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Effect of plant spacing on the yield of sweet potato cultivars at three times of planting

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Summary

During 1980-81 six sweet potato cultivars were assessed at three planting dates (September, November and January) at three plant spacings (40 cm, 26.6 cm and 20 cm) and at two harvest times (15 and 20 weeks after planting).

Spacing at 26.6 cm gave a significantly greater saleable yield than spacing at 40 cm. Spacing at 20 cm was significantly better than spacing at 26.6 cm only for yields from cultivar LO-323.

Closer spacing significantly reduced the production of oversized storage roots in the White Maltese cultivar. This effect was not found in LO-323.

INTRODUCTION

Between 1977 and 1979 a number of sweet potato (*Ipomoea batatas*) cultivars introduced from USA were field tested in southern Queensland. Several high yielding lines produced many oversize storage roots when harvested at 20 weeks, especially from spring and early summer plantings. A plant spacing of 40 cm within rows on hills 82 cm apart was being used.

Results of research in the USA indicated that plant spacings around 20 cm gave the highest yields for 20 week harvests, but spacings around 30 cm were likely to give greatest economic gain (Edmond 1952). For earlier harvesting 30 cm was considered optimum. Any greater spacing did not increase earliness of storage root development and reduced yield (Anderson 1940). Close spacing reduced the number of storage roots that grew too large, with some varieties requiring closer spacing than others (Anderson, Cochran and Edmond 1945).

In Queensland preliminary studies with cv. Centennial showed that 20 and 40 cm spacings gave best yields. At 20 cm, the percentage of small and medium grade storage roots was significantly greater and percentage of larger sizes was significantly less than at 40 cm spacing.

The aim of this experiment was to test a group of cultivars across a range of in-row plant spacings and planting seasons, to determine the effect on distribution of grades and yield for each cultivar.

MATERIALS AND METHODS

The experiment was conducted on acid mottled duplex soil Dy 5.21 (Northcote 1971) at Beerwah Field Station 27°S, 153°E, altitude 34 m. The situation is representative of the sweet potato producing areas of southern Queensland.

Three trials were planted at intervals of two months in September and November 1980 and January 1981. Six sweet potato cultivars were grown. Rows were 82 cm apart and plant spacings within the rows were 40, 26.6 and 20 cm.

The experimental design was a split plot randomised block with three replicates in each trials. The cultivar×spacing treatments were fully randomised and times of harvest as sub plots randomly located within the main plots.

The plot size was four rows, 2.4 m long. Yields were determined from samples of four plants dug from each of the two middle rows from the 40 cm plots, six plants from the 26.6 cm plots and eight plants from the 20 cm plots.

Planting and general management of the experimental area followed recommended local practice.Growing conditions were good and no significant insect damage or disease losses were observed.

Storage root yields were determined 15 and 20 weeks after the September and November plantings and 16 and 21 weeks after planting in January. All results presented refer to the second time of harvest only. First harvests were considered to be too immature for grade composition to be valid.

Following harvest the storage roots were graded to the following standards:

Small	80—150 g
Medium	150—450 g
Large	450—850 g
Oversize	>850 g

Planting and harvest dates, precipitation (rainfall and irrigation) and mean air and soil temperature from plantings to final harvests are set out in Table 1.

Table 1. Planting and harvest dates and growing conditions

Trial	Planting date	Harvest date	Precipitation irrigation and rain	Mean Max/Min	Soil temperature 200 mm
1	10 Sep 1980	28 Jan 1981	487 mm	22.1°C	24.1°C
2	12 Nov 1980	1 Apr 1981	582 mm	23.6°C	25.3°C
3	14 Jan 1981	10 Jun 1981	712 mm	22.3°C	22.4°C

RESULTS AND DISCUSSION

Yields of small grade and medium grade storage roots and total saleable yield, all increased significantly with each reduction in spacing. Spacing had no significant effects on yield of large and oversize storage roots (Table 2).

