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Evaluation of sweet potatoes at several times of planting

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Summary

From 1980 and 1982 a high yielding sweet potato cultivar LO-323 was assessed across seasons of planting to determine production of vines, storage roots and starch. The influence of precipitation and soil temperature was monitored. Leaf and vine dry matter yields were highest from November planting at 10.25 t/ha and least from March planting at 2.68 t/ha. Highest storage root dry matter yield occurred from May planting at 15.16 t/ha and least from March planting at 7.89 t/ha.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L) Lam.) breeder lines introduced from USA into Queensland were field tested from 1978 to 1980 and some proved extremely high yielding. One in particular, LO-323, attained an average fresh yield of marketable storage roots from four separate trials of 50.6 t/ha (Harper 1982). These results were obtained on infertile loamy sands with the addition of only 40 kg/ha of nitrogen and 60 kg/ha of potassium indicating that sweet potatoes could be grown with relatively low inputs in this area.

Development of a reliable fresh tuber market depends on a continuity of supply. Similarly production of starch for possible ethanol production would rely on year round supply of raw material. Information was required on the variability and pattern of storage root, starch and top growth production as influenced by soil temperature and other climatic variables.

The present study was undertaken to evaluate the storage root yield and starch production potential of the cultivar LO-323 at five times of harvest at each of four planting times between November and May. It was anticipated that these planting times would provide harvests throughout a calendar year.

MATERIALS AND METHODS

The experiment was laid out on an area of acid mottled duplex soil Dy 5.21 (Northcote 1974) at Beerwah Field Station 27°S, 153°E, Altitude 34 m. The situation is representative of the sweet potato producing areas of coastal southern Queensland. The experiment comprised four times of planting replicated three times as main plots with five times of harvest as independently randomised subplots.

Times of planting were at nine week intervals occurring in November, January, March and May. Soil temperature at 200 mm was recorded daily in the experiment site. Weekly mean soil temperatures to a base of 10°C were used to accumulate progressive heat sums for each planting. Harvesting from plantings in November and January commenced at 10 weeks with subsequent harvests at 5 week intervals. Harvesting from March and May plantings commenced when their heat sum totals equalled the mean achieved by the November and January plantings at ten weeks. This placed the March plantings first harvest at 12 weeks and the May plantings first harvest at 23 weeks. Subsequent harvests were at 5 week intervals.

The breeding line LO-323 was selected for the experiment because it is the highest yielding cultivar currently available. Plots comprised 4 rows of 8 plants at 81 cm inter row and 26.6 cm intra row spacings, with the centre 6 plants in the two inner rows being datum area for harvest. Vines were removed from the datum areas as a unit of area. Yields of storage roots were a total regardless of size, however, material breaking down as a result of soil borne disease was discarded.

Green weight of vines was recorded and sub-samples were oven dried to determine percent dry matter. Fresh weight of storage roots was recorded after washing. Sliced sub-samples were oven dried to determine percentage dry matter and subsequently were analysed for starch content.

Timing of land preparation, hilling, fertilizing etc. was as for normal cultural practice and similar for each time of planting. Replicates were laid out to provide adequate access for this purpose. Rainfall for the duration of the experiment is set out in Table 1 together with supplemental irrigation applied during dry periods as necessary.

Table 1. Monthly rainfall and irrigation (mm) for duration of experiment

Month Year	Nov 1980	Dec 1980	Jan 1981	Feb 1981	Mar 1981	Apr 1981	May 1981	Jun 1981
Rainfall	90	201	78	281	31	214	114	78
Irrigation	25	25	50	—	25	—	25	25
Month Year	**Jul 1981**	**Aug 1981**	**Sep 1981**	**Oct 1981**	**Nov 1981**	**Dec 1981**	**Jan 1982**	**Feb 1982**
Rainfall	26	58	11	24	261	193	560	143
Irrigation	50	25	75	50	—	—	—	—

RESULTS AND DISCUSSION

Vine production

Dry weight yields of leaf and vines were greatest from November planting peaking in 15 weeks at 10.25 t/ha. The January planting peaked in 20 weeks significantly lighter ($P<0.01$) at 7.01 t/ha. Both these plantings achieved very rapid ground cover and maintained a heavy leaf canopy to final harvest.

