HAND WEEDING SWEET POTATO: TIMING IS IMPORTANT TO MAXIMISE YIELD AND MINIMISE CROP INTERFERENCE

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INTRODUCTION

It has been estimated that weed competition causes food crop losses of 25 percent in the least developed areas of the world where weed control is achieved mainly by hand weeding. For sweet potato, yield reduction due to uncontrolled weed growth varies from 100 percent in some areas to nil in others. In some cases, the effects of weeds can be reduced by using a close crop spacing. However if sweet potato vines are planted too close together, a large number of small and unmarketable tubers will be produced.

For many crops, a 'critical period' for weed competition has been determined. The critical period is the period during which weeds must be controlled in order to avoid significant loss of yield. It usually commences between a few days and 2-3 weeks after planting, and extends for several weeks, or until the crop has covered the soil surface.

Work reported by L. Kasasian and J. Seeyave in 1969 suggests that the critical period for sweet potato commences sometime during the first three weeks after planting. R. Talatala and her co-workers have suggested that the critical period for sweet potato ends at or before one month after planting.

The critical period for weed competition can be determined by combining the results of the following two types of weed competition studies:

(a)keeping the crop free from weeds for varying periods at the beginning of the crop cycle, and

(b)allowing natural weed competition to develop initially in the crop and then to commence weed control at varying stages of the growth of the crop.

The experiments reported here used this approach to study the effects of different hand-weeding programmes on sweet potato crops, for three cultivars harvested at two different times after planting. Three separate experiments were carried out.

The methods used and results obtained are described below.

EXPERIMENTAL DETAILS

The three experiments were carried out at the Department of Agriculture and Livestock Plant Quarantine and Horticultural Research station at Laloki in Central province. The soil was a clay loam on a flat alluvial site. It was cultivated mechanically, and the experiments were planted immediately after ridges had been formed. Thus no weeds had germinated at the time of planting.

Experiment A. In Experiment A three sweet potato cultivars ('L11', 'L44', and 'L431') from the Laloki collection were grown using five different hand-weeding programmes, and two different harvest dates (110 days after planting (DAP) and 148 DAP). The weeding programmes involved weeding at fortnightly intervals until the sweet potato vines covered the soil surface. However the date after planting when weeding started was varied between the weeding programmes. The five weeding programmes were as follows:

(a) start weeding at 14 DAP
(b) start weeding at 28 DAP
(c) start weeding at 42 DAP
(d) start weeding at 56 DAP
(e) no weeding.

Four plots (replicates) for each cultivar, weeding programme, and harvest date were used. Each plot contained 20 sweet potato cuttings planted singly on ridges in an area of 4.44 sq. m. The experiment was planted on 23 January 1984, during the wet season at Laloki.

Experiment B. Experiment B was similar to Experiment A except that only two sweet potato cultivars ('L11' and 'L44') were used, all plots were harvested together at 120 DAP, and there were nine weeding programmes. These programmes were as follows:

(a) start weeding at 7 DAP
(b) start weeding at 14 DAP
(c) start weeding at 21 DAP
(d) start weeding at 28 DAP
(e) start weeding at 42 DAP
(f) start weeding at 56 DAP

(g) start weeding at 84 DAP
(h) start weeding at 112 DAP
(i) no weeding.

Five plots (replicates) of each cultivar and weeding programme treatment were used. Each plot had an area of 5.0 sq. m and contained 20 sweet potato cuttings planted singly on ridges. The experiment was planted on 28 February 1986.

Experiment C. In Experiment C the same two sweet potato cultivars were used as for Experiment B ('L11' and 'L44'). There were two harvest dates (110 DAP and 135 DAP) and eight weeding programmes. In this experiment the different weeding programmes involved stopping weeding at various dates after planting. Hand weeding was carried out every two weeks up to and including the date chosen to stop weeding. The eight weeding programmes were as follows:

(a) weed until 14 DAP
(b) weed until 28 DAP
(c) weed until 42 DAP
(d) weed until 56 DAP
(e) weed until 84 DAP
(f) weed until 112 DAP
(g) weed until 136 DAP
(h) no weeding.

Five plots (replicates) were used for each treatment. Each plot contained 25 plants in an area of 6.0 sq. m. Experiment C was planted on 13 March 1986, towards the end of the wet season at Laloki.

