scottish seed had shorter sprouts than other sources after storage at 12 °C but there were no significant differences between other sources (Table 15).

After 12 °C storage seed from all sources emerged simultaneously and there were no differences in the timing or the completeness of final emergence. After storage at 4 °C the two Tenby stocks emerged at the same time and all seed stocks produced a full stand albeit about 2 weeks later than after 12 °C storage (Fig. 14).

Table 15. *Effect of storage temperature and seed source on mean date of ending of dormancy and total number of tubers ('000s/ha) at final harvest in Désirée (Expt 8)*

	Mean date of end of dormancy		No. of tubers at final harvest	
Storage temperature (°C) ...	4	12	4	12
Seed source				
Tenby (twice-grown, stored at 4 °C, 1975–6)	Dormant	26. xi	617	359
Tenby (twice-grown, stored at 12 °C, 1975–6)	Dormant	22. xi	658	369
Rhayader	Dormant	13. xii	502	493
Scotland	Dormant	26. xii	528	485
S.E.	—		24·1	

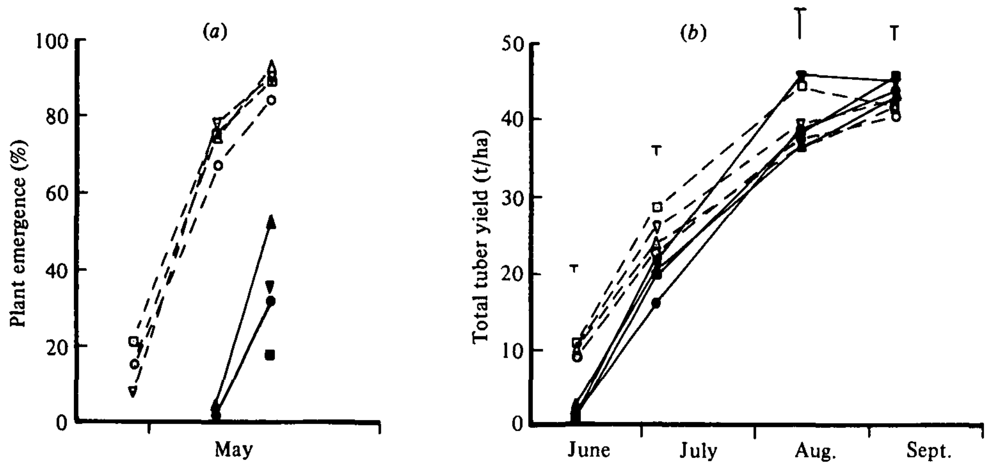

Fig. 14. Effect of storage temperature and seed source on (*a*) percentage plant emergence and (*b*) total tuber yield in Désirée, Expt 8. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Tenby (12 °C) 4 °C; ■——■, Rhayader 4 °C; ▼——▼, Scotland 4 °C; ○ — — ○, Tenby (4 °C) 12 °C; △ — — △, Tenby (12 °C) 12 °C; □ — — □, Rhayader 12 °C; ▽ — — ▽, Scotland 12 °C. T, S.E.

Storage at 12 °C produced larger leaf areas at the first harvest and lower leaf areas at the third and fourth harvests than storage at 4 °C. At both storage temperatures there were no consistent effects of seed source on leaf area index. After 12 °C storage the two seed stocks from Tenby produced fewer tubers than other stocks and significantly fewer than most stocks stored at 4 °C (Table 15).

Increasing the storage temperatures increased yields at the first two harvests (Fig. 14). At the first harvest there were no effects of seed stock at either temperature. However, at the second harvest after 4 °C storage Tenby seed from 4 °C storage in the previous year produced a lower yield than other stocks while at 12 °C both Tenby stocks were lower yielding than the other two stocks. These effects were not found at the subsequent harvests and at the final harvest there were no differences between stocks at either temperature although on average, seed stored at 4 °C now produced larger yield than seed stored at 12 °C.

Experiment 9 (*Maris Piper*)

As Table 16 shows storage of seed at 12 °C in the previous autumn (1975) advanced the end of dormancy in this variety by 12 days at 12 °C storage and 33 days at 4 °C storage. The Scottish seed broke

Table 16. *Effect of storage temperature and seed source on mean date of ending of dormancy, total sprout length per tuber (mm), length of longest sprout per tuber (mm) and percentage of plants emerged on* 9. v *in Maris Piper* (*Expt* 9)

	Mean date of end of dormancy		Sprout length per tuber		Length of longest sprout		Plants emerged on 9. v (%)	
Storage temperature (° C) ...	4	12	4	12	4	12	4	12
Seed source								
Tenby (twice-grown, stored at 4 °C, 1975–6)	29. xii	24. x	25·1	44·4	7·6	22·3	63	90
Tenby (twice-grown, stored at 12 °C, 1975–6)	26. xi	12. x	24·3	42·0	8·9	26·0	53	89
Scotland	Dormant	28. xii	4·9	30·9	2·0	16·5	1	75
S.E.	—		2·38		0·78		—	

