

## Yield of sweet potato cultivars in the wet tropical lowlands of Queensland

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### Summary

Nine sweet potato cultivars were grown in winter and summer experiments in 1977 and 1978 on the wet tropical coast of Queensland, Australia. Three harvest dates were used and the highest summer and winter yields of saleable roots were 19 400 and 20 600 kg/ha respectively. At both later harvest dates, the (mean of two years) saleable root yields of Jewel, Sweetgold and Centennial were more than 10 t/ha. The yields for Jewel were the most consistent. Saleable yields differed with harvest dates, the means from the first to last harvest date were 2770, 7273 and 9628 kg/ha respectively. Yield differences between years were large. Cultivar and growing period yield differences were significant in the four trials and a significant cultivar, growing period interaction occurred in the 1977 winter and the 1978 summer and winter trials.

### INTRODUCTION

The wet tropical coastal area of Queensland is a small strip extending approximately from latitudes 19°S to 16°S. Most of the farming is a monoculture of either sugar cane, bananas or grazing. The inherent agronomic and economic dangers of a monoculture are recognised and have stimulated the research into alternative crops.

In Queensland sweet potatoes are mainly grown in the south east, yields are high (Wood 1976). Production is limited to the summer months as the winters are too cold. On the wet tropical coast winters are mild and sweet potatoes grow all year round thus winter production could fill the supply gaps in the south.

The salmon and orange fleshed USA cultivars have, according to Austin *et al.* (1970) and Huett (1976) a short season and a determinate period of growth. Storage root growth slows around 21 weeks. MacDonald (1963) comments that the harvesting period of sweet potatoes varies from 15 to 34 weeks.

This paper examines the effects of cultivar and harvest period on yields of summer and winter grown sweet potatoes. Rainfall in summer is frequently high and even on well drained soils, waterlogging may be a periodic problem. The significance of this on soil borne rots is investigated. Observations on weed control are recorded.

### MATERIALS AND METHODS

There were four experiments, one summer and one winter experiment, in 1977 which were repeated in 1978. The cultivars were Jewel, Redmar, Bunch, Sweetgold, Nemagold, Runners, Baker, Goldrush and Centennial. These are described in Table 1. Runners and Bunch were locally grown cultivars and the others were introduced from the USA. At harvest the roots were separated into three grades. The saleable grade root was 4.5 to 9.0 cm in diameter and 15.0 to 23 cm long. Wood (1976) considered this the most desirable size range of roots for market. Larger roots were classified second grade and smaller roots, third grade. Roots which were either split or had rots were not weighed at harvest.

A randomised block design with three replicates was used for each experiment. The treatments were nine cultivars by three harvest periods (H). Details of the experiments are set out in Table 2. The centre three rows of each plot were harvested.

**Table 1. Sweet potato cultivar description**

	Jewel	Redmar	Bunch	Sweetgold	Nemagold	Runners	Baker	Goldrush	Centennial
Flesh colour	deep orange	reddish orange	creamy white	deep orange	pale orange	white	light orange	copper orange	deep orange
Root colour	light orange	cherry red	creamy white	bronze orange	orange tan	white	orange	light tan	lightorange
Testure on cooking	semi moist	semi moist	dry	moist	semi moist	dry	semi moist	moist	moist
Vine growth	medium long	medium	thick and very bunched	vigorous short and thick	very long and slender	prolific and very long	long and trailing	bunched	short thick and trailing

**Table 2. Experiment details and harvest periods**

Experiment	Site	Season	Year	Harvest period (weeks)					
				H1	H2	H3	H4	H5	H6
1	South Johnstone	summer	1977	16	21	26			
2	Bingil Bay	summer	1978	17	22	27			
3	Bingil Bay	winter	1977				16	21	26
4	South Johnstone	winter	1978				18	23	28

Each site was part of a grazing block and prior to ridging they were disced and spring tye cultivated to a loose friable tilth. In Experiment 2, trifluralin was incorporated immediately prior to ridging and gave effective weed control for six weeks. Cuttings 25 to 35 cm long were used as planting material for all cultivars except Bunch whose vines rarely grew longer than 15 cm. Sweet potato weevils were combated when observed with one or two sprayings of chlorpyrifos. Inter-row weeds were controlled by spraying with gramoxone and weeds on top of the ridges were hoed out. Rainfall and temperature data are shown in Figure 1.

### Summer experiments

The nine cultivars were planted during summer on the 26 January 1977 at South Johnstone (17°20'S, 145°58'E), Experiment 1.