All three experiments were planted during the wet season, and following the onset of the dry season they were irrigated with 40-50 mm of water every 7-10 days, as required.

Harvesting. At each harvest of each experiment, the number of surviving plants and the vine fresh weight were recorded for each plot. The tubers were lifted by hand and graded into marketable size (greater than 60 g) and unmarketable size (less than 60 g) categories. For each category, the tubers were counted and weighed.

RESULTS

Experiment A. A summary of the results obtained from Experiment A is given in Table 1. The main weed species competing with sweet potato early in the life of the crop were milkweed (*Euphorbia geniculata* Ort.) and to a lesser extent nut-grass (*Cyperus rotundus* L.), pigweed (*Portulaca oleracea* L.), and cobbler's pegs (*Bidens pilosa* L.). In the later stages of crop growth kunai grass (*Imperata cylindrica* (L.) P. Beauv.) was the predominant weed. Other species which were present at moderate or low density included crowsfoot grass (*Eleusine indica* L.), mollugo (*Mollugo pentaphylla* L.), sneezeweed (*Euphorbia hirta* L.), mimosa (*Mimosa invisa* Mart. ex Colla), and broomstick (*Sida rhombifolia* L.).

Plant survival (%) was low and there were no significant differences between the cultivars. However delaying the commencement of weeding, and delaying the harvest date from 110 DAP to 148 DAP both caused a reduction in plant survivial at harvest. Vine fresh weight at harvest was greatest for cultivar 'L11', intermediate for 'L44' and lowest for 'L431'. Delaying the start of weeding caused a reduction in vine weight similar to that for plant survival. Vine fresh weight increased between 110 DAP and 148 DAP, particularly for cultivars 'L44' and 'L431'.

Total yield was low for all three cultivars and typical of sweet potato yields obtained in the wet season at Laloki. Delaying the first weeding reduced total yield (see Figure 1) in proportion to the number of days that the crop was left unweeded. Between 110 DAP and 148 DAP, yield increased by 62 percent overall. However the yield increase during this period was much greater for the plots which were weeded regularly from 14 or 28 days after planting. For plots which were not weeded until 56 DAP and for unweeded plots, the yield increase between 110 DAP and 148 DAP was relatively small (Figure 1). Thus weeding during the first four weeks after planting greatly improved tuber development in the later stages of crop growth.

The weeding schedule greatly affected the percentage of total yield that was marketable (tubers in excess of 60 g). For plots where weeding was commenced at 14 DAP, an average of 71 percent of the crop was marketable. This percentage declined steadily as weeding was delayed (see Table 1). For plots which were not weeded until 56 DAP only 53 percent of the crop was marketable, and in unweeded plots an average of only 43 percent of the crop was marketable.

The average weight of marketable tubers varied between cultivars. Cultivar 'L44' produced larger tubers than the other two cultivars. Also, marketable tubers were larger at 148 DAP (mean 203 g) than at 110 DAP (mean 150 g). For marketable tuber weight, cultivar 'L44' was relatively tolerant of delayed weeding up to 56 DAP. However the 'no weeding' treatment resulted in the average marketable tuber weight being approximately halved. In contrast, cultivar 'L431' was very sensitive to delayed weeding for mean marketable tuber weight (see Figure 2). Delaying the first weeding from 14 DAP to 28 DAP resulted in a marked reduction in the average weight of marketable tubers (see Figure 2).

Figure 1. Line graphs for total yield (kg/sq. m) against weeks after planting until first weeding, for a harvest at 110 days after planting, and a harvest at 148 days after planting.