Table 17. *Effects of storage temperature and seed source on mean date of ending of dormancy, total sprout length per tuber (mm), percentage of emerged plants on* 16. v *and percentage of plants with 'little potato disorder' in Stormont Enterprise* (*Expt* 10)

	Mean date of end of dormancy		Sprout length per tuber		Plants emerged on 16. v (%)		Percentage of plants with 'little potato disorder'	
Storage temperature (°C) ...	4	12	4	12	4	12	4	12
Seed source								
Tenby (twice grown, stored at 4 °C, 1975–6)	7. iii	10. xi	9·0	54·6	39	43	0	53
Rhayader	Dormant	25. xi	1·4	67·3	17	39	0	43
Scotland	Dormant	Dormant	0	0	67	61	0	0
S.E.	—		2·26		—		—	

dormancy much later than the Tenby seed at 12 °C storage and remained dormant at 4 °C. Previous storage history of the Tenby seed did not affect total sprout length at either storage temperature but the length of the longest sprouts was increased in seed produced from seed stored at 12 rather than 4 °C in the previous year. Seed from Tenby had significantly greater sprout growth than seed from Scotland at both temperatures. The difference in sprout growth of Tenby seed stored at 12 °C was not reflected in emergence (Table 16) and both seed stocks emerged earlier than Scottish seed at both temperatures. Full plant stands were produced by all seed stocks although Scottish seed stored at 4 °C was several days later in achieving complete plant emergence than Tenby seed.

Figure 15 shows that the differences in emergence largely determined early leaf area growth. There was no effect of seed stock on peak leaf area index but subsequent decreases were more rapid in seed from 12 °C storage. In seed from 4 °C storage the Scottish seed showed least decrease in leaf area index and in the Tenby seed increasing storage temperature in the previous year increased the rate of decrease in leaf area index.

There were no consistent effects on total number of tubers; at final harvest Scottish seed stored at 12 °C had significantly fewer tubers than all other stocks.

At the first two harvests seed stored at 12 °C outyielded seed stored at 4 °C. There were no differences between seed stocks at 12 °C storage but at 4 °C Scottish seed produced low yields especially at the first harvest. At the two later harvests differences became progressively smaller and at final harvest there were no significant effects of seed stock or storage temperature (Fig. 16).

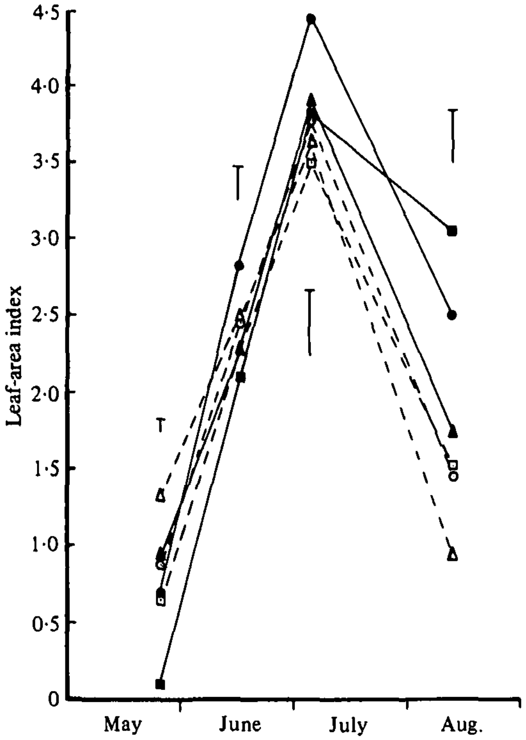

Fig. 15. Effect of storage temperature and seed source on leaf area index in Maris Piper, Expt 9. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Tenby (12 °C) 4 °C; ■——■, Scotland 4 °C; ○ – – – ○, Tenby (4 °C) 12 °C; △ – – – △, Tenby (12 °C) 12 °C; □ – – – □, Scotland 12 °C. T, S.E.