The trial site was a deep well drained alluvium (Um 6.34, Northcote 1965) with average chemical analyses for depth 0 to 15 cm as follows: pH, CaCl<sub>2</sub> 3.8, 1:5 soil water 4.4, available P (Kerr and von Steiglitz, 1938) 9 ppm and exchangeable K 0.32 meq%. Fertiliser was applied at the following elemental rates (kg/ha): 33 N, 42 P and 39 K, with another 33 N at 12 weeks. Plots contained five rows each 6 m long with the rows 0.85 m apart. Plants were spaced at 50 cm centres.

The second summer, Experiment 2, was planted on 26 January 1978 at Bingil Bay, North Queensland (17°50'S, 146°06'E). Temperature data were not recorded at Bingil Bay and South Johnstone data were used as the best substitute.

The trial site was a well drained colluvium (Um 6.34, Northcote 1965) with average chemical analyses for depth 0 to 15 cm as follows: pH, 1:5 soil water 4.8, available P (Kerr and von Steiglitz 1938) 6 ppm and exchangeable K 0.15 meq%. Fertiliser was applied, prior to planting, at the following elemental rates (kg/ha): 56 P, 96 K and 15 Bo. At eight weeks and again at twelve weeks 38 kg/ha N was applied. Plots contained five rows each 5.5 m long with the rows 0.80 m apart. Plants were spaced at 50 cm centres.

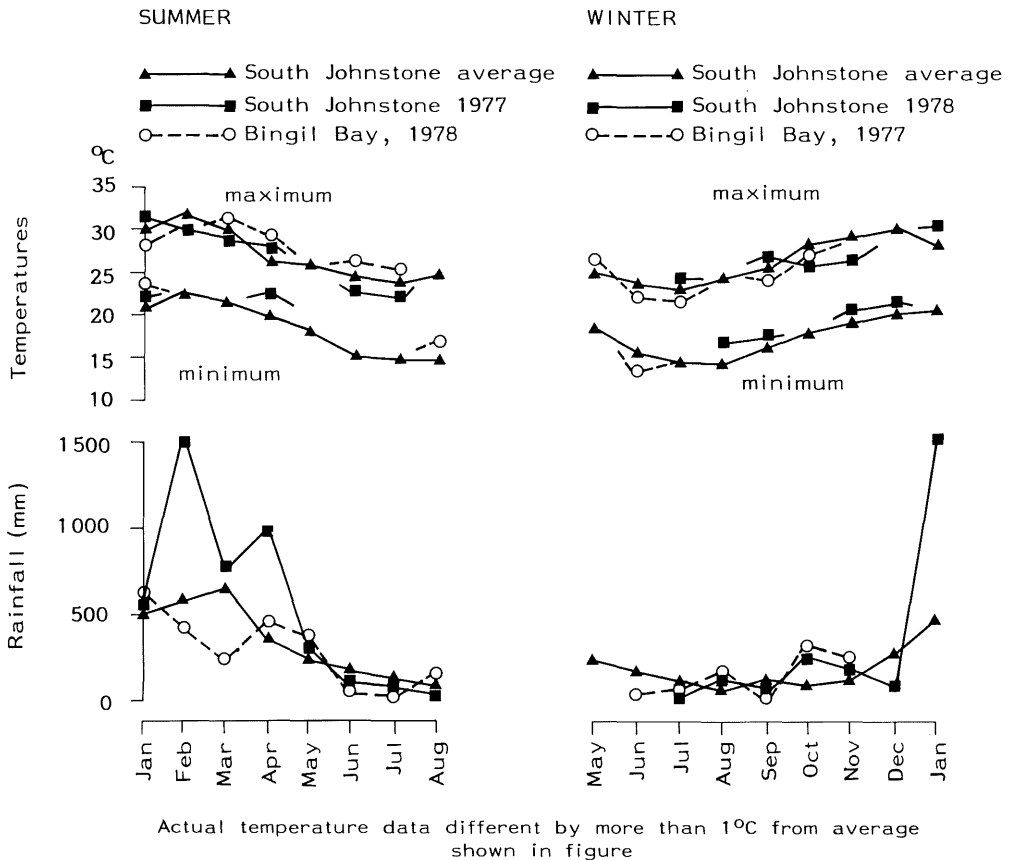


Figure 1. Rainfall and temperature data.