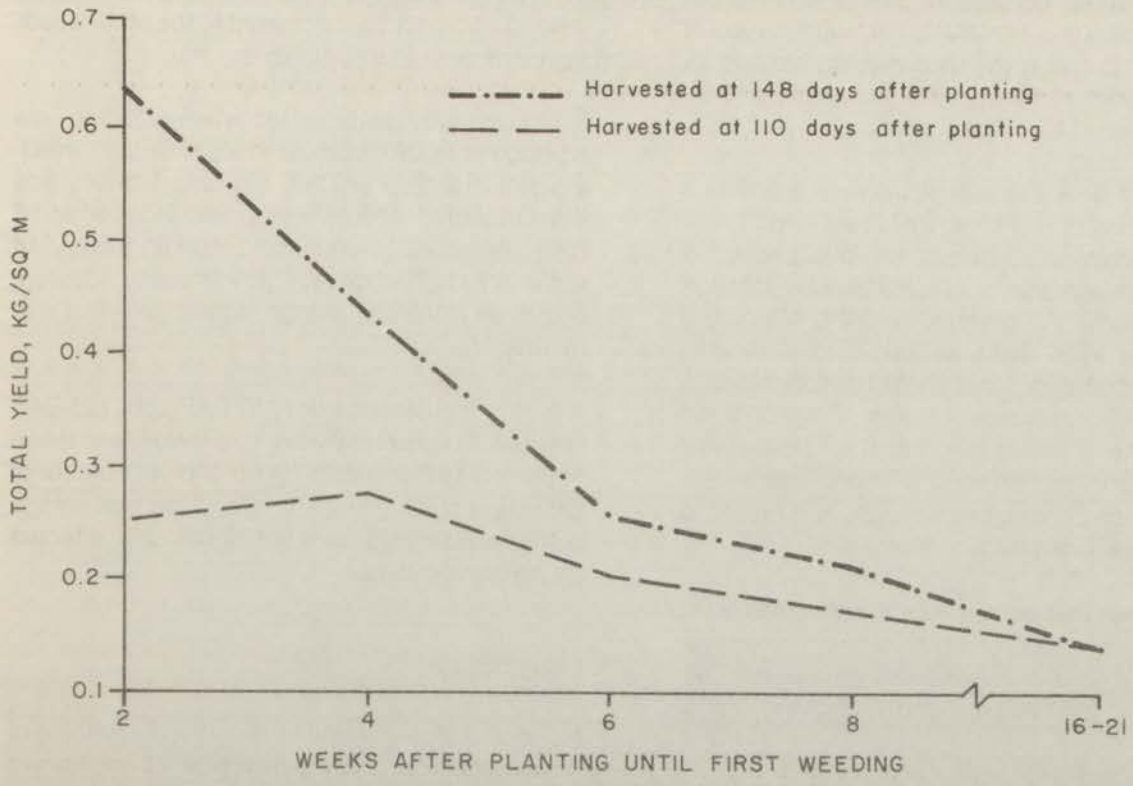
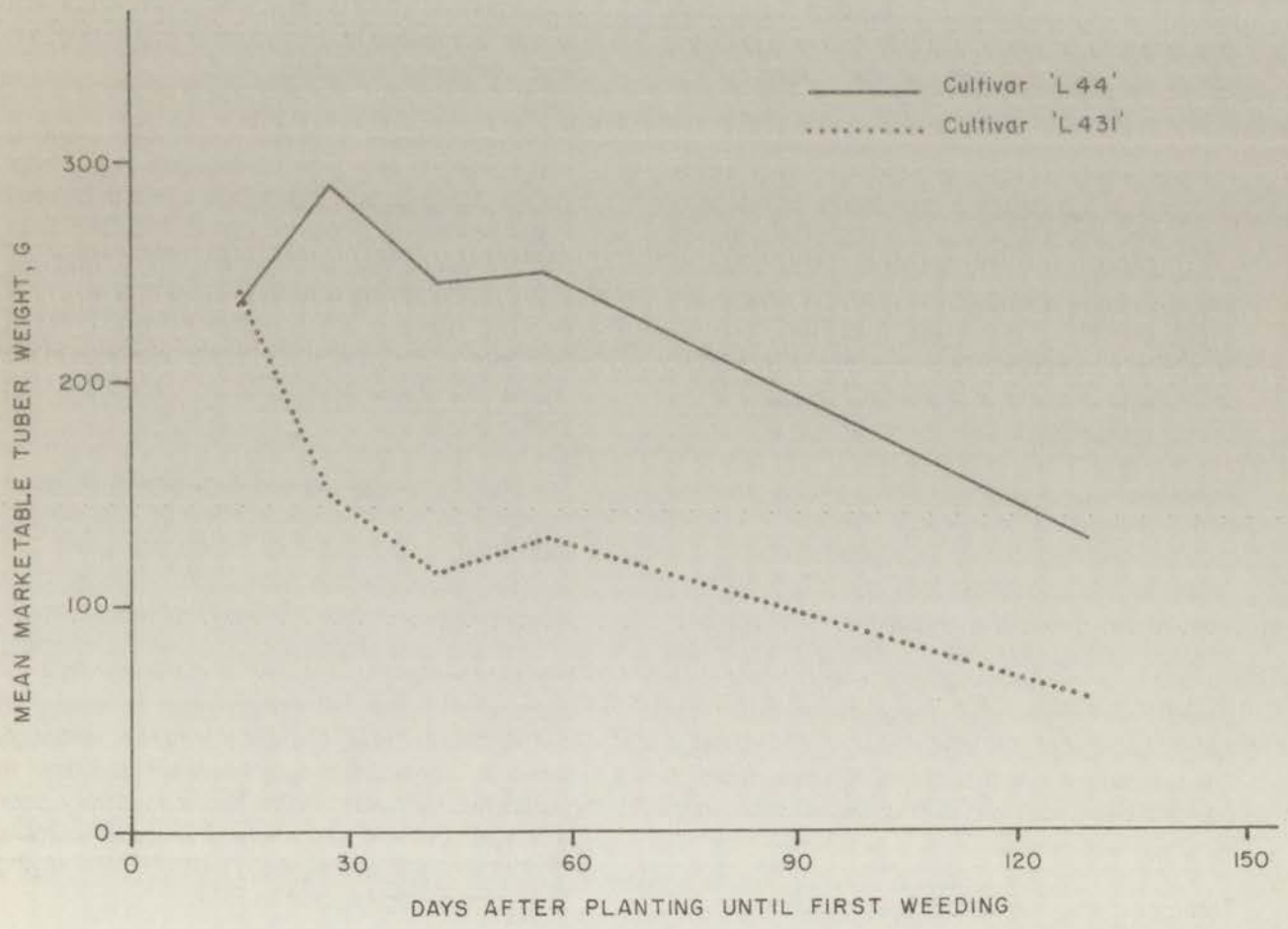