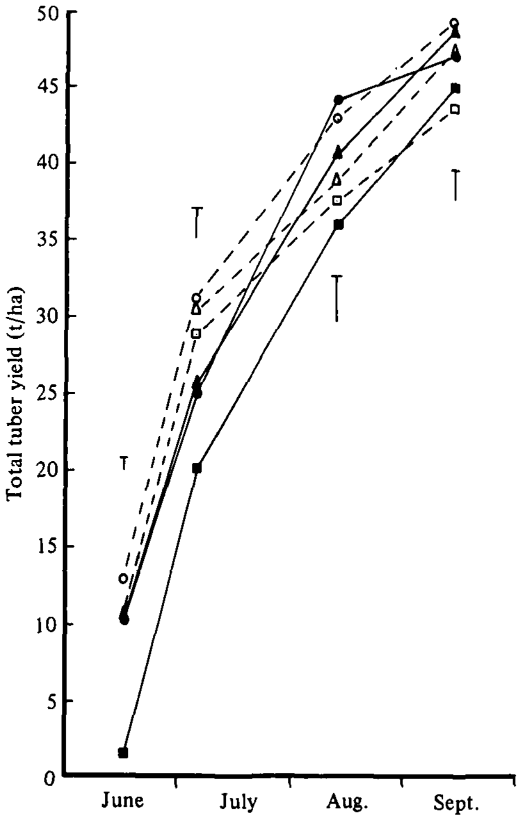

Fig. 16. Effect of storage temperature and seed source on total tuber yield in Maris Piper, Expt 9. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Tenby (12 °C) 4 °C; ■——■, Scotland 4 °C; ○ – – – ○, Tenby (4 °C) 12 °C; △ – – – △, Tenby (12 °C) 12 °C; □ – – – □, Scotland 12 °C. T, S.E.

Experiment 10 (*Stormont Enterprise*)

The Scottish seed was not delivered until mid-February and produced little measurable sprout growth at either temperature. At 12 °C storage seed from Tenby broke dormancy 15 days earlier than seed from Rhayader and this earlier onset of sprout growth resulted in greater length of the longest sprouts at planting (Table 17). The greatest amount of total sprout growth was produced by seed from Rhayader (Table 17). Table 17 also shows that seed from 12 °C emerged before seed from 4 °C storage but the seed from Tenby and Rhayader had little advantage over seed from Scotland as a large proportion of plants suffered from 'little potato disorder'. The results from the two harvests in June and July (Table 17) show that more plants were affected by the disorder from Tenby than from Rhayader seed, and Scottish seed was unaffected. There was no 'little potato disorder' after storage at 4 °C. The reduced number of plants with Welsh seed reduced their leaf area indices and there were no differences between other treatments (Fig. 17). Consequently the Welsh seed stocks produced the lowest yields at the three harvests from July onwards. There were no significant differences in yields between the other treatments, which was to be expected as there were only small differences in sprout growth and emergence and none in leaf area index (Fig. 18).

DISCUSSION

Significant effects of physiological age of seed on dormancy, sprout growth but not field growth of progeny seed were found in Expt 1 and similar effects were also found in Expts 5–10. However, the size of the effects was invariably small even after two multiplications and storage phases designed to maximise effects (Expts 6–10). The absence of effects on final yields in these experiments was particularly interesting as the weather conditions in the 3 years would have been expected to accentuate effects. In the 'seed' multiplication years of

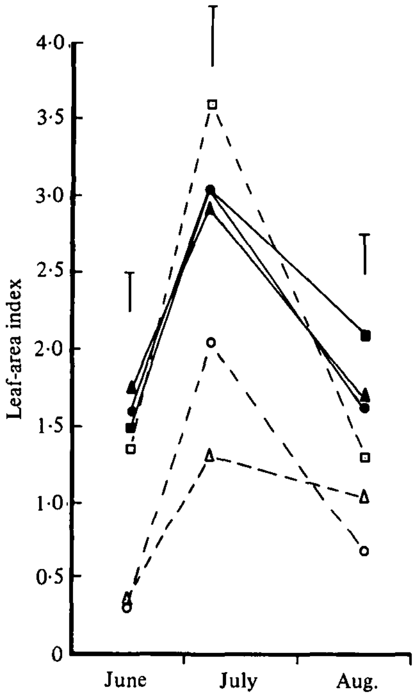

Fig. 17. Effect of storage temperature and seed source on leaf area index in Stormont Enterprise, Expt 10. ●——●, Tenby (4 °C) 4 °C; ▲——▲, Rhayader 4 °C; ■——■, Scotland 4 °C; ○ — — ○, Tenby (4 °C) 12 °C; △ — — △, Rhayader 12 °C; □ — — □; Scotland 12 °C. T, s.e.

