BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

FINAL REPORT - SRDC PROJECT BSS241
REGIONAL EVALUATION
OF HIGH DENSITY PLANTING

by

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SD03005

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SUMMARY

This project was successful in comparing two farming systems: conventional 1.52-m single rows and the High Density Planting system (HDP), which consists of four rows on a 2.1-m wide bed using controlled-traffic and minimum-tillage principles.

Site-replicated strip trials were used to compare the performance of the two farming systems under field conditions in all the major sugarcane districts of Queensland and New South Wales. A significant yield response was measured in 9 of the 21 plant-cane trials and 8 of the 15 first-ratoon trials. Where a response was measured between the two planting configurations, the HDP treatment produced an average of 37% and 16% more cane compared to the 1.52-m rows in the plant and first-ratoon crops, respectively. No difference in yield or CCS was measured between the two farming systems in any of the second-ratoon crops. Stalk counts and sample harvests were effective methods of monitoring crop growth in the trials. The stalk-count data and associated cane-yield data collected from the trials highlight the importance of good establishment. Poor germination in both planting configurations was a significant problem in the trials planted in the 1999 season in the wet tropics. Of the seven trials planted, only one had acceptable germination. Adverse weather conditions also caused widespread germination failures in commercial plantings throughout this district that year.

A major part of this project was the design and construction of equipment to allow management of the trials. Over the project, significant modifications were made to the harvester to improve the feeding characteristics and overall machine performance. When correctly adjusted, the bed-forming and planting equipment worked well in most soil types. The very narrow traffic area in the HDP system caused some harvester navigation problems, particularly in large, heavily lodged crops. The cumulative stool damage and loss of vigour were major factors contributing to lack of response in the second-ratoon crop. The installation of a guidance system (DGPS or similar) on the harvester would have overcome this problem. Considering the vast range of harvesting conditions experienced, the equipment performed extremely well.

Due to the extensive nature of the trials, the equipment had to perform under a large array of conditions and soil types. The distance between trials caused logistical problems, particularly with movement of equipment and timeliness of operations. As a result, some trials may have suffered some yield loss due to inappropriate timing of weed control and fertiliser application.

Compared to the current conventional system, the HDP system requires considerably more precision in all farming operations. As a minimum, the harvesting and haulout equipment must have some form of precision-guidance system to keep the equipment off the beds. Because of the high cost of modifying equipment to suit the 2.1-m wide beds and the requirement for a high degree of precision, it is unlikely that the HDP system will become a commercial reality, at least in the near future.

The benefits of higher-density planting, good crop establishment, minimum tillage and controlled traffic have already been recognised by many growers throughout the industry. The HDP project has been an excellent conduit for initiating grower and industry interest in different farming systems. Growers in the Bundaberg, Mackay, Maryborough, and Ingham districts are currently investigating new farming systems consisting of two and three rows on 2-m wheel spacings. Due to the wider traffic area, the need for precision guidance equipment has been reduced. Significant cost savings associated with less turning and shorter travelling distance per hectare; reduced cultivation costs and increased rainfall infiltration rates make these farming systems economically viable options. The major cost of modifying harvesting equipment continues to be a major constraint to wide spread acceptance.

Much of the equipment used in this project has applications in reduced- and minimum-till planting systems. The double-disc opener was highly effective at accurately planting cane into beds with minimal soil disturbance. The concept of forming mounds matched to harvesting equipment prior to planting probably increased germination in waterlogged conditions and reduced harvester ‘pickup’ losses and soil in the cane supply.

The trials in this project did not provide enough information about the performance of the HDP system over the entire crop cycle. The second-ratoon harvests showed no difference in yield between the 1.5-m rows and the HDP configurations. In the second ratoon, many of the HDP treatments appeared very gappy compared to the single rows. There is no doubt that the harvester caused substantial stool damage, due to a lack of appropriate vehicle guidance system. However, it is uncertain that this was the only reason for a lack of response in the second ratoon. Methods of reducing stool damage at harvest need further investigation.

Many of the trials in this project suffered from poor establishment in both treatments. Unfortunately, many of the factors controlling germination are difficult to control or as yet unknown. A more scientific approach to assessing if a cane sett will germinate is required.

1.0 BACKGROUND

Previous research in Australia and several other sugar industries has reported significant cane-yield increases due to higher plant density. Singh and Singh (1963) and Kanwar and Sharma (1974) reported yield increases in India, Herbert *et al.* (1965), Matherne (1971, 1974), Irvine *et al.* (1980), Irvine and Benda (1980a,b) and Benda *et al.* (1987) reported increases in Louisiana, and Gascho and Shih (1981) recorded similar responses in Florida. A trend for higher yields at reduced row spacing was also reported from research trials in Australia (Bull 1975). In most cases, the physiological basis of the responses and the specific operational and equipment requirements for higher-density planting were not recognised. Conventional farming practices, equipment and sugarcane cultivars were used without modification.

The result has been that attempts to move to commercial production have failed almost universally. Bull and Bull (1996, 1999) (including SRDC project BSS137 'Genotype selection and management strategies for exploitation of responses to high planting densities' showed, that by modifying the farming equipment and management techniques, it is possible to commercially realise the yield increases demonstrated in plant-density trials.

The aim of this project was to develop a farming system to capitalise on the plant-density response and incorporate a range of improved technologies and management techniques, including the principles of mound planting and controlled-traffic farming. The High Density Planting (HDP) farming system tested comprises four rows planted on 2.1-m beds [termed 2.1-m beds in this report].

2.0 OBJECTIVES

- Establish site replicated strip trials (SRSTs) to investigate crop response to the HDP farming system in the major regions of the industry.
- Support the design, fabrication and procurement of multi-row equipment to plant, maintain and harvest SRSTs.
- Develop a model for the establishment of a pool of multi-row equipment in each region to facilitate the adoption of the HDP system.
- Develop an extension package and protocols for the HDP farming system.

The original project was modified in February 2002 following a SRDC-initiated review. Milestones 7-10 and most of 11 were deleted. This meant that objective 3 could not be accomplished. No work on this objective was possible before that time, because the project was still in the experimental phase.

A network of replicated strip trials was used to test the new farming system in all the major sugarcane growing areas of Australia under a range of management practices using locally significant cultivars. These trial sites were used to promote and extend the project results to growers and the general industry.

This project successfully supported the development and fabrication of suitable multi-row farming equipment that was developed in conjunction with SRDC projects BSS165 and BSS208. In addition, the project was linked with a QRail-funded project to design a prototype multi-row billet planter, and a BSES-funded project (2079) to collaborate with Austoft in the design and testing of a prototype multi-row harvester.

The conventional sugarcane farming system currently used in Australia is based on single rows 1.52 m apart [termed 1.5-m rows in this report]. However, harvesting equipment is not matched to this row spacing, the majority having a wheel spacing of 1.83 m. As a result, significant soil compaction and associated problems exist within the conventional system. In addition, the majority of Australia's sugarcane harvesting equipment uses public roads to transport cane to the siding or mill. Legally, equipment used on public roads can be no wider than 2.5 m in outside dimensions. As a result, when narrow (400-mm wide) tyres are used, the maximum legal wheel spacing is 2.1 m. In this project, 2.1-m wheel spacing was used to minimise soil compaction and distance travelled per hectare and maximise the cropping area. All equipment used had the same 2.1-m wheel spacing to confine traffic to the wheel tracks.

3.0 METHODS

3.1 Establishment of SRST trials

SRST trials were designed to test the crop response to the HDP farming system compared to the conventional 1.5-m single-row system in the major sugarcane production areas of Australia. The trials were also used to investigate the practical and physical constraints to the adoption of HDP on commercial sugarcane farms.

All SRSTs were established in three-replicate, randomised-block designs. Three appropriate cultivars selected for each district were planted in split-plot designs comparing two row spacings, 1.5-m rows (1.6 m in Mareeba trial) and 2.1-m beds with four rows planted 0.47 m apart. The exception was the Mackay trial, where the outbreak of orange rust meant that only the resistant cultivar Q135 was planted. The 1.5-m rows were planted conventionally into furrows with a single-row whole-stick planter and the 2.1-m beds were planted with four rows using the whole-stick multi-row planter. Trial size was 1-1.5 ha, depending upon location. In the Ayr-BSES and Ayr-Parker trials, an additional planting configuration of 1.83-m dual rows was included. The Broadwater trial also included a configuration of three rows on a 2.1-m bed.

To measure stalk dynamics, 5-6 permanent areas, 10 m by one row in the 1.5-m rows and 5 m of a 2.1-m bed, were marked out in each subplot and stalks were counted at various intervals during crop growth. Sample harvests were collected from many of the trials prior to lodging and harvest to estimate cane yield. The trial plots were all harvested with the multi-row harvester and weighing tipper bin on 2.1-m wheel spacings. Weights were taken from the internal two rows or beds in each plot and yield per hectare calculated. Where possible, random six-stalk samples were collected from each plot and crushed in a small mill. The CCS and cane-yield estimates were used to calculate sugar yields.

3.2 Design and fabrication of multi-row equipment

Bed forming, planting and harvesting equipment required to manage the SRST trials was designed and fabricated in conjunction with other research projects. The design of the multi-row whole-stick planter was based on results of the SRDC project BSS208 'Improved planting systems for sugarcane'. A QRail project funded the construction by P&H Rural of two multi-row double-disc-opener whole-stick planters. These planters were used to plant all of the trials. Results of the SRDC project BSS165 'Improved feeding of green cane by harvesters' were used to design the multi-row harvester. In collaboration with Austoft, a harvester was modified to enable the mechanical harvesting of the trials.

3.3 Develop an extension package and protocols for HDP

Throughout the project extension officers have arranged regular field visits to the trials for growers and industry personnel to view planting and harvesting of the trials and the equipment used. Two booklets *Manual for dual rows in sugarcane* and *A high density farming system for improved sugarcane production* have been published and made available to growers.

4.0 RESULTS

4.1 SRST trial results

The SRSTs were all planted during the years 1999 and 2000 (Table 1). Seventeen SRSTs plus five grower demonstrations were planted from March to November 1999. One demonstration trial and two SRSTs were subsequently ploughed out due to poor germination. Four additional SRSTs were planted successfully between July and September 2000. A total of 19 SRSTs and 4 grower demonstration trials was successfully planted. The Harwood and Brushgrove trials were designed to compare cane production in 1-year and 2-year cane systems.

Crop establishment is one of the key factors affecting crop production. The trials in this project compare the performance of two different farming systems, which can inherently cause differences in germination and crop establishment. To enable a comparison between the two planting methods, stalk counts were taken after germination and during crop growth. During the early crop-establishment phase, competition effects should be minimal, so the number of stalks will closely reflect the number of eyes planted.

The single-row whole-stick planter allows for overlap between stalks, planting at a rate of 4-5 two-eye setts per metre of row or approximately 52-66,000 eyes per hectare. The multi-row planter was designed to provide a gap of about 5 cm between billets and should result in a planting rate of about 3.5 two-eye setts per metre of row (14 sets per metre of 2.1-m bed) or approximately 133,000 eyes per hectare. Good establishment conditions should result in 26-33,000 stalks per hectare on 1.52-m rows and 67,000 stalks per hectare on 2.1-m beds; the 2.1-m beds should have about twice as many stalks per hectare than the 1.5-m rows. A difference from this ratio suggests a change in the germination conditions under the two farming systems.

Table 1. Summary of SRST and demonstration sites and preliminary germination and establishment assessments

No	Site*	Planted	Type	Strike	Comments
1	Mareeba	24 July 99	SRST	Good	Some misses from shallow planting, good weed control
2	Atherton	15 July 99	Demo	Good	Water hen damage and extensive peanut volunteers
3	Mossman	1 June 99	SRST	Good	Some water stress in HDP, moderate weeds
4	Mulgrave – Turf Farm	3 August 99	SRST	Poor	Poor bed preparation, extended dry spell, heavy weeds
5	Mulgrave - Bacalakis	19 July 99	SRST	Poor	Heavy weeds, problems alleviated by mill mud
6	Babinda	22 September 99	SRST	Poor	Shallow planting, moderate weeds
7	Innisfail	24 September 99	SRST	Moderate	Poor material for Q166[(l)] and shallow planting.
8	Tully	20 August 99	SRST	Moderate	Missing setts, sett damage and poor planting material
9	Ingham - Robino	8 June 99	SRST	Moderate	Poor planting material and missing setts
10	Ingham 2		Demo	Poor	Dry conditions followed by flood, part ploughed out
11	Ayr – BSES station	10 May 99	SRST	Moderate	Operating problems
12	Ayr 2		SRST	Poor	Poor planting material, trial ploughed out
13	Ayr - Parker	3 August 00	SRST	Moderate	
14	Sarina	23 May 99	SRST	Poor	Grower damage from 1.5-m gear
15	Mackay	25 July 00	SRST	Good	
16	Bundaberg - Qunaba	29 April 99	SRST	Good	Good weed control
17	Bundaberg - Bannister	14 October 99	SRST	Good	Flood damage in 1.5-m rows
18	Bundaberg 3		SRST	Poor	Poor planting material, trial ploughed out
19	Bundaberg 4	24 September 99	Demo	Excellent	Good weed control
20	Maryborough - Petersen	4 November 99	SRST	Good	
21	Maryborough 2	6 November 99	Demo	Good	
22	Rocky Point 1	30 March 99	Demo	Poor	Half field poor due to bed formation and dry conditions
23	Rocky Point - Keith	5 September 00	SRST	Poor	Dry conditions
24	Broadwater	17 September 00	SRST	Good	
25	Harwood	12 October 99	SRST	Good	
26	Brushgrove	21 October 99	SRST	Good	

*Trials 'greyed' were ploughed out following poor establishment

4.1.1 Mareeba

This trial was planted on 15 July 1999 at Paul Murat's farm following a maize crop on a red ferrosol. The crop was irrigated as required.

4.1.1.1 Stalk counts and crop growth measurements

Stalks were counted in the plant crop at 69 and 243 days after planting (DAP). In the second-ratoon crop, stalks were counted at 95, 110, 164 and 200 days after harvest (DAH) and one biomass sampling was taken at 110 DAH.

At 69 DAP in the plant crop, there was no significant cultivar by spacing interaction (P=0.77). There was a trend to more stalks in the 2.1-m beds (P=0.055; Table 2). The cultivar Q135 had significantly fewer stalks than either Q124 or Q120 (P=0.003).

Table 2. Mareeba trial - effect of planting configuration on stalk numbers per hectare at 69 DAP (9 September 1999)

Cultivar	1.6-m rows	2.1-m beds
Q120	28,958	47,619
Q124	29,479	47,515
Q135	18,542	33,312
Mean	**25,660**	**42,815**

At 243 DAP in the plant crop, there was no significant cultivar by spacing interaction (P=0.75). There were significantly more stalks in the 2.1-m beds (P=0.016; Table 3). The cultivar Q124 had significantly fewer stalks than Q135 and Q120 (P=0.048).