### Winter experiments

Experiment 3, was planted on 11 and 12 May 1977 at Bingil Bay. The trial site was a well drained brown fine textured colluvium (Um 6.34, Northcote 1965) with average chemical analyses for depth 0 to 15 cm as follows: pH,  $\text{CaCl}_2$  4.5, 1:5 soil water 5.5, available P 9 ppm and exchangeable K 0.27 meq%. Fertiliser was applied at the following elemental rates (kg/ha): 33 N, 43 P, 40 K and 7 Bo, with a further 33 N at twelve weeks. Plots contained five rows each 6.0 m long with the rows 0.83 m apart. Plants were spaced at 50 cm.

The second winter, Experiment 4 was planted on 5 July 1978 at South Johnstone. The trial site was a well drained alluvium (Um 6.34, Northcote 1965) with average chemical analyses for depth 0 to 15 cm as follows: pH,  $\text{CaCl}_2$  3.8, 1:5 soil water 4.4, available P 8 ppm and exchangeable K 0.32 meq%. Fertiliser was applied before planting at the following elemental rates (kg/ha): 71 P, 124 K and 14 Bo. At six and again at 12 weeks 33 kg N/ha was applied. Irrigation was applied three times, 50 mm on 20 July 1978, 50 mm on 2 August 1978 and 50 mm on 7 August 1978 during an early dry establishment period. Alachlor was sprayed over the trial prior to irrigation on 20 July 1978. Plots were five rows wide and 6.0 m long with the rows 0.83 m apart. Plants were spaced at 50 cm.

## RESULTS AND DISCUSSION

### Summer experiments 1977, 1978

Significant saleable root yield differences (Table 3) for cultivars, harvest periods and cultivar×harvest period interactions occurred in both years. The yield differences were large between the years especially at H3 for all cultivars apart from Jewel.

Sweet potatoes after a drier than average summer, 1978, were visibly wilted by June, mean yields from H2 to H3 increased by only 9% (551 kg/ha, not significant) compared with 73% (5249 kg/ha, significant ( $P<0.01$ )) in 1977. Rainfall amounts varied widely (Figure 1) during the 1977 experiment and root cracking occurred especially with Jewel, Redmar and Bunch, 10% affected at H3; Sweetgold, Runners, Baker and Goldrush were unaffected. Healing of the cracks by suberisation resulted in half of these roots being marketable. In 1978, less rainfall variation, there was little cracking in any of the cultivars.

The mean yield (15 153 kg/ha) of Sweetgold (Table 3) was significantly ( $P<0.01$ ) higher than the mean yields of all other cultivars in the exceptionally wet year, 1977. Sweetgold had a few rots, these occurring at H3. This low level of rot was unexpected as Wood (1976) reported that data collected over several years for Sweetgold at 27 week harvests showed up to 20% roots affected by rots. In the drier 1978 season there were few rots.

**Table 3. Saleable root yields (kg/ha) of summer grown sweet potatoes at different harvest periods (H) and the interactions between cultivars and cultivars and H**

Cultivar	South Johnstone 1977				Bingil Bay 1978			
	H1	H2	H3	Mean	H1	H2	H3	Mean
Jewel	3 197	8 045	15 509	8 917	6 0431	3 490	11 414	10 316
Redmar	3 742	8 726	9 686	7 385	2 972	8 919	6 599	6 163
Bunch	6 035	5 566	13 181	8 261	3 043	6 818	8 876	6 246
Sweetgold	9 995	16 171	19 293	15 153	6 596	8 111	8 619	7 775
Nemagold	3 480	9 150	19 447	10 692	1 114	4 596	6 477	4 062
Runners	1 149	5 240	17 767	8 052	0	952	3 232	1 395
Baker	1 830	3 377	4 952	3 386	1 131	2 535	2 790	2 152
Goldrush	1 078	2 250	4 553	2 627	977	851	1 813	1 214
Centennial	2 634	5 442	6 817	4 964	7 543	10 217	11 631	9 797
Mean	3 682	7 107	12 356	7 715	3 269	6 277	6 828	5 458
I.s.d.		$P=0.05$	$P=0.01$			$P=0.05$	$P=0.01$	
Cultivar×H		3 170	4 229			1 982	2 641	
Cultivar		1 834	2 447			1 144	1 525	
H		1 056	1 408			661	880	

Jewel was the most consistent yielding cultivar between the years and then Redmar; yields of all other cultivars were very variable with Runners yields being the most variable. A comparison for Centennial was not made because poor quality planting material in 1977 limited yield. Yields were highest from H3 when in 1977 (wet year) Jewel, Sweetgold, Nemagold and Runners produced saleable yields in excess of 15 t/ha. All the cultivars in 1977 apart from Baker, Goldrush and Centennial yielded more than the Queensland commercial average of 9 t/ha (Wood 1976) for at least one harvest. In 1978 only Jewel and Centennial yielded more than the commercial average.