Table 2. Effect of plant spacing on yield

Spacing in row	Components of yield (t/ha)				
	Small	Medium	Large	Saleable	Oversize
40.0 cm	4.8	19.6	10.9	35.3	2.4
26.6 cm	6.4	22.8	10.4	39.7	2.5
20.0 cm	7.4	25.1	10.3	42.8	1.4
l.s.d. 5%	0.61	1.88	n.s.	2.59	n.s.
l.s.d. 1%	0.92	2.49		3.43	

Saleable yield did not vary significantly across the three seasons of planting. The September planting produced significantly more large and oversized storage roots ($P<0.01$) than the later plantings which produced more small and medium grade ($P<0.01$) than the September planting (Table 3).

Table 3. Effect of season on planting on yield

Season of planting	Components of yield (t/ha)				
	Small	Medium	Large	Saleable	Unsaleable
Sep 1980	4.3	20.3	14.1	38.8	4.3
Nov 1980	7.3	24.1	9.2	40.7	1.5
Jan 1981	6.9	23.1	8.3	38.3	0.5
l.s.d. 1%	0.92	2.49	2.17	n.s.	1.27

Responses by individual cultivars to in-row spacings is set out in Table 4. All cultivars except White Maltese produced significantly more small grade storage roots at reduced spacings. Significant increases in medium grade production occurred for Centennial, White Maltese and Jewel between 40 cm and 26.6 cm spacings ($P<0.05$) and for LO-323 between 26.6 cm and 20 cm spacings ($P<0.01$).

White Maltese produced significantly less oversized storage roots at 20 cm compared to 26.6 and 40 cm ($P<0.01$). However, it also produced significantly more large grade at 26.6 cm compared to 40 cm ($P<0.05$). LO-323 performed erratically producing significantly more oversize storage roots at 26.6 cm compared to 40 or 20 cm. Its production of large storage roots increased marginally at the closest in-row spacing only. All other cultivars showed reductions in large and oversize grades (n.s.).

Saleable yield increased significantly for White Maltese from 40 cm to 26.6 cm spacing ($P<0.01$) and for LO-323 from 26.6 cm to 20 cm spacing ($P<0.01$). The remaining cultivars showed a trend to increase saleable yield mainly between 40 cm and 26.6 cm spacings.

Response by cultivars to season of planting is shown in Table 5. All cultivars except White Maltese produced significantly more small grade storage roots from the November planting than the September planting ($P<0.01$) with no major differences between November and January plantings. Conversely production of large grade storage roots of most cultivars fell significantly between September and November planting and was further reduced from the January planting.

Medium grade yield was generally greatest from the November planting being significantly greater than September planting for Centennial and LO-323 ($P<0.01$). White Maltese was the exception with significantly lower medium grade yield from the November planting compared to those from September and January plantings.

Only two cultivars produced large amounts of oversize sweet potatoes. White Maltese produced 6 t/ha from September and November plantings and a negligible amount from January planting. LO-323 produced 15 t/ha from September planting and only 2.8 t/ha and 1.6 t/ha respectively from the November and January plantings.

This again is a reflection of normal seasonal behaviour by these cultivars the problem of oversize storage root production being largely confined to spring and early summer plantings.