Table 3. Mareeba trial - effect of planting configuration on stalk numbers per hectare at 243 DAP (15 March 2000)

Cultivar	1.6-m rows	2.1-m beds
Q120	107,333	131,111
Q124	92,667	121,587
Q135	109,556	131,111
Mean	**103,185**	**127,937**

In the second-ratoon crop, there was no significant (P>0.05) cultivar by spacing interaction at any of the stalk-count samplings. Stalk counts were significantly (P<0.05) higher in the 2.1-m beds in November 2001, January 2002 and March 2002, but not in December 2001 (Table 4, Figure 1).

Analysis of biomass samples collected from the same crop in December 2001 (Table 4) showed a significant ($P<0.05$) density by cultivar interaction. The Q124 and Q135 in 1.6-m rows produced more biomass than in the equivalent 2.1-m beds. There was no significant difference in biomass of Q120 in the 1.6-m rows and the 2.1-m beds.

Table 4. Mareeba trial - effect of planting configuration on crop growth and stalk count measurements in the second-ratoon crop

Sample date	Days after harvest	Cultivar	Stalk numbers per ha		Biomass (t/ha)	
			1.6-m rows	2.1-m beds	1.6-m rows	2.1-m beds
16/11/01	95	Q120	179,200	277,000		
		Q124	126,400	182,800		
		Q135	150,000	210,000		
1/12/01	110	Q120	168,700	254,100	12.43	12.57
		Q124	205,300	184,500	24.25	12.04
		Q135	239,300	220,000	13.10	9.26
24/1/02	164	Q120	142,300	175,100		
		Q124	159,100	154,300		
		Q135	155,000	173,500		
1/3/02	200	Q120	122,800	164,600		
		Q124	136,800	134,900		
		Q135	133,700	146,200		

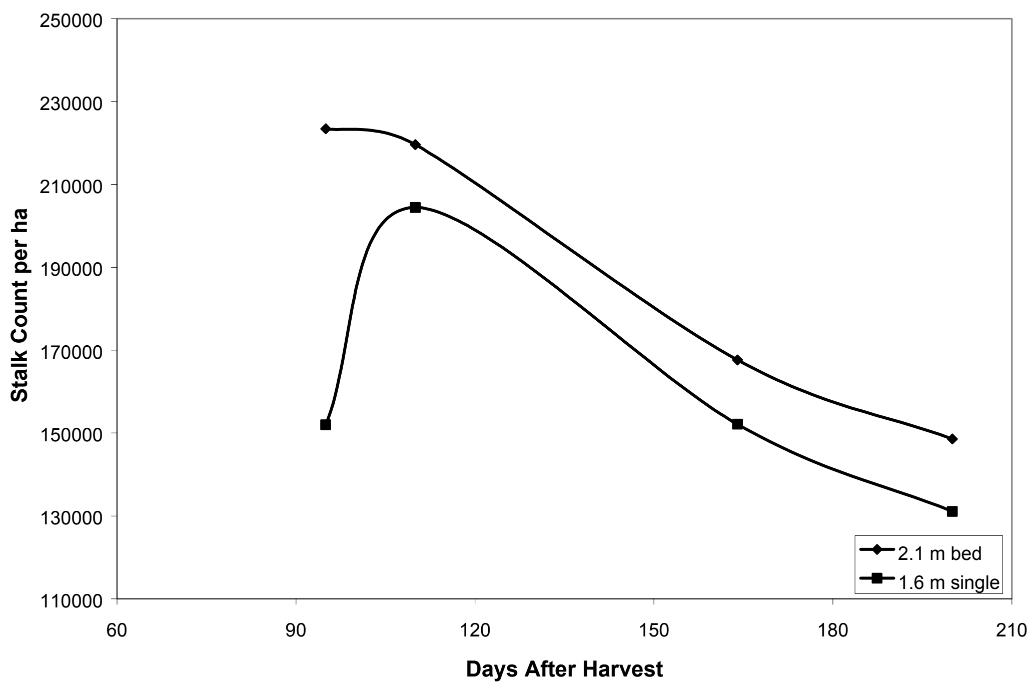

Figure 1. Mareeba trial - effect of planting configuration on stalk numbers in the second-ratoon crop

4.1.1.2 Harvest results

The trial was harvested as plant, first- and second-ratoon crops. There was no significant cultivar by row spacing interaction in any parameter at any harvest. The 2.1-m beds produced significantly ($P<0.05$) more cane in the plant and first ratoon, but not in the second-ratoon crop (Table 5). There was no significant effect of planting configuration on CCS or sugar yield.

4.1.2 Mossman

This trial was planted on 1 June 1999 at CB and JM Coulthard's farm, Cooya Beach, on a Brosnan soil type following a green-manure Leichhardt soybean crop.

4.1.2.1 Stalk counts

Stalks were counted only once in this trial, in the plant crop at 73 DAP. There was no significant cultivar by spacing interaction (P=0.45). There were significantly (P=0.0018) more stalks in the 2.1-m beds (Table 6). The cultivar Q175$^{\Phi}$ had significantly more stalks than either Q107 or Q124 (P=0.0005).

Table 5. Mareeba trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.6-m rows	2.1-m beds	1.6-m rows	2.1-m beds	t/ha	%	1.6-m rows	2.1-m beds
Plant	405 2/9/00	Q120	12.6	12.0	128	156	28	22	16.2	18.8
		Q124	8.8	10.3	122	155	32	26	10.8	15.9
		Q135	13.2	13.3	144	149	6	4	18.9	19.8
		Mean	**11.5**	**11.9 ns**	**139**	**153***	**21**	**16**	**15.3**	**18.2 ns**
First ratoon	345 13/8/01	Q120	16.16	16.69	106	126	20	19	17.2	21.1
		Q124	16.66	16.70	103	126	23	22	17.5	19.7
		Q135	17.26	17.07	137	144	7	2	23.6	24.6
		Mean	**16.69**	**16.82 ns**	**115**	**132***	**17**	**15**	**19.5**	**21.8 ns**
Second ratoon	358 7/8/02	Q120	13.30	12.13	108	121	31	29	14.0	18.4
		Q124	13.50	13.30	120	157	1	1	16.0	14.6
		Q135	13.00	13.20	140	139	17	12	18.9	20.6
		Mean	**13.30**	**12.88 ns**	**123**	**139 ns**	**16**	**13**	**16.3**	**17.9 ns**

* significant at $P < 0.05$; ns = not significant at the 5% level.

Table 6. Mossman trial - effect of planting configuration on stalk numbers per hectare in the plant crop at 73 DAP (13 August 1999)

Cultivar	1.5-m rows	2.1-m beds
Q107	38,963	106,667
Q124	42,556	103,698
Q175$^{\phi}$	50,000	117,698
Mean	**43,840**	**109,354**

4.1.2.2 Harvest results

The trial was harvested as plant, first- and second-ratoon crops (Table 7). There was no significant (P>0.05) cultivar by row spacing interaction on cane yield at any harvest. There was no significant (P>0.05) effect of row configuration on CCS, cane or sugar yield at any harvest.

Table 7. Mossman trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	Cane yield (t/ha)		Yield gain for 2.1-m beds	
			1.5-m rows	2.1-m beds	t/ha	%
Plant	454 28/8/00	Q107	105	107	3	2
		Q124	88	73	-15	-18
		Q175$^{\phi}$	93	109	16	17
		Mean	**95**	**96 ns**	**1**	**1**
First ratoon	343 8/8/01	Q107	103	114	4	5
		Q124	70	80	-1	-1
		Q175$^{\phi}$	98	97	11	11
		Mean	**92**	**97 ns**	**5**	**5**
Second ratoon	351 14/8/02	Q107	72	72	0	0
		Q124	83	70	-13	-16
		Q175$^{\phi}$	72	67	-5	-7
		Mean	**75**	**70 ns**	**-6**	**-8**

ns = not significant at the 5% level.

4.1.3 Mulgrave – Turf Farm

This trial was planted on 3 August 1999 at the Mulgrave Mill 'Turf Farm' on a white schist soil type in an area that had previously been used for turf production for 15 years. Aged mill mud was spread on a small part of the trial prior to planting. Because of the large gaps and severe weed competition in this trial, it was considered to be of no further use to the program and was ploughed out after the plant-crop harvest.

4.1.3.1 Stalk counts

Stalks were counted only once in this trial, in the plant crop 97 DAP (Table 8). There was no significant cultivar by spacing interaction (P=0.064). There was no significant effect of planting configuration or cultivar on stalk numbers (P=0.12 and P=0.19, respectively).

Stalk counts in both row spacings taken at 97 DAP were lower than expected; the 2.1-m beds had particularly poor germination. Several factors, including poor bed formation, miss-planting, extremely wet weather and strong weed competition during early crop establishment, all contributed to the poor germination in this trial.

Table 8. Mulgrave – Turf Farm trial - effect of planting configuration on stalk numbers per hectare in the plant crop 97 DAP (8 November 1999)

Cultivar	1.5-m rows	2.1-m beds
Q120	20,611	30,794
Q124	21,000	26,190
Q174$^{\Phi}$	22,444	27,063
Mean	**21,352**	**28,016**

4.1.3.2 Harvest results

This trial heavily lodged early in February 2000 and the plant crop was harvested on 23 August 2000 at 385 DAP (Table 9). There was no significant (P>0.05) cultivar by planting configuration interaction on CCS, cane or sugar yield at harvest. There was no significant (P>0.05) effect of planting configuration on CCS, cane or sugar yield at harvest.

Table 9. Mulgrave- Turf Farm trial - effect of planting configuration on yield parameters in the plant crop at 385 DAP (23 August 2000)

Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Q120	12.4	14.3	73	87	14	19	9.0	12.4
Q124	11.0	14.4	81	77	-4	-5	8.9	11.1
Q174$^{\Phi}$	13.1	14.7	109	97	-12	-11	14.3	14.3
Mean	**12.2**	**14.5 ns**	**88**	**87 ns**	**-2**	**3**	**10.7**	**12.6 ns**

ns = not significant at the 5% level.

4.1.4 Mulgrave – Bacalakis

This trial was planted on 19 July 1999 at Theo Bacalakis' farm. The block previously grew sugarcane. Because there were large gaps after the plant-crop harvest, particularly in the 2.1-m beds, this trial was also considered to be of no further use and was ploughed out after harvest of the plant crop.

4.1.4.1 Stalk counts

Stalks were counted only once in this trial, in the plant crop 72 DAP (Table 10). There was no significant cultivar by planting configuration interaction (P=0.66). There was no significant effect of planting configuration (P=0.079) or cultivar (P=0.13) on stalk numbers. This trial suffered from similar crop establishment problems as the previous trial. Stalk counts in the 2.1-m beds were much lower than expected (Table 10).

Table 10. Mulgrave – Bacalakis trial - effect of planting configuration on stalk numbers per hectare in the plant crop at 72 DAP (28 September 1999)

Cultivar	1.5-m rows	2.1-m beds
Q120	24,500	29,603
Q124	28,056	39,286
Q174[(b]	30,778	37,222
Mean	**27,778**	**35,370**

4.1.4.2 Harvest results

There was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P=0.05) effect of planting configuration on CCS, cane or sugar yield at harvest (Table 11).

Table 11. Mulgrave – Bacalakis trial - effect of planting configuration on yield parameters in the plant crop at 400 DAP (22 August 2000)

Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Q113	15.1	15.4	78	76	-2	-2	11.8	11.7
Q120	16.8	16.7	81	91	10	13	13.6	15.2
Q174[(b]	15.8	15.4	100	89	-11	-11	15.8	13.6
Mean	**15.9**	**15.9 ns**	**86**	**85 ns**	**-1**	**-2**	**13.7**	**14.2 ns**

ns = not significant at the 5% level.

4.1.5 Babinda

This trial was planted on 22 September 1999 at Bundaberg Sugar's farm at Fishery Falls on Thorpe soil type. The previous crop was a third-ratoon crop of Q154. This trial was ploughed out after plant-crop harvest because there was a large number of gaps and poor growth in both row spacings.

4.1.5.1 Stalk counts

Stalk counts were taken twice in the plant crop, 56 and 172 DAP (Table 12). There was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) effect of planting configuration on stalk number at either sampling.

Table 12. Babinda trial - effect of planting configuration on stalk numbers per hectare in the plant crop

Sample date	Days after planting	Cultivar	1.5-m rows	2.1-m beds
16/11/99	56	Q152	116,028	95,250
		Q166$^{\Phi}$	68,083	62,500
		Q174$^{\Phi}$	84,667	98,500
12/03/00	172	Q152	81,000	85,476
		Q166$^{\Phi}$	85,333	66,667
		Q174$^{\Phi}$	59,667	76,190

The stalk counts at 56 DAP in both configurations were much lower than expected, indicating poor germination. This was probably caused by the excessively wet conditions that occurred immediately after planting. Germination failure was a widespread occurrence on most commercial cane farms in the 1999-planting season in the wet tropics, particularly in Babinda, Innisfail and Ingham.

4.1.5.2 Harvest results

Results of the plant-crop harvest (Table 13) show no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield.

Table 13. Babinda trial - effect of planting configuration on yield parameters in the plant crop at 330 DAP (19 August 2000)

Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Q152	12.4	14.3	70	57	-13	-19	8.7	8.1
Q166[(b]	14.7	13.7	73	66	-7	-9	10.7	8.9
Q174[(b]	14.2	13.2	61	56	-5	-8	8.7	7.5
Mean	**13.8**	**13.8 ns**	**68**	**60 ns**	**-8**	**-12**	**9.4**	**8.2 ns**

ns = not significant at the 5% level.

4.1.6 Innisfail

This trial was planted on 24 September 1999 on Bundaberg Sugar's Mundoo Farm on a Mundoo soil type. The previous crop was sixth ratoon of Q138. This trial was ploughed out after the plant-crop harvest because of the large number of gaps in both row spacings, particularly in the Q166[(b].

4.1.6.1 Stalk counts

Stalk counts were taken at 55 and 171 DAP in the plant crop (Table 14).

At 55 DAP, there was no significant (P=0.14) planting configuration by cultivar interaction. There were significantly (P=0.005) more stalks in the 2.1-m beds, and the cultivar Q174[(b] had significantly (P=0.001) more stalks than either Q172[(b] or Q166[(b].

At 171 DAP, there was no significant (P=0.099) planting configuration by cultivar interaction and no significant effect of planting configuration (P=0.15) or cultivar (P=0.33).

Germination in this trial was low because of very wet conditions following planting. In addition, the cultivar Q166[(b] suffered poor germination due to poor-quality planting material.