The March planting reached maximum vine production of only 2.68 t/ha dry matter at final harvest at 32 weeks significantly below November and January plantings ($P<0.01$). Ground cover was adequate initially then deteriorated due to desiccation caused by low temperatures, then improved prior to final harvest as conditions warmed up. The May planting attained only 1.64 t/ha of leaf and vines by first harvest at 23 weeks then improved steadily into summer achieving 5.21 t/ha by final harvest ahead of the March plantings peak ($P<0.05$) (Table 2).

Storage root production

The fresh and dry weight yields of storage roots from the November planting increased rapidly up to harvest 4 with slow increase to final harvest on June 1st. This planting significantly outyielded those in January and March ($P<0.05$) and ($P<0.01$) respectively.

The January planting increased yield rapidly to harvest 3 with negligible increase from subsequent harvest on June 29th and negative dry matter accumulation to final harvest on August 3rd. The March planting increased yield very slowly overwinter attaining its greatest 5 week increment of fresh weight and dry matter between harvests 4 and 5 (September 14th to October 19th).

The May planting exhibited a similar production pattern to the November planting for harvests 1 to 3 inclusive. This was followed by a massive increment of 35 t/ha fresh weight to harvest 4 on February 1st attaining the highest fresh and dry matter yields in the experiment significantly better than peak performance by January and March plantings ($P<0.01$).

Table 2. Dry weights of vines, storage roots and starch and fresh weight of storage roots (tonne/ha)

Planting Date	Vines Dry weight	Storage roots		
		Fresh weight	Dry weight	Starch
November 3rd				
Harvest 1	5.489	20.5	3.779	3.03
Harvest 2	10.231	44.3	9.449	7.91
Harvest 3	10.160	56.4	12.420	9.96
Harvest 4	10.257	73.2	13.725	10.76
Harvest 5	8.299	78.5	13.917	10.79
January 5th				
Harvest 1	5.258	9.9	1.723	1.37
Harvest 2	6.373	31.7	6.317	5.04
Harvest 3	7.015	54.5	9.922	7.90
Harvest 4	6.386	56.6	10.460	8.31
Harvest 5	4.489	57.1	9.492	7.14
March 9th				
Harvest 1	2.238	16.9	2.734	2.17
Harvest 2	2.364	22.7	3.955	3.07
Harvest 3	1.907	25.1	4.332	3.17
Harvest 4	2.341	33.7	5.387	4.07
Harvest 5	2.680	46.0	7.898	5.50
May 11th				
Harvest 1	1.647	19.6	3.269	2.62
Harvest 2	2.575	43.4	8.167	6.82
Harvest 3	2.741	54.0	9.795	7.87
Harvest 4	4.841	89.0	15.169	11.57
Harvest 5	5.216	85.2	13.124	10.28
l.s.d. 5%	1.820	12.94	3.777	5.89
l.s.d. 5%	2.542	19.44	5.316	7.92
s.e. mean	6.01	4.60	1.23	2.04

Starch production

Starch production in tonnes/ha being a result of yield and percent starch of storage roots, varied considerably between plantings. November and May gave the highest yields of starch. The January planting was intermediate and the March planting compared very poorly producing 5.5 t/ha at final harvest compared to over 10 t/ha from November and May plantings (Table 2).

Yields of up to 89 t/ha fresh storage roots with a starch production of up to 11.5 t/ha compare favourably with previous work in New South Wales where American orange flesh cultivars yielded a mean 23.3 t/ha of storage roots in 21 weeks. These storage roots had a mean carbohydrate content of 19.7% or 4.6 t/ha (Huett 1976).

Influence of soil temperature

Figure 1 superimposes production curves for dry matter accumulation of storage roots onto soil temperature at 200 mm as recorded in the experiment site. In the November planting storage root dry matter accumulated rapidly to harvest 3 and slowly thereafter. In the January planting there was rapid dry matter accumulation to harvest 3, slow accumulation to harvest 4 and then a decline. In these two trials falling soil temperatures appear to reduce the rate of dry matter accumulation after the first 20 weeks of crop growth, the reduction becoming more pronounced at lower temperatures.