Table 4. Effect of cultivars and in row spacing across three planting seasons

Cultivar	In row spacing	Components of yield (t/ha)				
		Small	Medium	Large	Saleable	Oversize
Centennial	40.0	5.7	16.6	7.6	30.0	0.5
	26.6	6.0	23.7	6.0	35.8	—
	20.0	9.1	21.1	4.3	34.5	—
White Maltese	40.0	2.0	12.7	11.8	26.7	6.7
	26.6	3.4	17.1	16.0	36.6	4.8
	20.0	3.2	20.7	16.9	40.8	1.9
LO-323	40.0	2.0	12.7	11.8	26.7	6.7
	26.6	6.7	24.5	21.0	52.3	9.4
	20.0	6.4	35.6	23.6	65.7	6.0
NC-3	40.0	4.9	20.1	9.4	34.5	0.9
	26.6	6.5	22.3	6.3	35.3	0.4
	20.0	7.9	24.6	6.3	38.8	—
Beerwah Gold	40.0	6.5	22.2	6.5	35.4	1.0
	26.6	7.3	23.1	8.6	39.1	—
	20.0	8.0	25.7	5.7	39.4	0.1
Jewel	40.0	5.1	20.7	8.4	34.4	1.2
	26.6	8.3	26.4	4.5	39.2	0.4
	20.0	9.2	23.0	5.2	37.5	0.7
l.s.d. 5%		1.71	4.62	4.03	6.35	2.35
l.s.d. 1%		2.26	6.11	5.33	8.40	3.11

The effect of cultivars, plant spacing and planting season on yield composition is shown in Figure 1. From the September planting LO-323 produced significantly more large and oversize grades at 26.6 and 20 cm spacings than at 40 cm but yields of medium grade storage roots were similar at all spacings. From the November and January plantings at 20 cm spacing, LO-323 produced significantly more desirable medium grade storage roots than at either of the wider spacings with no increase in large or oversize grades.

From the September plantings, White Maltese produced significantly more medium grade at 26.6 and 20 cm spacings than at 40 cm spacing without any increase in large grade yield. From the November planting, large grade yield did increase significantly at both close spacings, however, and from the January planting there was no significant increase in any component of yield at close spacings. The other four cultivars showed a general tendency to increase yields of small and medium grades at decreasing in-row spacing which were neither consistent nor significant.

The results of Anderson *et al.* (1945) were largely substantiated by this work. Close spacing reduced the incidence of oversize sweet potatoes, with the exception of LO-323. This finding supports Anderson *et al.* conclusion that response varied with the genetic tendency of cultivars to produce overlarge storage roots.