Table 14. Innisfail trial - effect of planting configuration on stalk numbers per hectare in the plant crop

Sample date	Days after planting	Cultivar	1.5-m rows	2.1-m beds
17/11/99	55	Q166(b	43,222	66,750
		Q172(b	63,861	105,500
		Q174(b	98,333	139,000
13/03/00	171	Q166(b	78,667	128,095
		Q172(b	81,167	111,667
		Q174(b	95,667	114,048

4.1.6.2 Harvest results

At the plant-crop harvest (Table 15), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield.

Table 15. Innisfail trial – effect of planting configuration on yield parameters in the plant crop at 328 DAP (18 August 2000)

Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Q166(b	16.0	16.6	78	73	-5	-6	12.5	12.1
Q172(b	16.5	16.6	79	81	2	2	13.0	13.5
Q174(b	16.7	16.4	96	94	-2	-2	16.1	15.4
Mean	**16.4**	**16.5 ns**	**85**	**83 ns**	**-5**	**-6**	**13.9**	**13.6 ns**

ns = not significant at the 5% level.

4.1.7 Tully

The Tully trial was at Dick Camilleri's farm on a sandy-loam soil. It was planted on 19 August 1999, following a 6-month bare fallow.

4.1.7.1 Stalk counts and crop growth measurements

Biomass production and stalk counts were measured once in the plant crop at 168 DAP (Table 16). Two stalk-count measurements were collected in the second ratoon at 115 and 169 DAH (Table 17).

In the plant crop, there was a significant (P=0.015) cultivar by planting configuration interaction on stalk numbers (Table 16). All cultivars had significantly (P<0.05) more stalks in the 2.1-m beds than in the 1.5-m rows; Q152 had significantly more stalks than the other two cultivars only in the 2.1-m beds.

There was a significant planting configuration by cultivar interaction on stalk weight (P<0.05), with Q117 having higher stalk weight in the 1.5-m rows (Table 16). Stalk weights for Q120 and Q152 did not differ between the two planting configurations.

For biomass production in the plant crop (Table 16), all cultivars had significantly (P<0.05) more biomass in the 2.1-m beds; in the 2.1-m beds Q152 had significantly more biomass than the other two cultivars.

Table 16. Tully trial - effect of planting configuration on crop growth in the plant crop at 168 DAP

Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
Q117	35,833	149,365	0.649	0.550	23	81
Q120	59,972	164,127	0.653	0.598	39	98
Q152	62,222	226,349	0.544	0.582	34	129
Mean	**52,675**	**179,947**	**0.615**	**0.576**	**32**	**103**

In both samplings of the second-ratoon crop, there was no significant (P>0.05) cultivar by planting configuration interaction and no significant planting configuration effect on stalk numbers (Table 17).

Table 17. Tully trial - effect of planting configuration on stalk numbers per hectare in the second ratoon

Sample date	Days after harvest	Cultivar	1.5-m rows	2.1-m beds
20/11/01	115	Q124	190,600	133,500
		Q120	148,200	192,600
		Q152	245,200	254,200
15/1/02	169	Q124	107,800	108,700
		Q120	111,700	147,500
		Q152	149,000	156,200

Table 18. Tully trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	362 16/8/00	Q117	14.50	15.60	29	56	26	90	4.3	8.7
		Q120	15.20	15.10	60	66	6	10	9.1	10.0
		Q152	15.10	15.40	56	78	22	39	8.5	12.1
		Mean	**14.90**	**15.40 ns**	**49**	**67 ns**	**18**	**38**	**7.3**	**10.2 ns**
First ratoon	348 30/7/01	Q117	15.61	15.06	33	54	20	60	5.2	8.1
		Q120	15.49	15.85	43	54	11	26	6.7	8.6
		Q152	15.00	14.63	76	98	22	29	11.4	14.3
		Mean	**15.36**	**15.18 ns**	**51**	**68 ns**	**18**	**38**	**7.8**	**10.3 ns**
Second ratoon	373 7/8/02	Q117	15.27	15.39	75	79	4	5	11.5	12.2
		Q120	16.06	16.00	76	86	10	13	12.2	13.8
		Q152	15.62	15.27	84	92	8	10	13.1	14.0
		Mean	**15.62**	**15.55 ns**	**78**	**86 ns**	**7**	**9**	**12.2**	**13.4 ns**

ns = not significant at the 5% level.

4.1.7.2 Harvest results

Analyses of the harvest results of the plant, first- and second-ratoon crops (Table 18) show no significant (P>0.05) cultivar by planting configuration interactions and no significant (P>0.05) differences between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield in any of the crops. There were significant (P<0.05) cultivar effects; the cultivars Q152 and Q120 produced more cane and sugar than Q117 in the plant crop, and Q152 produced significantly more cane and sugar in the first-ratoon crop. No significant (P>0.05) cultivar effect was detected on cane or sugar yield in the second-ratoon harvest. No significant (P>0.05) cultivar effect on CCS was detected at any of the harvests.

In this trial, cane grown in the 2.1-m beds appeared to have a greater tendency to lodge. It is not known what causes this phenomenon.

4.1.8 Ingham - Robino

The Ingham trial was planted on 8 June 1999 at Alan Robino's farm on an alluvial sandy-loam following a green-manure soybean crop and mill-mud application.

4.1.8.1 Stalk counts

Stalks were counted only once in this trial, in the plant crop 45 DAP (Table 19). There was no significant cultivar by planting configuration interaction (P>0.05). There was no significant effect of planting configuration (P>0.05) or cultivar (P>0.05) on stalk numbers. Stalk numbers in this trial were less than expected in both the 1.5-m rows and the 2.1-m beds, suggesting poor germination.

Table 19. Ingham – Robino trial - effect of planting configuration on stalk numbers per hectare in the plant crop at 45 DAP (20 July 1999)

Cultivar	1.5-m rows	2.1-m beds
Q120	33,333	21,905
Q124	33,333	43,810
Q174[(b]	27,333	48,571
Mean	**31,333**	**38,095**

Stalks were counted twice in the second ratoon at 118 and 183 DAH (Table 20). There was no significant (P>0.05) planting configuration by cultivar interaction at either sampling. There was no significant effect of row spacing at 118 DAP, but the 2.1-m beds had significantly (P<0.05) more stalks at 183 DAP. The cultivar Q179[(b] had significantly (P<0.05) more stalks than either Q124 or Q164 at 118 DAP, and Q164 and Q179[(b] had significantly (P<0.05) more stalks than Q124 at 183 DAP

Table 20. Ingham – Robino trial - effect of planting configuration on stalk numbers per hectare in the second-ratoon crop

Sample date	Days after harvest	Cultivar	1.5-m rows	2.1-m beds
21/11/01	118	Q124	169,200	138,800
		Q164	175,800	161,500
		Q179$^{\phi}$	197,900	206,200
25/1/02	183	Q124	80,700	91,300
		Q164	120,900	132,800
		Q179$^{\phi}$	102,600	128,700

4.1.8.2 Harvest results

At the plant-crop harvest (Table 21), there was no significant (P=0.26) cultivar by planting configuration interaction and no significant (P=0.13) difference between the 1.5-m rows and 2.1-m beds in cane yield. The cultivar Q179$^{\phi}$ produced significantly (P=0.019) more cane than did either Q164 or Q124.

In the first-ratoon crop (Table 21), there was no significant (P>0.05) cultivar by planting configuration interaction in CCS, cane or sugar yield. The 2.1-m beds produced significantly more cane and sugar (P=0.0059 and 0.017, respectively) than the 1.5-m rows. Cane grown on the 2.1-m beds produced 46 tonnes of cane and 5.85 tonnes of sugar more than did the 1.5-m rows (Table 21). There was a significant (P<0.05) cultivar effect on CCS, cane and sugar yield; Q179$^{\phi}$ produced significantly (P<0.05) more cane and sugar than Q124.

In the second-ratoon crop (Table 21), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield.

4.1.9 Ayr – BSES Station

This trial was planted at the BSES station on 15 May 1999. The trial was flood irrigated down the wheel tracks, however, due to poor lateral movement of water in the soil, application uniformity was quite poor, particularly in the 1.8-m duals and 2.1-m beds. Attempts were made to irrigate down the middle of the 2.1-m beds.

Because there were large gaps, particularly in the middle two rows of the 2.1-m beds, the trial was ploughed out after the harvest of the first-ratoon crop.

Table 21. Ingham – Robino trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	430 12/8/00	Q124	-	-	79	101	21	27	-	-
		Q164	-	-	87	131	44	51	-	-
		Q179$^{\phi}$	-	-	115	130	15	13	-	-
		Mean	**-**	**-**	**94**	**120 ns**	**27**	**29**	**-**	**-**
First ratoon	348 26/7/01	Q124	14.21	13.46	104	146	41	45	12.87	17.80
		Q164	13.99	13.90	91	132	42	40	14.54	20.90
		Q179$^{\phi}$	13.31	13.03	120	175	55	46	15.99	22.87
		Mean	**13.80**	**13.46 ns**	**105**	**151****	**46**	**44**	**14.51**	**20.36***
Second ratoon	363 24/7/02	Q124	14.19	13.81	115	138	23	20	16.32	19.06
		Q164	14.42	14.66	130	116	-14	-11	18.75	17.01
		Q179$^{\phi}$	13.95	12.94	117	138	21	18	16.32	17.86
		Mean	**14.19**	**13.80 ns**	**120**	**131 ns**	**11**	**9**	**17.02**	**18.08 ns**

*,** significant at $P < 0.01$, 0.05 respectively; ns = not significant at the 5% level.

4.1.9.1 Stalk counts

Stalks were counted at 60, 118 and 444 DAP in the plant crop (Table 22).

At both 60 and 444 DAP, there was no significant (P>0.05) planting configuration by cultivar interaction and no significant (P>0.05) planting configuration effect on stalk numbers. At 118 DAP, there was a significant (P=0.0041) cultivar by planting configuration interaction, with Q96 having more stalks in the dual rows and 2.1-m beds than the other cultivars (Table 22). The 2.1-m beds and dual-row treatments had significantly (P=0.0039) more stalks than the 1.5-m rows.

Table 22. Ayr – BSES trial - effect of planting configuration on stalk numbers per hectare in the plant crop

Sample date	Days after planting	Cultivar	1.5-m rows	1.8-m duals	2.1-m beds
13/7/99	60	Q96	26,100	61,700	80,000
		Q117	25,300	53,900	48,400
		Q124	19,500	44,500	38,600
9/9/99	118	Q96	104,000	132,000	252,600
		Q117	76,800	135,000	151,900
		Q124	94,900	114,500	144,800
1/8/00	444	Q96	58,600	73,900	84,800
		Q117	62,500	73,600	75,700
		Q124	56,300	67,500	68,400

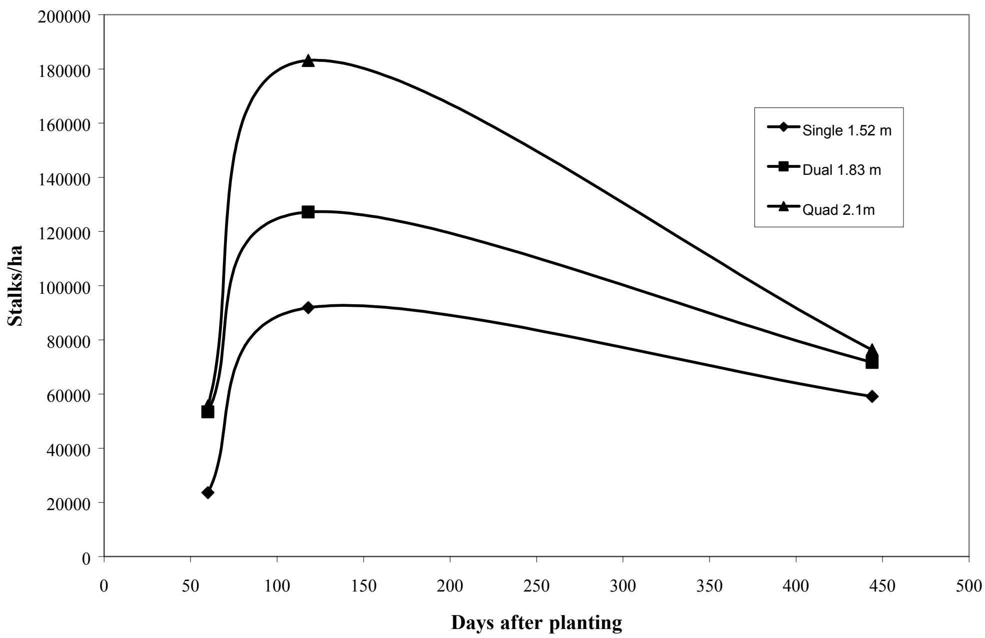

Figure 2. Ayr – BSES trial - effect of planting configuration on stalk numbers during the plant crop

4.1.9.2 Harvest results

At the plant-crop harvest (Table 23), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield. The cultivar Q124 was badly affected by lodging, orange rust, and weevil-borer and moth-borer damage.

At the first-ratoon harvest (Table 23), there was no significant (P=0.22) cultivar by planting configuration interaction. The 1.5-m rows produced significantly (P<0.05) more cane and sugar than either the 1.8-m dual rows or the 2.1-m beds. Overall, the cultivar Q117 produced significantly (P<0.05) more cane and sugar than did either Q96 or Q124.

4.1.10 Ayr – Parker

This trial was planted on Alan Parker's farm on 3 August 2000. To improve surface drainage and irrigation application, this block was laser levelled prior to planting. The trial was established successfully, but problems with irrigation application on the 2.1-m bed mounds were observed. SIRMOD, a flood-irrigation model, was used to predict water infiltration and irrigation application efficiency in the different row configurations. The model showed that the inside two rows of the 2.1-m beds did not receive adequate irrigation water. A small furrow was formed down the middle of the mounds, but, because the rows were so close together, it was not possible to obtain a large enough furrow to irrigate the middle two rows. Flood irrigation of the 2.1-m beds continues to pose considerable problems, particularly on soils with poor lateral water movement and low infiltration rates.

4.1.10.1 Stalk counts

Stalks were counted at 126, 169 and 360 DAP in the plant crop (Table 25).

At both 126 and 169 DAP, there was no significant (P>0.05) planting configuration by cultivar interaction. The 2.1-m beds had significantly more stalks per hectare than either the 1.8-m duals or 1.5-m single-row treatments (P=0.029, P=0.04, respectively).

Stalk counts taken at harvest (360 DAP) show no significant (P>0.05) cultivar by planting configuration interaction, effect of planting configuration, or cultivar.