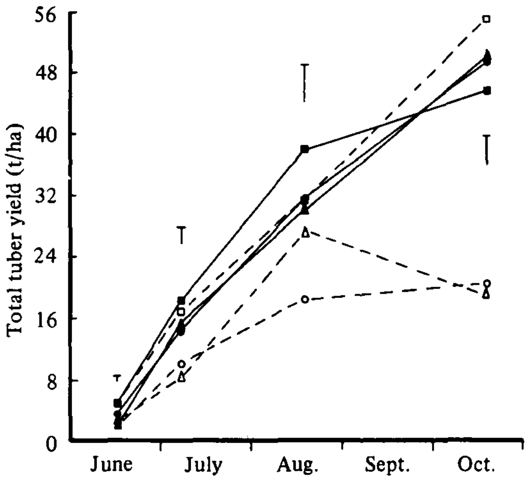

Fig. 18. Effect of storage temperature and seed source on total tuber yield in Stormont Enterprise, Expt 10. ●—●, Tenby (4 °C) 4 °C; ▲—▲; Rhayader 4 °C; ■—■, Scotland 4 °C; ○ — — ○, Tenby (4 °C) 12 °C; △ — — △, Rhayader 12 °C; □ — — □, Scotland 12 °C. T, s.e.

1975 and 1976 the weather was very warm (Table 6 in Jones & Allen, 1983) and this, together with the early harvesting and high storage temperature (12 °C) did not affect the regrowth of the seed. As such growing and storage conditions are often thought to affect the vigour of the seed (Went, 1959; Kawakami, 1952), the cold, late planting and relatively poor soil conditions of 1977 ought to have been ideal for detecting effects in the growth of the final ware crop. Few effects were found and none at final harvest when yields were low as a consequence of a relatively cold, dull summer (Table 7). Generally in 1977 yields at Trefloyne were among the lowest of the period 1973–83 (Table 18). Thus, in contrast to the findings of Went (1959) the results suggest that any carry-over effect of seed age from one generation to the next is small and of no commercial significance.

Although effects of physiological age of seed tubers on regrowth of their progeny tubers were small they were consistent. Increasing age of seed tubers generally hastened the end of dormancy and increased sprout length at replanting of the progeny tubers but the effects were not detected in emergence and field growth. This absence of effects in field growth of progeny tubers occurred despite large effects of age on the growth of 'seed' crops. All aspects of growth were affected by age achieved by manipulation of storage temperature. In Expts 1 and 2 chronological age of progeny tubers was affected as the timing of tuber initiation was altered by several weeks and this contributed to effects of age on seed yields which changed with delay in harvest. These effects of age on yield were consistent with those suggested by O'Brien *et al.*

Table 18. *Saleable tuber yield (t/ha) of unirrigated Désirée at Trefloyne*, 50000 *plants/ha*, 1973–83

Year ...	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
Size grade (mm)	> 44	> 38	> 38	> 38	> 44	> 38	> 44	> 44	> 44	> 40	> 40	—
Tuber yield	53·4	61·6	48·1	39·1	45·2	65·5	65·4	51·4	71·9	51·2	53·8	55·1

(1983) for Home Guard. There were also significant effects of storage temperature in the maincrop varieties which had no missing plants in Expts 8 and 9 and the effects of age changed with delay in harvest in a similar way to Home Guard. Increasing temperature of storage increased early yields but effects decreased with delay in harvest and were usually small or reversed (Désirée) by final harvest.

The effects of physiological age of seed tubers on the number of tubers and hence yield of seed-size tubers were important, especially for early varieties such as Home Guard, Arran Comet and Pentland Javelin. The commercial multiplication of seed would produce physiological ages at the lower end of the range found in Expts 1–3 but the inference is clearly that seed with little or no sprout growth which produces mainly mainstems is likely to set the most tubers. Similar increases in number of tubers from seed stored at 4 °C were found in some of the maincrop experiments and the use of seed with restricted sprout growth seems desirable for maximizing yields of seed-size tubers. The data of Expts 1–3 suggest that for early varieties maximum seed tuber yield is produced when fewer than 200 day-degrees > 4 °C are accumulated by the seed during storage and the maximum number of seed-size tubers is produced from seed which accumulated no day-degrees > 4 °C. Ageing of seed is often used in seed production systems in order to shorten the period of field growth of the crop, by hastening emergence and thereby minimizing the risk of disease infection. As there is increasing awareness of the value of small seed, especially for maincrops, crops can be defoliated earlier without sacrificing economic returns (Allen & O'Brien, 1986) from short-season crops.

The results support the conclusions of O'Brien & Allen (1986) who found that source of seed usually was not an important determinant of yield. Effects were generally found only where seed from different sources entered storage temperatures at different times consequent upon different dates of delivery to Wales. In these cases the effects were caused by different amounts of sprout growth (ageing) and indicate the magnitude of apparent source effects caused by ageing which may previously have been mistaken as real effects of source of seed. These results emphasize the major effect of temperature in the current storage phase on field growth and yields of the next crop. Exposure to 12 °C in several varieties produced 'little potato disorder' while seed from lower temperatures produced full plant stands and yields. These results suggest that the type of physiological deterioration of seed tubers found by Kawakami in Japan is unlikely to occur in Northern Europe even after a relatively long period of storage.

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