Figure 2. Graph showing the variation in mean marketable tuber weight (g) with days after planting until first weeding for two sweet potato cultivars ('L44' and 'L431') in Experiment A.



The average number of tubers per plant increased from 0.81 at 110 DAP to 1.43 at 148 DAP due largely to a very marked increase for cultivar 'L431' (from 0.71 tubers/plant at 110 DAP to 2.07 tubers/plant at 148 DAP). Delaying the first weeding beyond 28 DAP resulted in a lower number of tubers per plant being produced (see Table 1).

Experiment B. A summary of the results obtained from Experiment B is given in Table 2. Nut-grass and short kyllingia (*Cyperus brevifolius*) were the main competing weeds prior to canopy closure, although some tall grasses including kunai and itchy grass (*Rottboellia exaltata* L.f.) were also present at moderate density. After canopy closure, broomstick, crowsfoot grass, khaki weed (*Alternanthera pungens* Kunth), Spiderwort (*Commelina diffusa* Burm. f.) and some tall grasses were the main species that emerged and persisted amongst the sweet potato vines.

Plant survival was not significantly affected by the weeding treatments for either cultivar. However vine fresh weight at harvest was greater for 'L44' than for 'L11' and it was reduced by delaying the first weeding.

Total yield was generally low, but slightly higher for 'L44' than for 'L11'. Delaying the first weeding had a marked effect on yield. In particular it should be noted that when weeding was started at 7 days after planting a higher yield was obtained than when weeding was delayed until 14 DAP. The number of tubers per plant followed the same trend for the weeding treatments.

The percentage of total yield that was marketable, and the average weight of marketable tubers, were higher for cultivar 'L44' than for 'L11'. Delaying the first weeding until 112 DAP had very little effect on the percentage of marketable yield, but it did cause a reduction in the mean weight of marketable tubers. The 'no weeding' treatment resulted in a lower percentage of marketable yield (67 percent) and a lower average marketable tuber weight (203 g).