Table 23. Ayr – BSES trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS			Cane yield (t/ha)			Yield gain for 2.1-m beds		Sugar yield (t/ha)		
			1.5-m rows	1.8-m duals	2.1-m beds	1.5-m rows	1.8-m duals	2.1-m beds	t/ha	%	1.5-m rows	1.8-m duals	2.1-m beds
Plant	476 2/8/00	Q96	15.55	16.11	15.72	150	143	179	29	19	23.3	23.1	28.2
		Q117	14.94	14.71	15.73	151	147	159	8	5	22.6	21.4	25.0
		Q124	11.27	11.12	12.30	129	128	122	-7	-5	14.6	14.1	15.1
		Mean	**13.92**	**13.98**	**14.58 ns**	**143**	**140**	**153 ns**	**10**	**6**	**20.2**	**19.6**	**22.8 ns**
First ratoon	368 5/8/01	Q96	15.92	15.52	15.18	142	116	117	-26	-18	22.6	17.9	17.8
		Q117	16.52	16.47	15.79	149	126	111	-38	-26	24.6	20.8	17.5
		Q124	14.69	14.32	13.60	116	96	72	-44	-38	17.1	13.7	9.8
		Mean	**15.71**	**15.43**	**14.86 ns**	**136***	**113**	**100**	**-36**	**-26**	**21.4***	**17.5**	**15.0**

* significant at $P < 0.05$; ns = not significant at the 5% level.

Table 24. Ayr – Parker trial - effect of planting configuration on yield parameters in the plant crop at 360 DAP

Cultivar	CCS			Cane yield (t/ha)			Yield gain for 2.1-m beds		Sugar yield (t/ha)		
	1.5-m rows	1.8-m duals	2.1-m beds	1.5-m rows	1.8-m duals	2.1-m beds	t/ha	%	1.5-m rows	1.8-m duals	2.1-m beds
Q96	14.73	14.59	15.72	126	122	120	-6	-5	18.5	18.0	18.8
Q127	16.48	16.45	17.24	146	129	144	-2	-1	24.0	21.3	24.9
Q163[(b]	14.68	14.94	15.12	119	136	133	14	12	17.3	20.4	20.2
Mean	**15.30**	**15.51**	**16.03 ns**	**130**	**126**	**133 ns**	**3**	**1**	**19.9**	**19.6**	**21.3 ns**

ns = not significant at the 5% level.

Table 25. Ayr – Parker trial - effect of planting configuration on stalk numbers per hectare in the plant crop

Sample date	Days after planting	Cultivar	1.5-m rows	1.8-m duals	2.1-m beds
8/12/00	126	Q96	128,000	131,944	220,600
		Q127	132,300	144,444	210,300
		Q163[Φ]	111,500	118,981	170,200
19/01/01	169	Q96	104,400	123,148	172,900
		Q127	115,900	118,056	152,400
		Q163[Φ]	80,400	11,111	138,100
20/08/01	360	Q96	109,000	112,037	91,300
		Q127	115,200	112,654	115,600
		Q163[Φ]	85,300	91,049	105,800

Over the course of the plant crop, there was large reduction in stalk numbers in the 2.1-m beds (Figure 3). Problems with the application of sufficient irrigation water to the middle two rows of the 2.1-m beds may have accelerated stalk death in these rows.

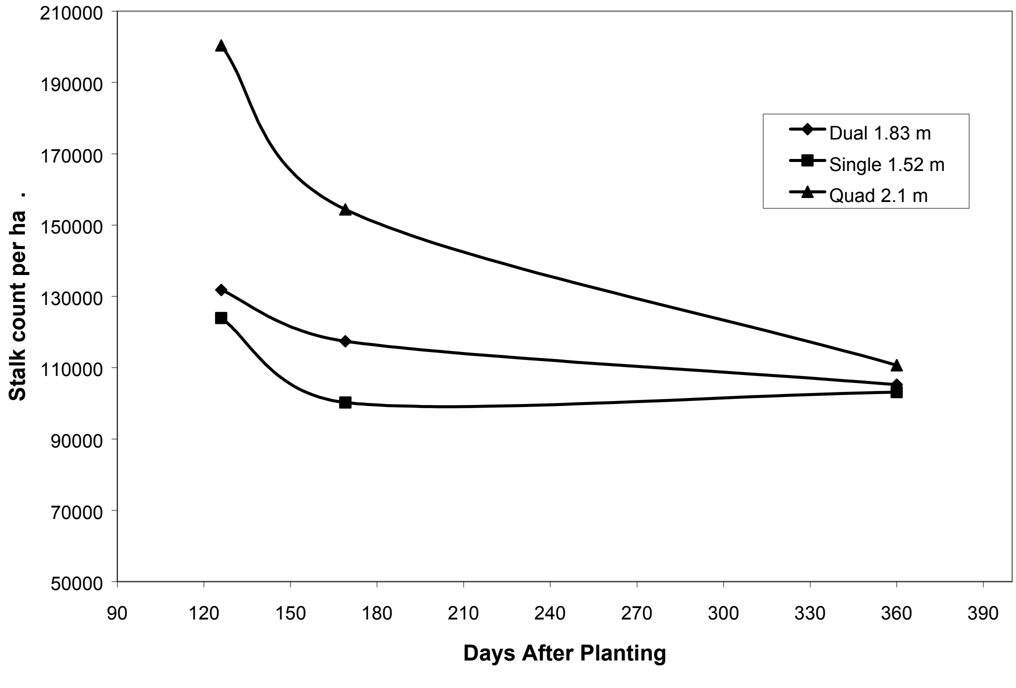

Figure 3. Ayr – Parker trial - effect of planting configuration on stalk numbers in the plant crop

4.1.10.2 Harvest results

At the plant-crop harvest (Table 24), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield. The cultivar Q127 produced significantly more cane and sugar than either Q96 or Q163[Φ].

4.1.11 Mackay

This trial was planted at Trevor Matsen's farm on a block that has two distinct soil types, a heavy clay 'glue pot' and a sandy loam. The trial was planted on the 25 July 2000, following a 6-month bare fallow. Irrigation was scheduled according to ENVIROscan® and tensiometers installed in the sandy loam soil. The moisture monitoring equipment indicated that the 2.1-m beds required more water than the 1.5-m rows during early crop establishment.

4.1.11.1 Stalk counts and crop growth measurements

Three biomass samples and seven stalk counts were taken in the plant and first-ratoon crops (Table 26).

In the plant crop (Table 26), there were significantly (P<0.05) more stalks in the 2.1-m beds at both 139 and 249 DAP. The biomass sample taken at 249 DAP showed that the 2.1-m beds had significantly (P=0.0027) more biomass. No significant (P=0.31) difference in stalk weight was measured between the two planting configurations.

Stalk numbers in the first-ratoon crop were significantly (P<0.05) higher in the 2.1-m beds at all sampling dates (Table 26; Figure 4). The biomass sampling shows there was a strong trend (P=0.06) to more biomass in the 2.1-m beds in the sampling 200 DAH, but there was no significant (P>0.05) difference in the sampling 295 DAH.

Table 26. Mackay trial - effect of planting configuration on crop growth and stalk numbers in the plant and first-ratoon crops

Crop	DAP or DAH	Stalks per ha		Weight of 1 stalk (kg)		Cane yield (t/ha)	
		1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
Plant	132	47,037	84,841	-	-	-	-
	249	78,519	131,534	0.998	0.941	78	124
First ratoon	70	66,217	100,661	-	-	-	-
	145	146,166	223,916	-	-	-	-
	200	96,000	128,000	-	-	105	146
	277	90,167	122,445	-	-	-	-
	295	102,000	120,000	-	-	110	120

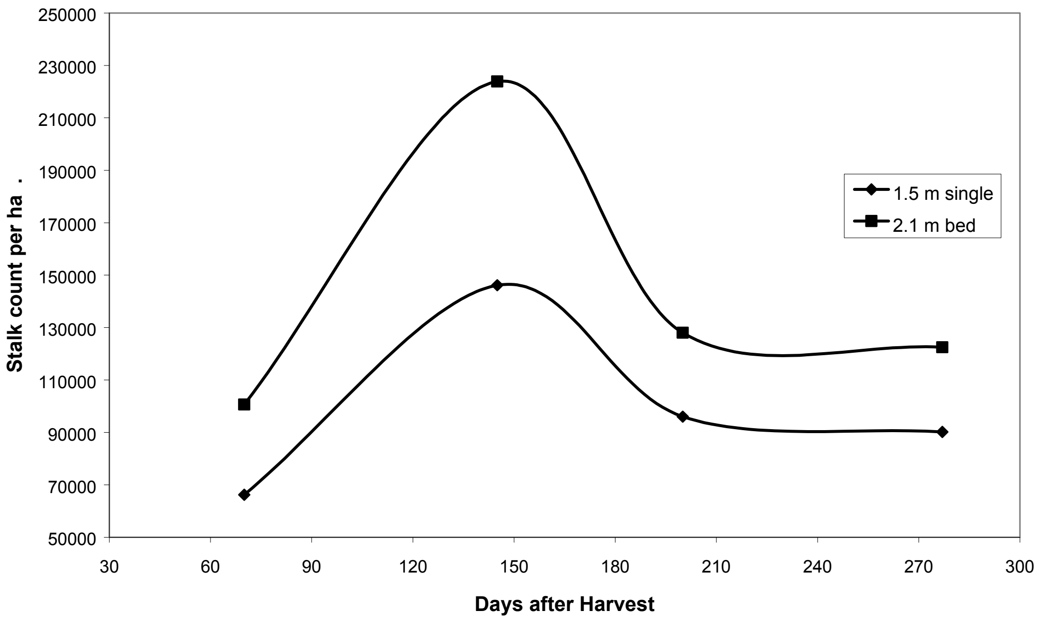

Figure 4. Mackay trial - effect of planting configuration on stalk numbers in the first-ratoon crop

4.1.11.2 Harvest results

At the plant-crop harvest (Table 27), the 2.1-m beds had produced significantly more cane (P=0.0068) and sugar (P=0.0102) than the 1.5-m rows. The 2.1-m beds increased cane and sugar yield by 30 tonnes of cane and 4.9 tonnes of sugar per hectare, respectively. There was no significant (P=0.12) effect of planting configuration on CCS.

At the first-ratoon harvest (Table 27), the 2.1-m beds had produced significantly more cane (P=0.024) and sugar (P=0.022) than the 1.5-m rows. The 2.1-m beds increased cane and sugar yield by 30 tonnes of cane and 4.3 tonnes of sugar per hectare, respectively. There was no significant (P=0.11) effect of planting configuration on CCS.

Table 27. Mackay trial - effect of planting configuration on yield parameters in the plant and first-ratoon crops

Crop	Age at harvest (days) and date	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
		1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	359 19/7/01	14.75	15.19 ns	85	115**	30	35	12.5	17.4*
First ratoon	363 17/7/02	15.58	15.22 ns	88	119*	30	34	13.8	18.1*

*,** significant at P < 0.05 and P < 0.01, respectively; ns = not significant at the 5% level.

4.1.12 Sarina

The Sarina trial was planted on 23 May 1999 at Keith Schmidtke's farm on a solodic duplex soil type following a bare fallow. Some establishment problems were experienced, due to very dry conditions prior to and very wet weather immediately after planting.

4.1.12.1 Stalk counts

Stalk counts taken at 73 DAP (Table 28) show a significant (P=0.012) cultivar by planting configuration interaction, with Q135 having more stalks in the 2.1-m beds than the other cultivars, and the 2.1-m beds having significantly (P=0.013) more stalks than the 1.5-m rows.

Initial stalk establishment in the 2.1-m beds was suboptimal and this problem was exacerbated when the grower used a 1.5-m-based tractor and tillage implement for weed control on the 2.1-m beds, which caused some damage to the outer rows on the 2.1-m beds. Despite later attempts to rehabilitate the site, an early stalk count suggested that stool establishment on the 2.1-m beds was only about 50-60% of the expected numbers (Table 28).

4.1.12.2 Harvest results

At both the plant and first-ratoon harvests (Table 29), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane or sugar yield. There was no significant (P>0.05) cultivar effect on CCS, cane or sugar yield.

4.1.13 Bundaberg – Qunaba

This trial was planted on 29 April 1999 at Bundaberg Sugar's Qunaba Plantation on a red volcanic (euchrozem) soil. Planting followed a bare fallow and application of mill mud.

4.1.13.1 Stalk counts and crop growth measurements

Stalk count and sample harvest results from the plant, first- and second-ratoon crops are shown in Figures 5-7 and Tables 30-31.

Stalk counts taken in the plant crop (Figure 5) showed there was a significant (P<0.01) cultivar by row configuration interaction measured on all counts except the 263 and 390 DAP counts. The cultivar Q151 had significantly more stalks than the other two cultivars only in the 2.1-m beds. There were significantly (P<0.05) more stalks in the 2.1-m beds in all counts, including the 263 and 390 DAP counts.

Table 28. Sarina trial - effect of planting configuration on stalk numbers per hectare in the plant crop at 73 DAP (14 August 1999)

Cultivar	1.5-m rows	2.1-m beds
Q124	17333	24603
Q135	12222	23333
Q138	31667	56190
Mean	**20407**	**34709**
Eyes planted	67000	133000

Table 29. Sarina trial - effect of planting configuration on yield parameters in the plant and first-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	432 28/7/00	Q124	11.2	12.1	60	83	23	38	6.6	9.8
		Q135	12.3	10.3	78	105	26	34	9.8	10.8
		Q138	9.8	11.9	70	95	25	35	7.1	11.4
		Mean	**11.1**	**11.5 ns**	**70**	**95 ns**	**25**	**36**	**7.9**	**10.7 ns**
First ratoon	357 20/7/01	Q124	14.0	14.6	50	88	38	75	7.1	12.8
		Q135	13.4	14.9	111	126	15	14	14.9	18.8
		Q138	14.4	15.2	75	99	24	32	10.8	15.0
		Mean	**13.9**	**14.9 ns**	**79**	**105 ns**	**26**	**40**	**10.9**	**15.6 ns**

ns = not significant at the 5% level

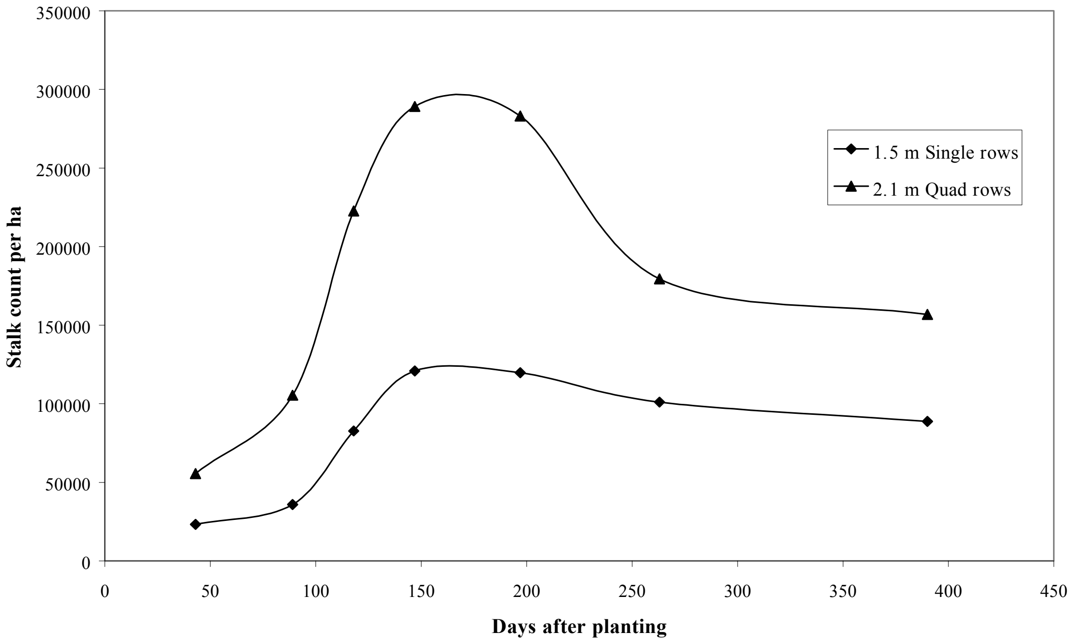

Figure 5. Bundaberg – Qunaba trial - effect of planting configuration on progressive stalk numbers in the plant crop (average of three cultivars - Q124, Q138 and Q151)

At the sample harvest at 263 DAP (Table 30), there was no significant (P>0.05) planting configuration by cultivar interaction for stalk number, stalk weight and cane yield. The 2.1-m beds produced significantly (P=0.005) more cane (69 t/ha) than the 1.5-m rows. There was a trend (P = 0.051) to heavier stalks in the 1.5-m rows.