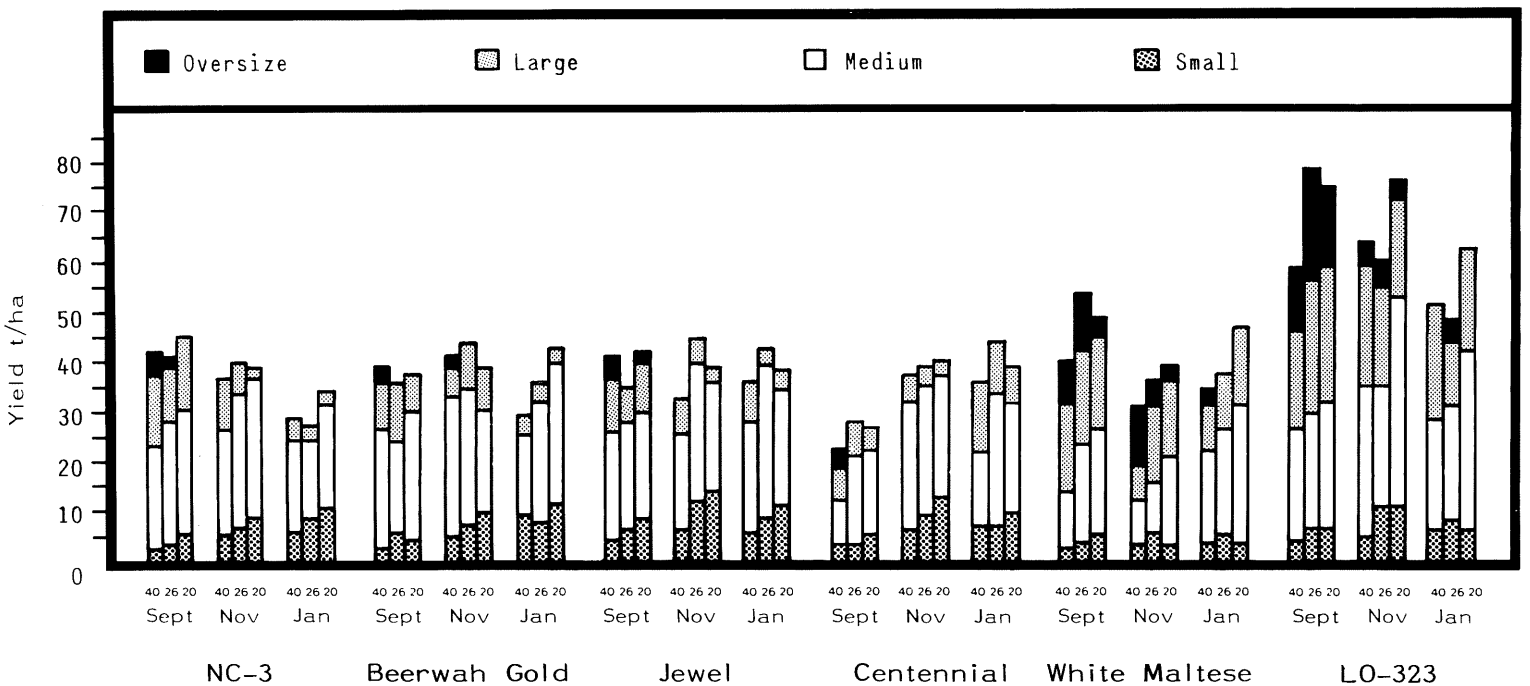

Figure 1. Yield (t/ha) for cultivars at 20 weeks for 3 plant spacings

Table 5. Effect of cultivars and season of planting

Cultivar	Planting	Components of yield (t/ha)				
		Small	Medium	Large	Saleable	Oversize
Centennial	Sep	3.2	14.7	5.8	23.8	0.5
	Nov	9.7	24.9	3.3	38.0	0.0
	Jan	7.9	21.8	8.8	38.6	0.0
White Maltese	Sep	3.0	17.0	19.5	39.5	6.9
	Nov	2.7	12.5	12.8	28.2	6.1
	Jan	3.0	21.0	12.3	36.4	0.4
LO-323	Sep	4.8	23.8	25.7	54.3	15.2
	Nov	7.0	34.2	21.8	63.2	2.8
	Jan	5.8	27.1	18.7	51.7	1.6
NC-3	Sep	4.2	22.7	14.0	41.1	1.2
	Nov	7.0	24.7	5.6	37.5	0.0
	Jan	8.0	19.6	2.3	30.0	0.2
Beerwah Gold	Sep	4.5	22.5	10.2	37.3	0.3
	Nov	8.1	25.0	7.4	40.5	0.5
	Jan	9.2	23.5	3.2	36.0	0.2
Jewel	Sep	5.8	21.3	9.6	36.8	1.7
	Nov	9.5	23.2	4.1	36.9	0.0
	Jan	7.2	35.6	4.4	37.4	0.7
l.s.d. 5%		1.71	4.62	4.03	6.35	1.80
l.s.d. 1%		2.26	6.11	5.33	8.40	2.38

The seasonal pattern exhibited by all cultivars (increasing small material and decreasing large material as the season progressed) indicates the time from planting to harvest could be increased progressively for later crops with cultivars other than LO-323.

There is a clear yield response to close spacing for LO-323 and White Maltese. Production of overlarge material was effectively reduced by close spacing of White Maltese but not of LO-323 particularly from the September planting. The proportion of desirable medium grade storage roots was, however, greatly increased for LO-323 by the close spacing of 20 cm from November and January plantings.

For the remaining four cultivars responses were either erratic or of insignificant magnitude. A combination of increased fertilizer and later harvesting could give increased yields of saleable storage roots from those cultivars, which have little tendency to produce oversize storage roots, if planted at closer in-row spacings.

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