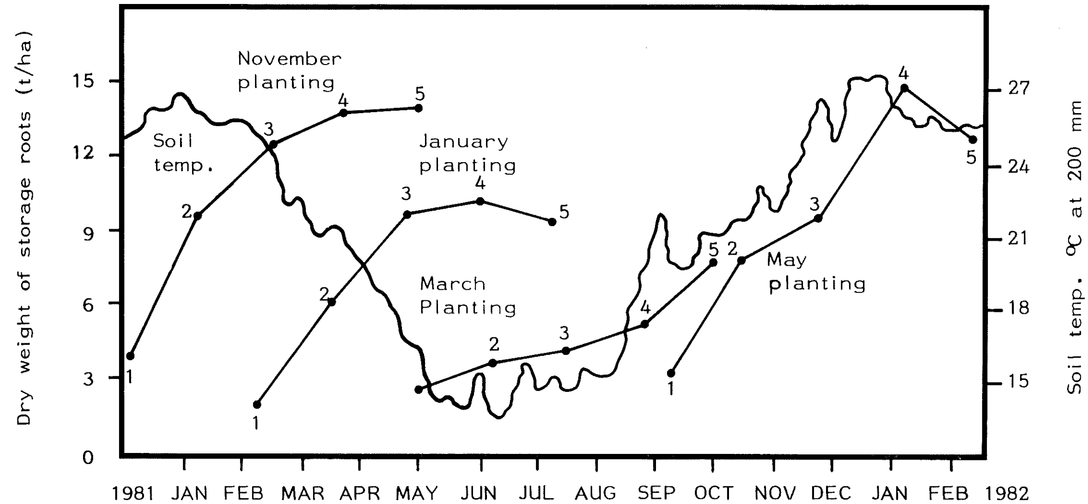

Figure 1. Dry matter yields of tubers (tonnes/ha) across seasons of plantings and times of harvest as influenced by soil temperatures at 200 mm.

The May planting growing on rising soil temperatures from harvest 1 onwards showed no decline in dry matter accumulation in spite of being 38 weeks of age at harvest 4. The reduced yield at final harvest was due to a high incidence of pathogenic rots, infected material being unharvestable. This was caused by the very high rainfall preceding this harvest. The March planting exhibited a slow but fairly uniform rate of dry matter accumulation restricted in both vine and storage root accumulation by soil temperatures mainly below 16°C from harvests 1 to 4 inclusive.

Influence of vine production on tuber yields

The production of leaf and vine appeared to have little influence on storage root yields. The November, January and May plantings all had similar storage root yields at third time of harvest but had vastly differing leaf and vine yields at these points in time of 10.1, 7.0 and 2.7 t/ha dry matter weight respectively.

Decrease in vine mass due to cold injury can be related to a slowing of storage root production e.g., November planting harvest 5, January planting harvests 4 and 5 and the March planting harvest 3 (Table 2).

The optimum harvest time for each season of planting as indicated by the results have been presented to compare efficiency of production across seasons (Table 3). The November planting was the most efficient in terms of tonnes of starch per week of crop duration. The January planting was the most efficient for conversion ratio from dry matter yield to starch but from a lower yield. The March planting compares unfavourably being low yielding with an inferior starch content. The May planting produced the highest yield of starch but was less efficient than November or January for production per week or per tonne of fresh weight due to a longer growing period and slightly lower starch content.

Table 3. Optimum harvest time for each planting time to maximise starch production

Plantings	Harvest	Weeks to harvest	Tonnes ha starch	Percent starch of d.m. yield %	Tonnes starch per week	Tonnes fresh yield handled per tonne
Nov 3rd	5	30	10.79	77.5	0.35	7.27
Jan 5th	4	25	8.31	79.5	0.33	6.81
Mar 9th	5	32	5.50	69.7	0.17	8.36
May 11th	4	38	11.57	76.3	0.30	7.69
Means		31.25	9.03	75.75	0.28	7.53

The results of these four plantings can be used to estimate year round production of starch in this environment. This production would amount to approximately 9 t/ha starch with a mean production period of 31 weeks.

Brown and Burton (1943) demonstrated that sweet potatoes fermented by *Clostridium acetobutylicium* and *Clostridium felsineum* yielded butyl alcohol, acetone and ethyl alcohol in greater quantities than corn. In laboratory tests (Anon. 1945) it was found that sweet potatoes produced 14.4 L and corn 12.1 L of 140° proof per 25 kg fermented. This would indicate that the mean fresh weight production of 66 t/ha in this experiment could be converted on a basis of 500 L of alcohols per tonne into 33 000 L of fuel alcohols per hectare of sweet potatoes produced.

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