Table 30. Bundaberg – Qunaba trial – effect of planting configuration on crop growth and stalk count measurements in the plant crop

Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
	1.5-m rows	**2.1-m beds**	**1.5-m rows**	**2.1-m beds**	**1.5-m rows**	**2.1-m beds**
Q151	119,222	202,857	0.902	0.908	108	184
Q124	79,667	150,317	1.353	1.244	107	187
Q138	104,111	185,079	1.159	0.927	120	171
Mean	**101,000**	**177,418**	**1.138**	**1.026**	**112**	**181**

There was a significant (P=0.011) cultivar by planting configuration interaction detected in the first-ratoon stalk counts (Table 31, Figure 6) only at the 105 DAH sampling. The cultivar Q151 had more stalks in the 2.1-m beds than either of the other two cultivars. The 2.1-m beds had significantly (P<0.05) more stalks than the 1.5-m rows at 105, 190 and 237 DAH samplings. The stalk weight measurements taken at the two sample harvests show no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) planting configuration or cultivar effect on stalk weight. Cane yield measurements taken at 190 and 237 DAH showed no significant (P>0.05) planting configuration by cultivar interactions. At 190 DAH, no significant (P>0.05) planting configuration or cultivar effect on cane yield was detected. At 237 DAH the 2.1-m beds had significantly (P=0.038) more cane than the 1.5-m rows. There was no significant (P=0.87) cultivar effect on cane yield measured at 237 DAH.

Table 31. Bundaberg – Qunaba trial - effect of planting configuration on crop growth and stalk count measurements in the first-ratoon crop

Days after harvest	Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
		1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
105	Q151	84,556	213,889	-	-	-	-
	Q124	44,500	131,032	-	-	-	-
	Q138	68,667	175,635	-	-	-	-
190	Q151	104,667	200,317	0.495	0.483	53	97
	Q124	85,778	158,889	0.544	0.603	48	96
	Q138	102,667	187,619	0.577	0.541	60	100
237	Q151	93,778	147,302	0.892	0.915	83	134
	Q124	85,000	123,175	0.956	1.084	82	132
	Q138	94,000	139,683	0.958	0.938	90	131

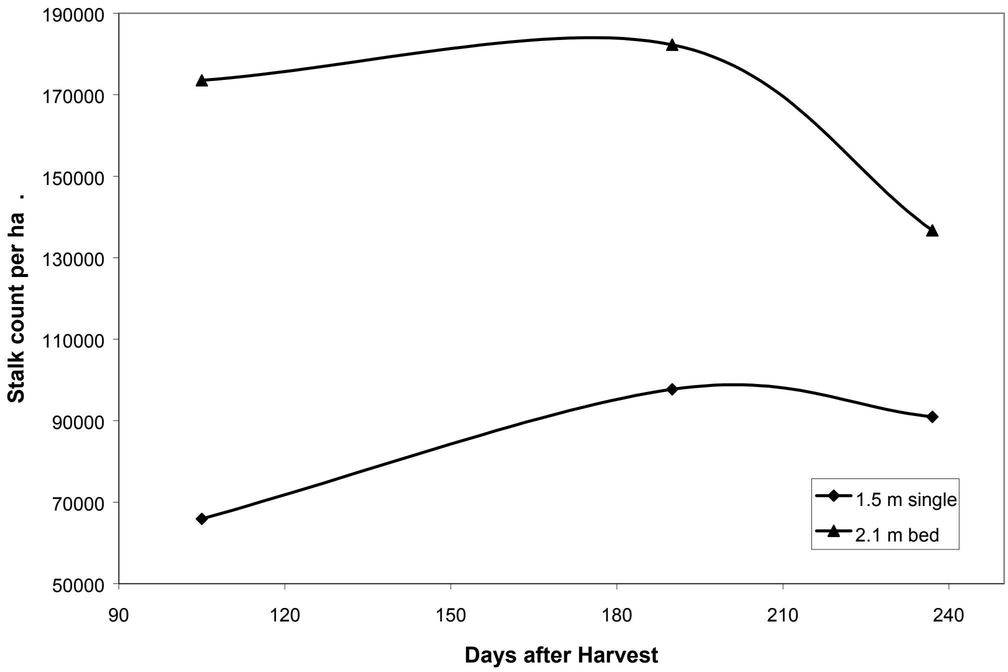

Figure 6. Bundaberg – Qunaba trial – effect of planting configuration on progressive stalk numbers in the first-ratoon crop (average of three cultivars - Q124, Q138 and Q151)

In the second ratoon (Figure 7 and Table 32), there was no significant (P>0.05) planting configuration by cultivar interaction measured at any of the three stalk counts. The 2.1-m beds had significantly (P<0.05) more stalks than the 1.5-m rows in all counts. The cultivars Q151 and Q138 had significantly (P<0.05) more stalks than Q124 at all counts.

Table 32. Bundaberg – Qunaba trial - effect of planting configuration on crop growth and stalk count measurements in the second-ratoon crop

Days after harvest	Cultivar	Stalks per ha	
		1.5-m rows	2.1-m beds
120	Q151	146,856	72,667
	Q124	71,746	33,333
	Q138	165,238	90,667
246	Q151	157,143	99,889
	Q124	111,111	84,556
	Q138	141,905	109,334
279	Q151	127,937	87,889
	Q124	104,603	70,111
	Q138	130,318	90,444

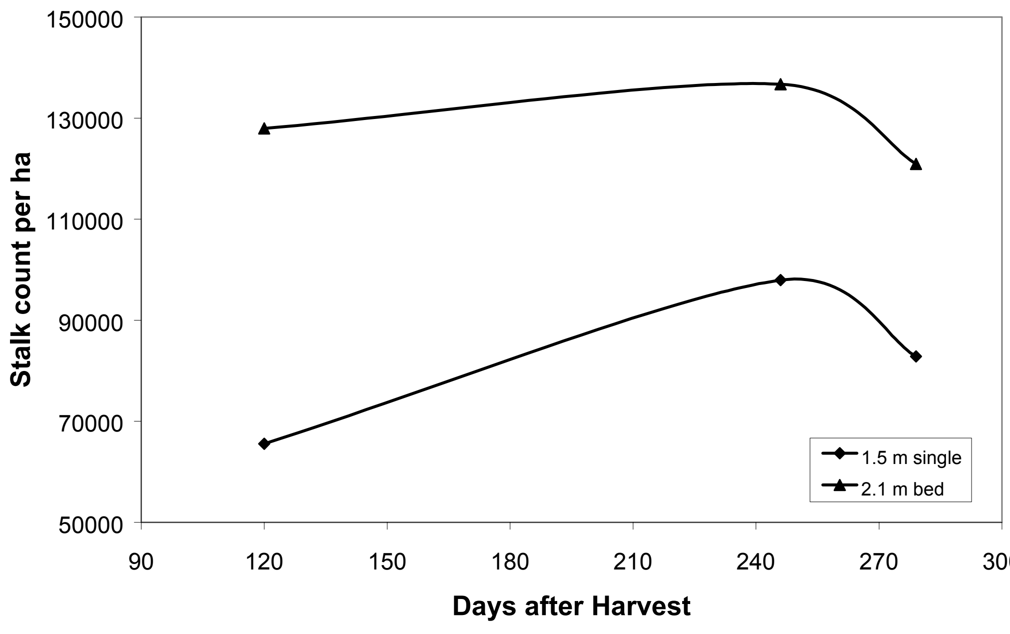

Figure 7. Bundaberg – Qunaba trial - effect of planting configuration on progressive stalk numbers in the second-ratoon crop (average of three cultivars - Q124, Q138 and Q151)

4.1.13.2 Harvest results

In each of the plant, first- and second-ratoon crops there was no significant (P>0.05) planting configuration by cultivar interaction in CCS, cane or sugar yield (Table 33).

In the plant crop, cane and sugar yields were significantly (P=0.012, 0.0029, respectively) higher in the 2.1-m beds (85 t cane/ha and 10 t sugar/ha across all cultivars) (Table 33). No significant (P>0.05) effect of planting configuration on CCS was detected.

In the first ratoon (Table 33), CCS and cane and sugar yields were significantly (P = 0.012, 0.0007, 0.0052, respectively) higher in the 2.1-m beds (38 t cane/ha and 6.5 t sugar/ha).

In the second ratoon, there was no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield (Table 33). Several factors may have contributed to the lack of response in the second-ratoon crop. The 2001-2002 season was characterised by very low irrigation allocations and one of the lowest rainfalls on record in Bundaberg. As a result, crop growth was severely limited. In addition, the trial had become quite gappy in places due to stool damage at harvest, particularly after the harvest of the first-ratoon crop.

There were significant (P<0.05) cultivar effects measured in all three harvests.

The harvest results from this trial show that the 2.1-m beds have the potential to increase cane and sugar production even in very high-yielding conditions.

4.1.14 Bundaberg - Bannister

This trial was planted on the 14 October 1999 at Peter Bannister's farm, Elliott Heads, on a black ferrosol soil. The trial was planted following a seedless watermelon crop.

4.1.14.1 Stalk counts and crop growth measurements

In the plant crop (Table 34), there was a significant (P=0.041) planting configuration by cultivar interaction at 92 DAP, but no significant (P>0.05) interaction was detected in the 148 and 187 DAP stalk counts. The cultivar Q138 had significantly more stalks in the 2.1-m beds than either Q135 or Q155. There was significantly (P<0.05) more stalks in the 2.1-m beds at all three sampling dates.

The sample harvest taken at 187 DAP (Table 34) shows a significant (P=0.012) planting configuration by cultivar interaction on stalk weight. The cultivars Q138 and Q155 had heavier stalk weights in the 2.1-m beds than Q135, but this was not repeated in the 1.5-m rows. There was, however, no significant (P=0.15) planting configuration effect on stalk weight. The sample harvest showed a significant (P=0.045) planting configuration by cultivar interaction on cane yield. The cultivar Q138 had a higher cane yield than Q155, but only in the 2.1-m beds. The 2.1-m beds produced significantly (P=0.012) more cane than the 1.5-m rows.

Table 33. Bundaberg – Qunaba trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	440 12/7/00	Q124	14.4	14.1	155	271	116	74	22	38
		Q138	12.8	12.9	159	225	66	41	20	29
		Q151	14.4	14.8	165	240	75	45	24	35
		Mean	**13.9**	**13.9 ns**	**160**	**245****	**85**	**53**	**22.2**	**34.2****
First ratoon	350 28/6/01	Q124	11.6	12.4	138	177	39	28	15.9	21.9
		Q138	10.7	12.0	143	190	47	33	15.3	22.8
		Q151	12.6	14.0	143	171	28	19	18.0	24.1
		Mean	**11.6**	**12.8***	**141**	**179****	**38**	**27**	**16.4**	**22.9****
Second ratoon	376 8/7/02	Q124	13.8	15.3	71	83	12	17	9.8	12.7
		Q138	13.3	13.7	101	97	-4	-4	13.5	13.3
		Q151	14.8	15.2	95	88	-7	-7	14.0	13.3
		Mean	**14.0**	**14.7 ns**	**89**	**89 ns**	**1**	**6**	**12.4**	**13.1 ns**

*,**, significant at P < 0.05 and P < 0.01, respectively. ns = not significant at the 5% level.

Table 34. Bundaberg – Bannister trial - effect of planting configuration on crop growth and stalk numbers in the plant crop

Days after planting	Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
		1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
92	Q135	90,815	225,820	-	-	-	-
	Q138	65,704	310,476	-	-	-	-
	Q155	64,667	244,762	-	-	-	-
	Mean	**73,729**	**260,353****	-	-	-	-
148	Q135	112,815	193,016	-	-	-	-
	Q138	116,222	207,196	-	-	-	-
	Q155	92,000	185,714	-	-	-	-
	Mean	**107,012**	**195,309****	-	-	-	-
187	Q135	96,370	157,460	0.698	0.593	66	92
	Q138	84,296	151,958	0.691	0.786*	60	120
	Q155	84,000	146,032	0.661	0.713*	54	106*
	Mean	**88,222**	**151,817****	**0.683**	**0.698 ns**	**60**	**106***

*,** significant at P<0.05 and P<0.01, respectively; ns = not significant at the 5% level.

Table 35. Bundaberg – Bannister trial - effect of planting configuration on crop growth and stalk numbers in the first-ratoon crop

Days after harvest	Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
		1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
56	Q135	66,296	170,370	-	-	-	-
	Q138	77,407	192,593	-	-	-	-
	Q155	57,778	126,772	-	-	-	-
	Mean	**67,160**	**163,245***	-	-	-	-
126	Q135	78,222	189,206	-	-	-	-
	Q138	72,074	191,111	-	-	-	-
	Q155	69,185	173,757	-	-	-	-
	Mean	**73,160**	**184,691***	-	-	-	-
154	Q135	85,481	174,603	-	-	-	-
	Q138	77,481	164,021	-	-	-	-
	Q155	81,630	171,852	-	-	-	-
	Mean	**81,531**	**170,159***	-	-	-	-
200	Q135	93,037	149,735	0.817	0.670	76	100
	Q138	83,925	144,973	0.934	0.803	78	116
	Q155	94,888	143,492	0.746	0.586	74	84
	Mean	**90,617**	**146,067***	**0.832***	**0.686**	**76**	**100****

*,** significant at P<0.05 and P<0.01, respectively; ns = not significant at the 5% level.