Experiment C. A summary of the results obtained from Experiment C are given in Table 3. The weed species which occurred in Experiment C were similar to those recorded for Experiment B. Plant survival was considerably higher for cultivar 'L11' than for 'L44', but it was not greatly affected by the harvest date. Weeding resulted in increased plant survival (77-81 percent survivial) and vine fresh weight at harvest (1.0-1.8 kg/sq. m) compared to the 'no weeding' (weed until 0 DAP) treatment (70 percent plant survival; 0.7 kg/sq. m vine fresh weight).

Total yield was similar for both cultivars tested, although 'L11' had a higher number of tubers per plant, and 'L44' had larger marketable tubers (Table 3). The 'no weeding' treatment resulted in a low yield (0.34 kg/sq. m) compared to the other weeding treatments (0.51-0.68 kg/sq. m).

A higher yield was recorded when weeding was stopped at 14 DAP compared to continuing weeding until 28 DAP or 42 DAP. Similarly, higher yields were recorded when weeding was stopped at 56 DAP compared to continuing weeding every 14 days until 112 DAP or 140 DAP. These trends were also seen in the percentage of total yield that was marketable.

Delaying the harvest from 110 DAP until 135 DAP resulted in higher total yield, vine weight and mean marketable tuber weight (g) but a lower number of tubers per plant. Plant survial and the percentage of marketable yield were not significantly effected by the harvest date.

DISCUSSION

Moderate to low yields were recorded for all three of the experiments. They were typical of wet season yields obtained at Laloki.

In Experiment a, cultivar 'L431' had a low vine weight at harvest and a low plant survival rate. This suggests that 'L431' is not a strong competitor with weeds, compared to the two other cultivars ('L11' and 'L44') used in this trial.

Weed competition in the first month after planting had a marked effect on tuberisation in the later stages of crop growth. From Figure 1 it can be seen that if harvesting is carried out at 110 DAP then weeding during the first four weeks of the crop gives only a moderate increase in yield compared to not weeding. However, if harvesting is delayed until 148 DAP then it is very improtant to control weeds in the first month after planting in order to ensure a high yield.

For both Experiment A and Experiment B, weed competition had the greatest effect on vine weight, total yield, and number of tubers per plant. In general, tuber number was more effected than tuber weight by weeds. It is likely that weed competition in the early stages of crop growth is effecting the photosynthetic capacity of the crop. The response by the sweet potato plant is mainly to reduce the number of tubers initiated, although there are some differences between cultivars. In particular, for 'L431' which had a relatively poor ability to compete with weeds, both tuber number and tuber weight were greatly reduced by delaying the first weeding beyond 14 DAP.

In both experiment A and Experiment B there was a trend of higher tuber number per plant when weeding was commenced at 56 DAP than when weeding was commenced at 42 DAP. It is possible that hand weeding in the first part of the second month of crop growth disturbs some sweet potato roots at the time when tuber initiation is occurring, and this may adversely effect the number of tubers per plant produced.

The results of the first two experiments (A and B) show that the critical period for weed competition begins before 14 days after planting. Data from Experiment B suggest that the critical period may start as early as 7 days after planting. It is unlikely to be earlier than this for land that has been cultivated or clean weeded immediately before planting since weed seeds take several days to germinate and emerge.

The results of Experiment C suggest that weeding beyond 56 days after planting does not result in any increase in yield. The sweet potato canopy has covered the soil by 56 DAP and the few weeds that develop in the crop after this time do not cause any loss of yield. Indeed the data obtained suggest that regular weeding after 56 DAP may cause a small reduction in yield. This may be due to disturbance of the sweet potato vines and canopy by workers moving through the crop to remove weeds.

CONCLUSIONS

1. The critical period of weed competition for sweet potato in the lowlands is from 7 days after planting until approximately 56 days after planting.

2. Sweet potato roots are sensitive to disturbance by hand weeding during the second month (approximately 30-50 days) after planting in the lowlands. Thus hand weeding during this period should be avoided if possible.

3. Regular weeding after canopy closure by sweet potato vines can cause damage to the crop foliage and a small reduction in yield.

4. Weed control during the first month of crop growth is especially important to obtain high yields at a late harvest (approximately 5 months after planting).

5. Weed control should be carried out during the critical period of weed competition, but crop disturbance should be minimised (a) during the period of tuber initiation, and (b) after canopy closure.