There were no large roots produced at H1 in either year and few at H2 and H3. Only Bunch had more than 5% (as proportion of saleable root yield) with 19.6% (1089 kg/ha) at H2 in 1977. The low values indicate that large roots are not a factor to be considered over the range of harvest periods.

The yields from H2 to H3 for saleable plus small roots (Table 4) increased substantially for some cultivars and further increases may be possible. Huett and O'Neill (1975) recorded time differences for cultivars to 90% asymptotic root yield. Calculating yield differences at H3 between Tables 3 and 4, small roots could contribute to a yield increase and possibly attain saleable size. Sweet potatoes can be left for 2 to 3 months after maturity (MacDonald 1963) indicating there is some flexibility in harvest date. The percentage of small roots varied little for mean data across harvest intervals at 25% in 1977 and 55% in 1978. In a nil or slight water stress situation a higher proportion of roots attain saleable size.

**Table 4. Saleable plus small root yields (kg/ha) of summer grown sweet potatoes at different harvest periods (H) and the interactions between cultivars and H**

Cultivar	South Johnstone 1977				Bingil Bay 1978			
	H1	H2	H3	Mean	H1	H2	H3	Mean
Jewel	4 929	11 443	21 967	12 780	10 492	22 331	20 909	17 911
Redmar	6 258	11 857	11 967	10 027	7 707	17 750	15 328	13 595
Bunch	7 162	7 124	14 602	9 629	5 328	9 381	11 371	8 693
Sweetgold	12 718	19 624	21 820	18 054	13 932	16 033	15 775	15 247
Nemagold	5 049	12 816	32 562	16 809	6 129	13 841	18 725	12 898
Runners	1 681	7 282	20 331	9 765	366	3 048	7 283	3 566
Baker	2 783	5 305	9 386	5 825	6 760	11 952	15 282	11 331
Goldrush	1 792	2 860	5 047	3 233	4 626	4 616	4 816	4 686
Centennial	3 526	6 939	7 990	6 152	13 957	17 192	18 465	16 538
Mean	5 060	9 472	16 186	10 253	7 700	12 905	14 217	11 607
<i>l.s.d.</i>		<i>P</i> =0.05	<i>P</i> =0.01			<i>P</i> =0.05	<i>P</i> =0.01	
Cultivar×H		3 984	5 315			3 595	4 791	
Cultivar		2 305	3 075			2 076	2 766	
H		1 327	1 770			1 198	1 597	

### Winter experiments 1977, 1978

Significant saleable root yield differences (Table 5) for cultivars and harvest periods occurred in both years and the cultivar×harvest period interaction was significant in 1978. There were cultivar and harvest period yield differences between the years.

**Table 5. Saleable root yields (kg/ha) of winter grown sweet potatoes at different harvest periods (H) and the interactions between cultivars and H**

Cultivar	Bingil Bay 1977				South Johnstone 1978			
	H4	H5	H6	Mean	H4	H5	H6	Mean
Jewel	4 861	14 667	13 831	11 120	1 342	10 170	20 580	10 697
Redmar	667	5 594	5 471	3 911	401	1 955	4 853	2 403
Bunch	4 033	7 823	8 209	6 688	2 308	13 299	15 050	10 196
Sweetgold	2 516	11 432	8 538	7 495	3 005	10 297	13 401	8 901
Nemagold	478	5 578	6 158	4 071	238	3 168	6 193	3 200
Runners	6 893	16 691	14 816	12 800	1 587	4 642	6 975	4 401
Baker	984	7 387	5 731	4 701	0	1 386	4 773	2 053
Goldrush	229	3 461	3 209	2 300	63	2 737	9 134	3 978
Centennial	3 150	9 698	11 080	7 976	4 404	11 456	15 966	10 609
Mean	2 646	9 148	8 560	6 785	1 483	6 560	10 769	6 271
<i>l.s.d.</i>		<i>P</i> =0.05	<i>P</i> =0.01			<i>P</i> =0.05	<i>P</i> =0.01	
Cultivar×H		<i>n.s.</i> *	<i>n.s.</i>			4 939	6 581	
Cultivar		1 847	2 461			2 851	3 799	
H		1 067	1 421			1 646	2 194	

\* *n.s.*=not significant.