In the first ratoon (Table 35, Figure 8), there was no significant (P>0.05) planting configuration by cultivar interaction on stalk numbers at any of the stalk counts. There were significantly (P<0.05) more stalks in the 2.1-m beds at all stalk counts.

The sample harvest (Table 35) taken at 200 DAH showed no significant (P>0.05) planting configuration by cultivar interaction on stalk weight or cane yield. The 2.1-m beds had significantly (P=0.0006) more cane than the 1.5-m rows, but the 1.5-m rows had significantly (P=0.04) heavier stalk weights than the 2.1-m beds.

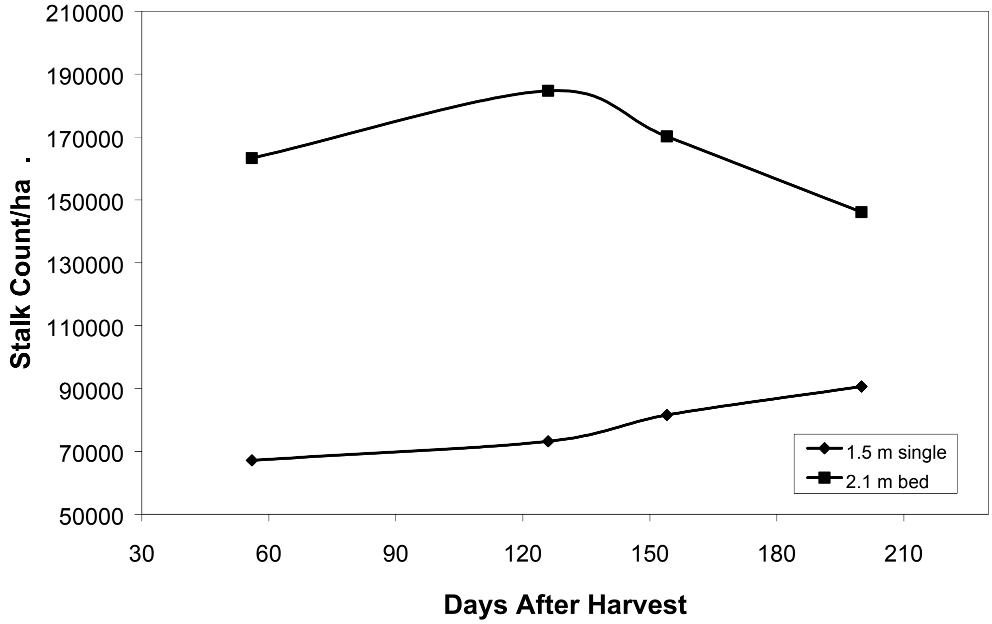

Figure 8. Bundaberg – Bannister trial – effect of planting configuration on progressive stalk numbers in the first-ratoon crop (average of three cultivars - Q135, Q138 and Q155)

Because there was a heavy trash blanket from the plant crop, germination of the first ratoon was very slow, particularly in the 2.1-m beds and for Q155. In the plant crop, the cane grown on the 2.1-m beds produced substantially more cane, but this also meant the 2.1-m beds had a larger trash blanket causing slower ratooning in the beds. To overcome this problem, this trial was burnt before harvest of the second-ratoon crop.

The second-ratoon stalk counts (Table 36 and Figure 9) showed a significant (P=0.012) planting configuration by cultivar interaction at 31 DAH. Q138 had significantly more stalks than either Q135 or Q155, but only in the 2.1-m beds. The 2.1-m beds had significantly (P=0.0011) more stalks than the 1.5-m rows. Stalk counts taken at 75, 114, 162 and 224 DAH show no significant (P>0.05) planting configuration by cultivar interaction. The 2.1-m beds had significantly (P<0.05) more stalks than the 1.5-m rows in all counts.

Table 36. Bundaberg – Bannister trial - effect of planting configuration on crop growth and stalk numbers in the second-ratoon crop

Days after harvest	Cultivar	Stalks per ha	
		1.5-m rows	2.1-m beds
31	Q135	78,290	172,910
	Q138	75,000	203,492*
	Q155	66,813	165,714
	Mean	**73,368**	**180,705****
75	Q135	102,485	214,921
	Q138	101,023	245,926
	Q155	86,184	195,873
	Mean	**96,564**	**218,907***
114	Q135	92,023	157,064
	Q138	85,472	167,818
	Q155	76,425	149,167
	Mean	**84,640**	**158,016***
162	Q135	75,137	147,302
	Q138	83,278	130,992
	Q155	83,470	153,889
	Mean	**80,628**	**144,061***
224	Q135	73,417	126,270
	Q138	81,528	109,841
	Q155	77,555	130,198
	Mean	**77,500**	**122,103***

*,** significant at P<0.05 and P<0.01, respectively; ns = not significant at the 5% level

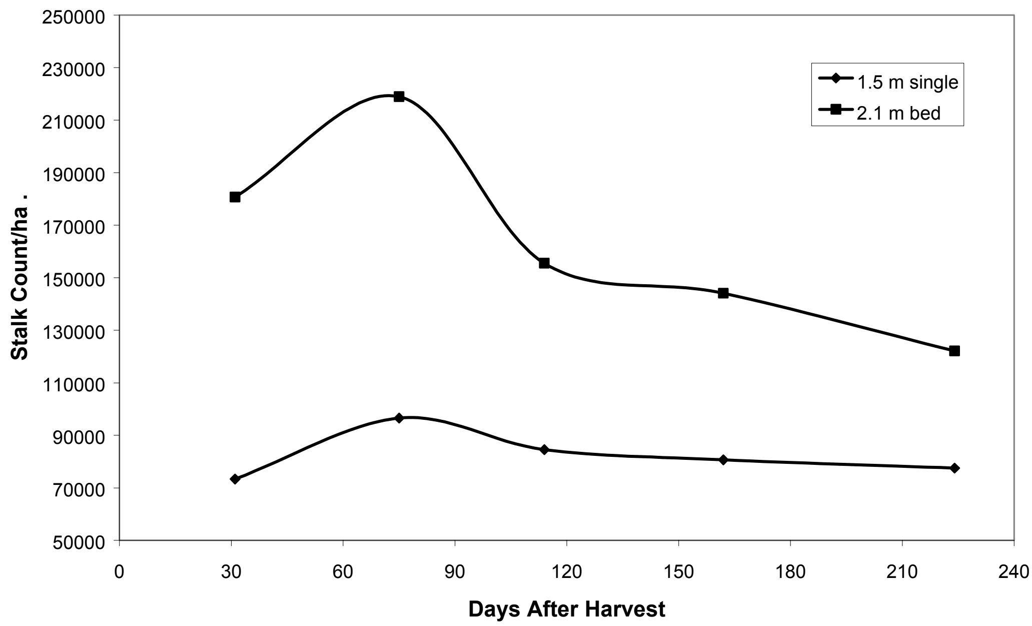

Figure 9. Bundaberg – Bannister trial – effect of planting configuration on progressive stalk numbers in the second-ratoon crop (average of three cultivars - Q135, Q138 and Q155)

4.1.14.2 Harvest results

At the plant-crop harvest (Table 37), there was no significant (P>0.05) planting configuration by cultivar interaction in CCS, cane yield or sugar yield. The 2.1-m beds produced significantly (P=0.03) more cane (27 t/ha) than the 1.5-m rows. There was no significant (P>0.05) effect of planting configuration on CCS, but there was a strong trend (P=0.054) towards more sugar production in the 2.1-m beds.

At the first-ratoon harvest (Table 37), there was a significant (P=0.0029 and 0.009, respectively) planting configuration by cultivar interaction on cane and sugar yield. Q138 produced more cane and sugar on the 2.1-m beds than did either Q135 or Q155. No significant (P>0.05) planting configuration by cultivar interaction and planting configuration effect was detected for CCS.

At the second-ratoon harvest (Table 37), there was no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield. The lack of response in the second ratoon and to some extent the first ratoon may be partly due to excessive stool damage particularly during the first-ratoon harvest, which increased the number of gaps within the stand and increased variability between the plots.

4.1.15 Maryborough - Petersen

This trial was planted on 4 November 1999 at Peterson's farm Hervey Bay on a sandy loam soil. The design of this trial lacks replication of the 1.5-m row treatment and, as a result, statistical analysis of data collected from the two planting configurations is not possible. Strips of 1.5-m single rows planted next to the trial and at the same time have been used to compare production of the 2.1-m beds.

4.1.15.1 Stalk counts and crop growth measurements

The stalk count and sample harvest results from the plant, first- and second-ratoon crops are shown in Table 38. It appeared that in the 2.1-m beds sample cane yield and stalk numbers were higher, but stalk weight was lower for Q124.

4.1.15.2 Harvest results

The harvest results are shown in Table 39. Compared to the 1.5-m rows, the 2.1-m beds appeared to have produced more tonnes of cane in all three crops (Table 39).

Table 37. Bundaberg – Bannister trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	357 6/10/00	Q135	16.4	16.1	97	116	18	19	16.0	18.6
		Q138	14.3	13.8	80	117	37	46	11.5	16.2
		Q155	15.9	16.3	88	115	27	30	14.1	18.6
		Mean	**15.6**	**15.4 ns**	**88**	**116****	**27**	**31**	**13.9**	**17.8**
First ratoon	360 1/10/01	Q135	15.6	16.0	103	100 ns	-3	-3	15.6	16.0 ns
		Q138	15.7	15.7	96	119**	24	25	15.0	18.7*
		Q155	16.2	15.4	89	102 ns	13	15	16.3	15.7 ns
		Mean	**15.8**	**15.7 ns**	**96**	**107**	**11**	**12**	**15.2**	**16.8**
Second ratoon	352 14/10/02	Q135	16.3	16.0	85	77	-8	-9	13.9	12.4
		Q138	15.8	15.8	85	80	-5	-6	13.5	12.5
		Q155	15.9	15.7	85	80	-5	-6	13.6	12.5
		Mean	**16.0**	**15.9 ns**	**85**	**79 ns**	**-6**	**-7**	**13.6**	**12.5 ns**

*,**, significant at $P < 0.05$ and $P < 0.01$, respectively. ns = not significant at the 5% level.

Table 38. Maryborough – Petersen trial - effect of planting configuration on crop growth and stalk numbers in the plant and first-ratoon crops

Crop	Days after planting or harvest and date	Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
Plant	77 (20/1/00)	Q124	74,833	176,845	-	-	-	-
		Q138	118,167	214,851	-	-	-	-
		Mean	**96,500**	**195,848**	-	-	-	-
	183 (5/5/00)	Q124	49,667	122,173	1.096	0.931	55	114
		Q138	89,833	127,143	0.723	0.785	65	100
		Mean	**69,750**	**124,658**	**0.909**	**0.858**	**60**	**107**
First ratoon	62 (18/12/00)	Q124	86,167	16,991	-	-	-	-
		Q138	138,000	219,732	-	-	-	-
		Mean	**112,083**	**194,821**	-	-	-	-
Second ratoon	121 (8/2/02)	Q124	75,500	111,146	-	-	-	-
		Q138	90,750	157,113	-	-	-	-
		Mean	**83,125**	**134,129**	-	-	-	-

4.1.16 Rocky Point - Keith

This trial was planted on 5 September 2000 at David Keith's farm at Gilberton on a clay loam soil type. The previous crop was sugarcane. Crop establishment in the 2.1-m beds suffered due to the very dry conditions before and after planting of this trial and the cane was watered post planting with a water truck. The 1.5-m rows had a better strike, as the cane was planted into good soil moisture.

4.1.16.1 Stalk counts and crop growth measurements

Stalk counts were measured in the plant crop three times and once in the first ratoon; a sample harvest was also taken just before the harvest of the plant crop (Table 40).

Table 39. Maryborough – Petersen trial – effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	357 6/10/00	Q124	-	-	98	127	29	30	-	-
		Q138	-	-	92	129	37	40	-	-
		Mean	**-**	**-**	**95**	**128**	**33**	**35**	**-**	**-**
First ratoon	357 10/10/01	Q124	15.3	15.4	94	109	15	16	14.4	16.7
		Q138	15.1	15.5	112	130	18	16	17.0	20.1
		Mean	**15.2**	**15.5**	**103**	**120**	**16**	**16**	**15.7**	**18.4**
Second ratoon	336 11/9/02	Q124	14.9	14.3	71	85	14	19	10.6	12.1
		Q138	15.9	14.6	74	112	38	51	11.8	16.3
		Mean	**15.4**	**14.5**	**73**	**98**	**26**	**35**	**11.2**	**14.3**

Table 40. Rocky Point – Keith trial - effect of planting configuration on stalk numbers and crop growth in the plant and first-ratoon crops

Crop	Days after planting or harvest and date	Cultivar	Stalks per ha		Weight per stalk (kg)		Cane yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
Plant	53 27/10/00	Q138	17,888	35,079	-	-	-	-
		Q124	11,666	16,984	-	-	-	-
		Q141	10,722	18,751	-	-	-	-
	80 24/11/00	Q138	38,401	63,492	-	-	-	-
		Q124	19,975	32,857	-	-	-	-
		Q141	25,287	31,746	-	-	-	-
	290 23/07/01	Q138	74,163	98,095	1.16	1.18	90	114
		Q124	69,719	87,301	1.15	1.12	86	96
		Q141	81,830	91,587	0.9	0.8	81	93
First ratoon	175 22/02/02	Q138	115,000	202,116	-	-	-	-
		Q124	87,281	134,286	-	-	-	-
		Q141	107,185	197,619	-	-	-	-

There was no significant (P<0.05) planting configuration by cultivar interaction on stalk counts taken at 53, 80 and 290 DAP. The 2.1-m beds had significantly (P<0.05) more stalks at 53 and 80 DAP, and a strong trend (P=0.054) to more stalks at 290 DAP.

The sample harvest collected at 290 DAP, just prior to harvest (Table 40), shows no significant (P>0.05) cultivar by planting configuration interaction and no significant (P>0.05) difference between the 1.5-m rows and 2.1-m beds in cane yield, stalk number and weight. This result was confirmed at final harvest (Table 41).

The stalk count taken at 175 DAH in the first-ratoon crop (Table 40) shows a significant (P=0.0006) planting configuration by cultivar interaction on stalk number. The cultivars Q141 and Q138 had more stalks than Q124 in the 2.1-m beds. There were significantly (P=0.0008) more stalks in the 2.1-m beds.