A generalised suitable hand weeding schedule for sweet potato in the tropical lowlands is as follows:

(1) First weeding at 7 days after planting;
(2) Second weeding at 18 days after planting;
(3) Third weeding at 30 days after planting;
(4) Fourth weeding at 56 days after planting.
(5) Fifth weeding (carefully to minimise vine damage) at 110 days after planting.

This schedule may require modifications for a particular locality depending on the sweet potato cultivars planted, the main weed species, and the environmental conditions.

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FURTHER READING

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Table 1. Mean values for plant survival (%), vine fresh weight at harvest (kg/sq. m), percentage of total yield that was marketable[1], number of tubers per plant, and marketable tuber weight (g), for three sweet potato cultivars, five weeding schedules and two harvest dates in Experiment A.

	Plant survival (%)	Vine weight kg/m²	Total yield kg/m²	Percentage of total yield that was marketable[1]	No. of tubers per plant	Mean wt. of marketable[1] size tubers, g
Cultivar						
L11	48	4.8	0.26	56	1.08	164
L44	48	3.6	0.30	69	0.90	228
L431	41	2.8	0.26	50	1.39	138
Weeding schedule						
Commenced weeding at						
14 DAP[2]	53	4.5	0.44	71	1.39	211
28 DAP	49	3.9	0.36	64	1.42	201
42 DAP	46	3.9	0.23	60	0.91	201
56 DAP	43	3.2	0.19	53	1.01	155
No weeding	37	3.2	0.14	43	0.88	166
Harvest						
110 DAP	53	3.2	0.21	54	0.81	150
148 DAP	39	4.3	0.34	63	1.43	203

1 marketable tubers are defined as tubers in excess of 60 g.
2 days after planting.

Table 2. Mean values for plant survival (%), vine fresh weight at harvest (kg/sq. m), total yield (kg/sq. m), percentage of total yield that was marketable[1], number of tubers per plant and marketable tuber weight (g), for two sweet potato cultivars and nine weeding schedules in Experiment B.

	Plant survival (%)	Vine weight kg/sq. m	Total yield kg/sq. m	Percentage of total yield that was marketable[1]	No. of tubers per plant	Mean wt. of marketable[1] size tubers, g
Cultivar						
L11	78	1.56	0.85	73	2.01	232
L44	78	2.09	0.99	81	1.43	311
Weeding schedule commenced weeding at						
7 DAP[2]	80	2.34	1.31	83	2.20	286
14 DAP	73	2.05	1.11	75	2.09	291
21 DAP	80	1.98	1.01	74	2.03	287
28 DAP	78	1.91	1.04	81	1.54	303
42 DAP	81	1.75	0.88	75	1.66	270
56 DAP	74	1.71	1.02	83	1.82	295
84 DAP	79	1.59	0.74	75	1.43	252
112 DAP	81	1.78	0.65	80	1.40	258
No weeding	74	1.32	0.48	67	1.32	203

1 marketable tubers are defined as tubers in excess of 60 g.
2 days after planting.

Table 3. Mean values for plant survival (%), vine fresh weight at harvest (kg/sq. m), total yield (kg/sq. m), percentage of total yield that was marketable[1] number of tubers per plant, and mean marketable tuber weight (g) for two sweet potato cultivars, eight weeding schedules, and two harvest dates, in Experiment C.

	Plant survival (%)	Vine weight kg/sq. m	Total yield kg/sq. m	Percentage of total yield that was marketable[1]	No. of tubers per plant	Mean wt. of marketable[1] size tubers, g
Cultivar						
L11	82	1.37	0.57	72	1.54	171
L44	73	1.48	0.56	78	1.21	231
Weeding schedule weeded until						
0 DAP[2]	72	0.71	0.34	54	1.09	162
14 DAP	77	1.63	0.59	79	1.50	208
28 DAP	81	1.80	0.51	74	1.26	222
42 DAP	80	1.03	0.51	77	1.26	204
56 DAP	77	1.82	0.68	81	1.54	222
84 DAP	80	1.46	0.65	80	1.50	209
112 DAP	78	1.50	0.59	79	1.44	208
140 DAP	78	1.46	0.65	76	1.51	207
Harvest						
110 DAP	77	1.26	0.45	74	1.46	165
135 DAP	79	1.59	0.68	76	1.31	245

1 marketable tubers are defined as tubers in excess of 60 g.
2 days after planting.