The May 1977 experiment established readily in warm moist conditions whereas establishment was slow for the July 1978 experiment when temperatures were lower (Figure 1) and irrigation was needed three times. Sweetgold and Centennial established faster than the other cultivars in 1978 and their yields at H4 were similar in both years while yields of other cultivars decreased substantially in 1978.

The 1977 crop which was water stressed in September–October did not fully recover in spite of good, October–November rains (Figure 1). This dry period in the 1977 winter reduced yields substantially at H6 for Jewel, Bunch, Sweetgold, Goldrush and Centennial. There was no significant mean yield difference between H5 and H6 (9148 and 8560 kg/ha respectively). In 1978, a year with no visible moisture stress, yields increased sequentially with harvest period. The H6 mean yield (10 769 kg/ha) was significantly ( $P<0.01$ ) higher than the H5 mean yield (6560 kg/ha).

Jewel, Sweetgold and Centennial were the most consistent higher yielding cultivars over the years closely followed by Bunch. Runners yielded the most at all harvests in 1977 and against the trend of yield increase its yields decreased substantially in 1978.

Large roots were produced only in 1978 and at H6. As a proportion of saleable root yield, Jewel, Bunch, Sweetgold, Runners and Centennial had 16, 21, 16, 21 and 11% respectively. H6 in 1978 was a 28 week harvest which was the longest and would favour the production of large roots.

The mean yields increased marginally from H5 to H6 for saleable plus small roots (Table 6) although there were large increases for Jewel and Goldrush in 1978. The trend for means indicates that more than 90% of asymptotic yield has been reached.

**Table 6. Saleable plus small root yields (kg/ha) of winter grown sweet potatoes at different harvest periods (H) and the interactions between cultivars and H**

Cultivar	Binbil Bay 1977				South Johnstone 1978			
	H4	H5	H6	Mean	H4	H5	H6	Mean
Jewel	10 561	18 189	19 020	15 923	4 116	15 771	23 064	14 317
Redmar	4 132	9 150	8 751	7 344	3 587	8 950	8 617	7 051
Bunch	6 854	10 390	10 982	9 409	3 540	15 365	16 365	11 757
Sweetgold	7 124	14 533	13 947	11 868	5 585	16 526	16 363	12 825
Nemagold	4 050	8 433	10 953	7 812	1 041	7 154	9 560	5 918
Runners	9 692	18 980	16 853	15 175	2 311	6 333	7 905	5 516
Baker	4 368	10 416	9 320	8 035	1 249	7 485	9 410	6 048
Goldrush	1 342	4 807	4 927	3 692	658	5 288	10 893	5 613
Centennial	6 272	11 356	14 800	10 809	8 050	18 485	18 857	15 131
Mean	6 044	11 806	12 173	10 007	3 349	11 262	13 448	9 353
<i>l.s.d.</i>		$P=0.05$	$P=0.01$			$P=0.05$	$P=0.01$	
Cultivar×H		n.s.*	n.s.			n.s.	n.s.	
Cultivar		1 847	2 461			3 331	4 439	
H		1 067	1 421			1 923	2 563	

\* n.s.=not significant.

Growth up to H4 was through winter and the proportion of small roots at H4 was 56% in both years. It seems reasonable to expect a high proportion of small roots during the cooler period of the year.

The most consistent higher yielding cultivars for summer and winter were Jewel and Centennial (excluding the 1977 summer results for Centennial) followed by Sweetgold and Bunch. Dry periods in the 1978 summer experiment and 1977 winter experiment resulted

in little root bulking, irrigation would increase yields. Planting was successful during summer and winter; rainfall was sufficient for a winter planting and in the heavy summer rainfall period ridging and ridge planting in well drained soil above flood level was satisfactory. The growing period, however, will not solely depend on yield, it may be desirable to forgo some yield increment if the price is high to ensure the best possible monetary return. Ideally quick root bulking and resistance to rots and root breakdown is required.

### CONCLUSION

Sweet potatoes were grown successfully in summer and winter. Chemical weed control is effective and soil cultivation for weed control is not essential. This results in a stable land management system.

The recommended cultivars are Jewel, Bunch, Sweetgold and Centennial (excluding results from Centennial, summer 1977). Apart from Bunch at H2 the mean yields, 1977 and 1978, were more than 10 t/ha of saleable roots at H2, H3, H5 and H5. Sweetgold had the highest (mean of two years) yields at all three harvest periods for summer plantings, however, there is a substantial yield advantage in harvesting at H3 for all cultivars. During winter Sweetgold and Bunch could be harvested at H5 or H6 but Centennial and Jewel benefit from the longer H6 harvest period.

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