4.1.16.2 Harvest results

The plant and first-ratoon harvest results (Table 41) show no significant (P>0.05) cultivar by planting configuration interactions and no significant (P>0.05) differences between the 1.5-m rows and 2.1-m beds in CCS, cane yield or sugar yield.

Table 41. Rocky Point – Keith trial - effect of planting configuration on yield parameters in the plant, first-ratoon and second-ratoon crops

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	361 1/9/01	Q124	16.5	16.0	86	96	11	12	14.2	15.4
		Q138	14.6	15.1	90	114	24	27	13.2	17.2
		Q141	15.9	16.2	80	93	12	16	12.8	15.1
		Mean	**15.7**	**15.8 ns**	**85**	**101 ns**	**16**	**18**	**13.4**	**15.9 ns**
First ratoon	377 13/9/02	Q124	14.5	14.4	66	73	7	10	9.6	10.5
		Q138	12.7	13.3	82	87	6	7	10.3	11.6
		Q141	14.8	14.7	70	63	-7	-10	10.3	9.2
		Mean	**14.0**	**14.1 ns**	**73**	**74 ns**	**2**	**7**	**10.1**	**10.5 ns**

ns = not significant at the 5% level.

4.1.17 Broadwater

This trial was planted on 5 September 2000 at Gary Wooley's farm at Dungarubba on a self-mulching medium clay loam soil. The previous crop was sugarcane. In addition to the 1.5- m rows and four rows on 2.1-m beds, this trial also had a three-row on 2.1-m beds treatment.

4.1.17.1 Stalk counts

Stalks were counted once in the plant crop and twice in the first ratoon. A sample harvest was also taken in the first-ratoon crop (Table 42). The cultivar Q155 suffered bad fox and rat damage that appeared to be worst in the 2.1-m beds.

There was no significant (P>0.05) planting configuration by cultivar interaction on stalk numbers in the plant crop at 118 DAP and in the first ratoon at 93 DAH. There were significantly (P<0.05) more stalks in the four rows on 2.1-m beds. The cultivar BN81-1394 had more stalks than either Q136 or Q155.

In the first ratoon, stalk counts and weights were measured at 161 DAH. There were significantly more stalks in the four rows on 2.1-m beds (P<0.05) and a significant cultivar effect (P<0.05), but no significant row spacing by cultivar interaction. There was no significant (P>0.05) effect of row spacing or cultivar on stalk weight or cane yield.

4.1.17.2 Harvest results

At the harvest of both the plant and first-ratoon crops (Table 43), there was no significant (P>0.05) cultivar by planting configuration interaction on CCS, cane yield or sugar yield. The four rows on 2.1-m beds and three rows on 2.1-m beds produced significantly more cane than the 1.5-m rows in both crops. No significant (P>0.05) planting configuration effect was detected on CCS or sugar yield.

Table 42. Broadwater trial - effect of planting configuration on stalk numbers and crop growth in the plant and first-ratoon crops

Crop	Days after planting or harvest and date	Cultivar	Stalks per ha			Weight per stalk (kg)			Cane yield (t/ha)		
			Single 1.5 m	Triple 2.1 m	Quad 2.1 m	Single 1.5 m	Triple 2.1 m	Quad 2.1 m	Single 1.5 m	Triple 2.1 m	Quad 2.1 m
Plant	118 14/1/01	Q136	-	-	-	-	-	-	-	-	-
		Q155	109,869	121,333	186,592	-	-	-	-	-	-
		BN81-1394	162,501	215,667	272,272	-	-	-	-	-	-
First ratoon	93 9/1/02	Q136	158,995	228,042	249,603	-	-	-	-	-	-
		Q155	160,582	179,894	207,275	-	-	-	-	-	-
		BN81-1394	252,646	329,101	392,196	-	-	-	-	-	-
	161 8/3/02	Q136	101,316	118,246	128,828	0.458	0.502	0.458	46	59	59
		Q155	110,839	113,538	107,136	0.579	0.487	0.462	64	55	50
		BN81-1394	114,014	125,389	125,389	0.536	0.486	0.453	61	61	66

Table 43. Broadwater trial - effect of planting configuration on yield parameters in the plant and first-ratoon crops

Crop	Days after planting or harvest	Cultivar	CCS			Sugar yield (t/ha)			Cane yield (t/ha)				
			Single 1.5 m	Triple 2.1 m	Quad 2.1 m	Single 1.5 m	Triple 2.1 m	Quad 2.1 m	Single 1.5 m	Triple 2.1 m	Quad 2.1 m	Yield gain for 2.1-m beds	
												t/ha	%
Plant	395	Q136	14.17	13.51	13.35	19.1	19.1	21.1	135	148	158	23	17
		Q155	14.66	14.74	14.92	17.2	16.7	17.9	118	119	120	2	2
		BN81-1394	14.62	13.84	13.86	17.5	17.9	19.2	119	135	138	19	16
		Mean	**14.49**	**14.03**	**14.1 ns**	**17.9**	**17.9**	**19.4 ns**	**124**	**134**	**139******	**15**	**12**
First ratoon	335	Q136	13.7	12.3	12.1	15.7	15.7	16.0	114	126	132	18	15
		Q155	14.5	13.8	13.2	18.2	17.5	15.8	125	124	120	-5	-4
		BN81-1394	13.5	13.4	12.9	16.2	16.7	16.5	119	126	129	10	8
		Mean	**13.9**	**13.2**	**12.7 ns**	**16.7**	**16.6**	**16.0 ns**	**119**	**126**	**127***	**8**	**6**

*,** significant at $P < 0.05$ and $P < 0.01$, respectively; ns = not significant at the 5% level.

4.1.18 Harwood and Brushgrove

The Brushgrove trial (Up River site) was planted at Lewis Hughes farm on a duplex texture contrast soil type following a plough-out replant sugarcane crop. The Harwood trial (Down River site) was planted on the Harwood Mill farm on a deep well-drained alluvial soil following a soybean fallow crop. These two trials were subject to intensive crop growth monitoring as a result of a final-year university project by Ensbey (2000).

4.1.18.1 Stalk counts and crop growth measurements

The effect of row spacing on stalk number at both sites is shown in Figure 10. At all times, the 2.1-m beds (close rows) had a significantly higher shoot density than 1.5-m rows at both the Brushgrove Site ($P<0.01$) and the Harwood Site ($P<0.05$). At the final sampling date, shoot density in the 2.1-m beds at Brushgrove was 48% greater than that in the 1.5-m rows, whereas at the Harwood site there was only a 21% increase in shoot density in the 2.1-m beds.

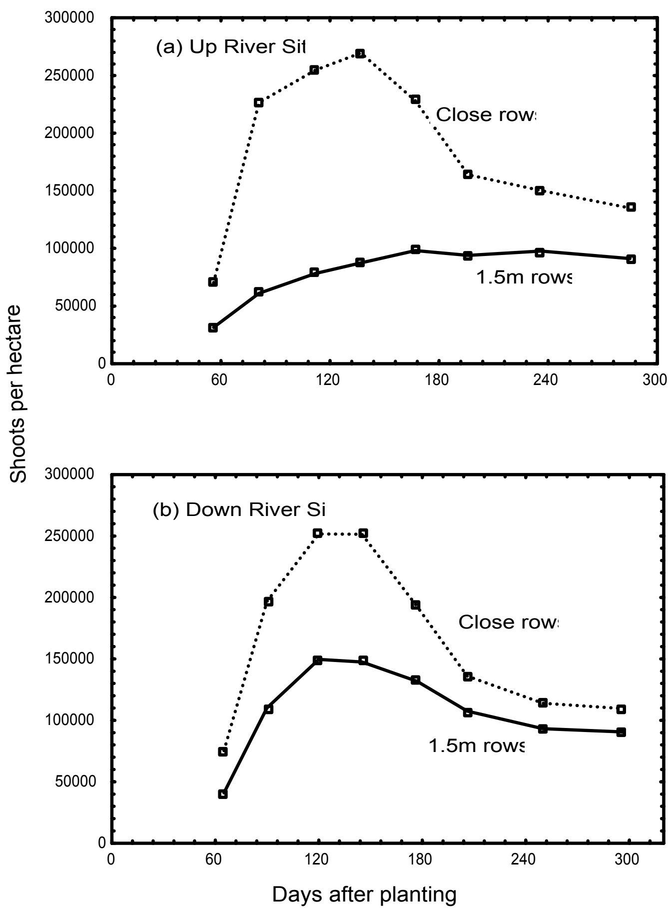

Figure 10. Effect of row spacing on shoot densities (mean of three cultivars) at the (a) Brushgrove (Up River site) and (b) Harwood (Down River site) trials at various times after planting

At the Brushgrove site there was a significant effect (P<0.01) of cultivar on shoot density from 112 DAP onwards, with BN81-1394 having the greatest shoot density. At the Harwood Site, RB72-454 initially (65 and 90 DAP) had the highest shoot density and Q124 the lowest. From 176 DAP onwards, Q155 had the greatest shoot density and Q124 the lowest. At neither site was there a significant (P<0.05) interaction between row spacing and the three cultivars.

4.1.18.2 Primary shoots reaching millable cane

Tagging emerged shoots enabled assessment of the regularity of shoot emergence and the proportion of shoots reaching millable cane. Over the period during which tagging occurred, shoot emergence was relatively consistent in the 1.5-m rows with about 20 shoots per 5 m of row emerging each month (Table 44). In contrast, shoot emergence in the 2.1-m beds peaked during December-January (56-81 DAP).

Table 44. Brushgrove trial - shoot emergence at various times and proportion of shoots reaching millable cane for three cane cultivars planted in 1.5-m rows and 2.1-m beds

Cultivar	Row spacing	Time of shoot emergence	Shoots per 5 m		Millable cane as proportion of emerged (%)
			Emerged	Millable	
75C326	**1.5-m rows**	0-56 DAP	22	20	91
		56-81 DAP	19	15	79
		81-112 DAP	23	12	52
		Total (0-112 DAP)	64	47	73
	2.1-m beds*	0-56 DAP	18	16	89
		56-81 DAP	52	7	14
		81-112 DAP	8	0	0
		Total (0-112 DAP)	78	23	29
Q155	**1.5-m rows**	0-56 DAP	24	22	92
		56-81 DAP	23	10	44
		81-112 DAP	19	15	79
		Total (0-112 DAP)	66	47	71
	2.1-m beds*	0-56 DAP	18	16	89
		56-81 DAP	30	11	37
		81-112 DAP	8	0	0
		Total (0-112 DAP)	56	27	48
BN81-1394	**1.5-m rows**	0-56 DAP	30	30	100
		56-81 DAP	23	12	52
		81-112 DAP	28	16	57
		Total (0-112 DAP)	81	58	72
	2.1-m beds*	0-56 DAP	17	16	94
		56-81 DAP	35	11	31
		81-112 DAP	15	2	13
		Total (0-112 DAP)	67	29	43

* Mean of four rows.

The proportion of initial shoots (0-56 DAP) reaching millable cane was similar (89-100%) for both row spacings. However, in the 2.1-m beds, fewer of the shoots emerging 56-81 DAP and 81-112 DAP reached millable cane compared to the 1.5-m rows (Table 41). On the 2.1-m beds, virtually none of the shoots emerging after early January reached millable cane, whereas more than 52% of the 1.5-m row shoots emerging in the same period reached millable cane. In the 2.1-m beds there was no effect of row position within the bed on the proportion of shoots reaching millable cane (data not shown).

4.1.18.3 Effect of row position on the bed

Stalks in individual rows within the 2.1-m beds were counted at each sampling date. For the 2.1-m beds at the Brushgrove Site, the outside rows of the bed had significantly (P<0.05) more shoots per metre of row (81, 167 and 196 DAP), or a trend for more shoots (556, 112, 137, 236 and 285 DAP), compared to the middle two rows (Figure 11).

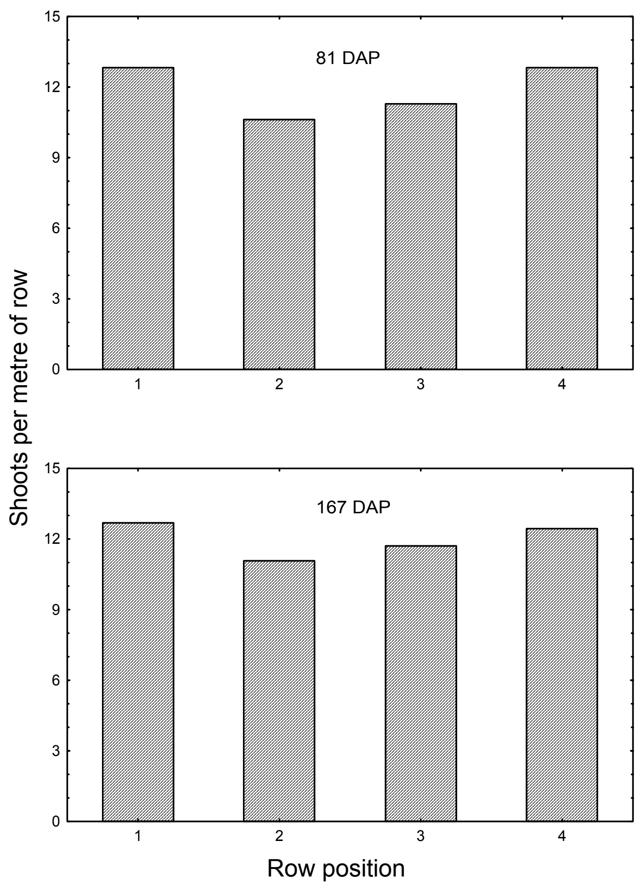

Figure 11. Brushgrove trial - effect of row position on shoots per metre of row in the 2.1-m beds at 81 and 167 DAP

At the Harwood Site there was a significant (P<0.05) effect of row position at all sampling times. As for the Brushgrove Site, the outside rows had higher shoot numbers (Figure 12). There was no significant interaction (P>0.05) between row position and cultivar at either site at any of the sampling times and values presented are the averages of the three cultivars at each site.

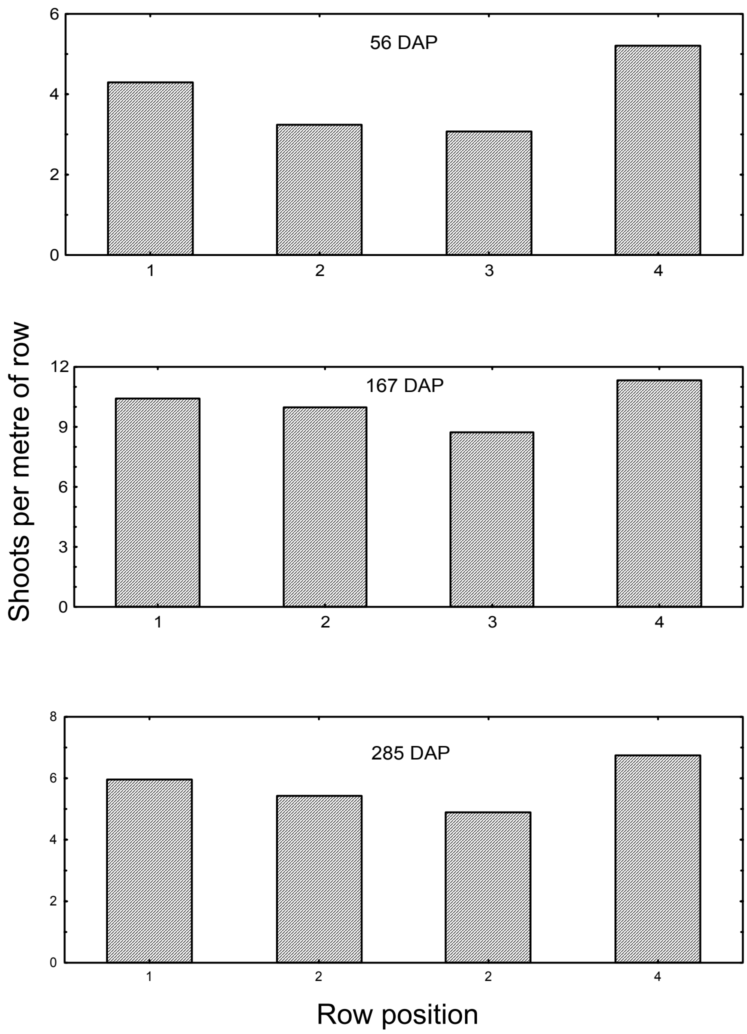

Figure 12. Harwood trial - effect of row position on shoots per metre of row in the 2.1-m beds at 56, 167 and 285 DAP

4.1.18.4 Stalk height

At the Brushgrove Site, stalks were significantly ($P<0.05$) higher in the 2.1-m beds at all times (Figure 13).

There were significant cultivar effects on height up to 137 DAP, with Q155 taller (data not shown). From 167 DAP onwards there was no significant effect of cultivar on stalk height. There was no significant interaction between row spacing and cultivar (data not shown).

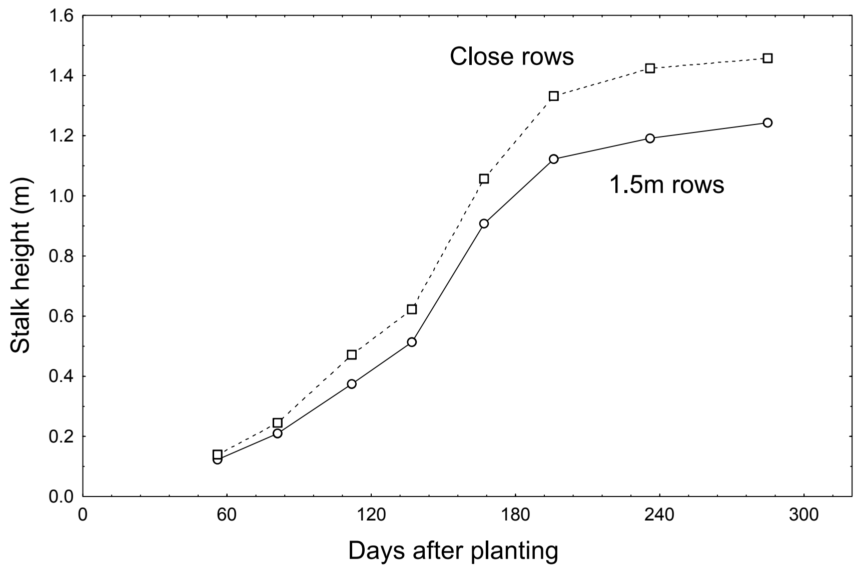

Figure 13. Brushgrove trial - stalk height (average of all cultivars) at various times after planting

At the Harwood site, stalks (Figure 14) were significantly higher ($P< 0.05$) in the 1.5-m row spacing up until 176 DAP. Between 206 and 296 DAP, there were no significant differences (Figure 14). There was a significant effect ($P<0.01$) of cultivar on height, with Q124 the highest at all measurement times (data not shown). From 120 DAP onwards there was a significant interaction ($P<0.01$) between cultivar and row spacing. For Q155 and Q124, cane was higher in the 1.5-m rows compared to the 2.1-m beds at all stages. In contrast, RB72-454 was taller in the 2.1-m beds than in the 1.5-m rows.

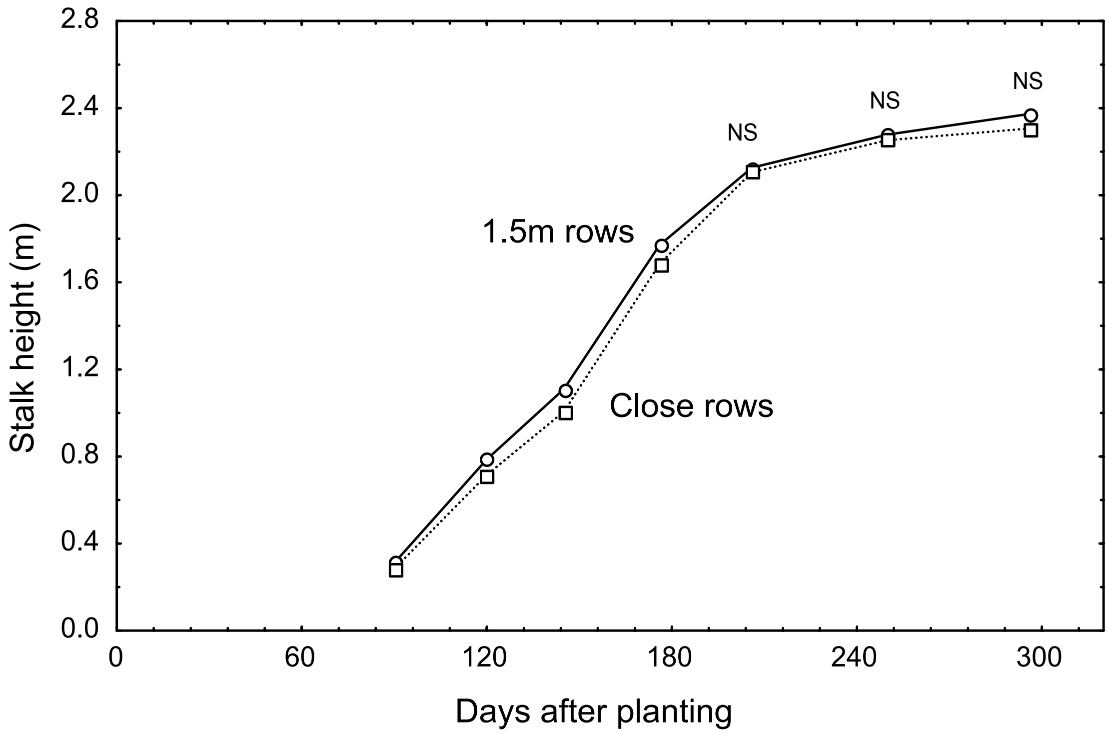

Figure 14. Harwood trial - stalk height (average of all cultivars) at various times after planting (NS= no significant difference (P<0.05))

4.1.18.5 Stalk diameter

At the Brushgrove Site, there was no significant (P<0.05) effect of row spacing on stalk diameter with 2.1-m beds and 1.5-m rows having stalk diameters of 24.3 and 24.5 mm, respectively. The clone 75C326 had a significantly larger stalk diameter than either Q155 or BN81-1394 (Figure 15). At the Harwood Site, there was no significant difference (P<0.05) between row spacing, with diameters of 26.1 and 26.3 for the 1.5-m rows and 2.1-m beds, respectively. Q155 had significantly lower stalk diameter compared to either RB72-454 or Q124 (Figure 15). There was no significant interaction (P<0.05) between row spacing and cultivar on stalk diameter at either of the trials.

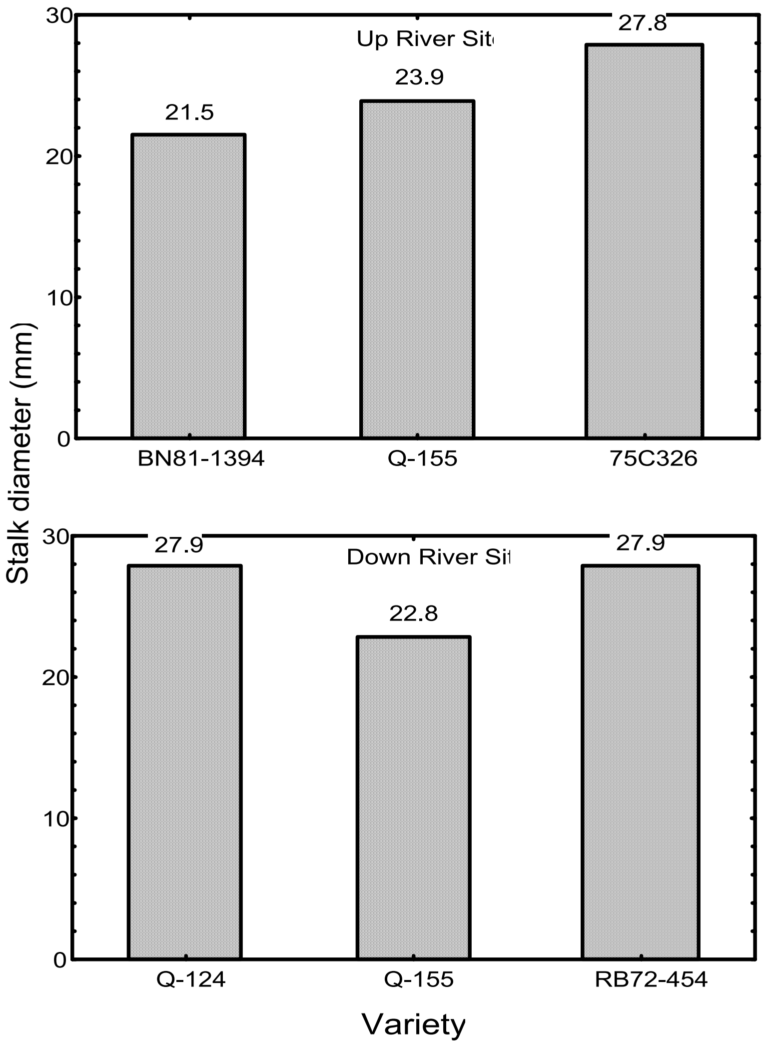

Figure 15. Mean stalk diameter for individual cultivars at Brushgrove and Harwood trials

4.1.18.6 Harvest results

In the Brushgrove trial (Table 45), the four rows on 2.1-m beds produced significantly ($P<0.05$) more cane and sugar than the 1.5-m rows. No significant CCS effect was detected.

Severe frosts in July 2002 caused the death of all growing points and eyes. As a result, the trial was harvested with a commercial machine in July 2002. No yield results are available.

Table 45. Brushgrove trial - effect of planting configuration on yield parameters in 1- and 2-year plant cane and first-ratoon crop

Crop	Age at harvest (days) and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant 1-year	358 27/10/00	Q155	15.4	15.2	38	73	35	92	5.9	11.1
		BN81-1394	14.2	14.5	34	69	35	103	4.8	10.0
		75C326	12.8	12.7	42	75	33	79	5.4	9.5
		Mean	**14.1**	**14.1 ns**	**38**	**73****	**34**	**89**	**5.4**	**10.2***
Plant 2-year	720 10/01	Q155	15.2	15.2	92	134	42	46	14.0	20.4
		BN81-1394	14.3	14.7	104	154	50	48	14.8	22.6
		75C326	14.5	14.5	96	162	66	68	14.0	23.5
		Mean	**14.7**	**14.8 ns**	**97**	**150***	**53**	**54**	**14.2**	**22.1***
First ratoon	350 09/01	Q155	15.0	15.9	50	68	18	36	7.5	10.8
		BN81-1394	14.9	14.7	55	77	21	39	8.2	11.3
		75C326	13.6	13.0	59	85	26	45	8.0	11.1
		Mean	**14.5**	**14.5 ns**	**55**	**77***	**22**	**40**	**7.9**	**11.0***

*,**, significant at P < 0.05 and P < 0.01, respectively. ns = not significant at the 5% level.

The harvest results from the 1-year-old cane at the Harwood trial are presented in Table 46. In the plant and first-ratoon crops, the 2.1-m beds produced 27 and 30 tonnes per hectare more cane, respectively, than the 1.5-m rows. There was no significant effect of planting configuration in the second-ratoon crop. No significant CCS effect was detected in any of the crops.

There was no significant difference in production between the two planting configurations in the 2-year-old cane harvested in the 2001 season (Table 47). There was also no difference in production between the two treatments when this trial was cut as 1-year-old first ratoon in 2002.

4.1.19 Summary of harvest results

4.1.19.1 Plant crops

Twenty-one trials were cut as plant cane. The 2.1-m beds produced significantly more cane in nine of those trials; in no trial was a significant reduction in cane yield measured. Where a significant response was measured, the 2.1-m beds produced 37% more cane than the 1.5-m rows; the increase varied from 2 to 103%.

The 2.1-m bed system has been shown to have the potential to increase cane yield under a wide range of growing conditions (Figure 16). Under severely limited growing conditions where cane grown on 1.5-m rows produced less than 50 t cane per hectare, the 2.1-m beds showed the potential to substantially increase cane yields (ca 85%). Under excellent growing conditions, the 2.1-m beds also produced significantly higher yields than the 1.5-m rows. The 2.1-m beds system has shown the potential to minimise some of the current variation in cane production due to environmental effects.

No significant difference in whole stalk CCS was measured in any of the trials. Over 36 individual cultivar performance comparisons were made on the two systems. No significant planting configuration by cultivar interaction was found in the plant crop. Cultivars had a significant effect on CCS, cane and sugar yield in many of the trials, as would be expected.

The stalk counts collected from the trials show the extreme importance of crop establishment on crop production and the response to the 2.1-m beds. Based on the planting rate, the 2.1-m beds should have approximately twice as many stalks than the 1.5-m rows in the early crop-establishment phase. The stalk counts suggest that eight of the trials suffered from less than optimal germination, the 2.1-m beds were particularly badly affected. In some of the trials, the stalk counts suggest that less than a quarter of the eyes planted successfully established. Less than acceptable germination was measured in 7 of the 12 trials where no significant difference in yield was measured. In these trials, the 2.1-m beds could not be expected to produce any more cane than the 1.5-m rows.

Table 46. Harwood trial - effect of planting configuration on yield parameters in 1-year-old plant, first-ratoon and second-ratoon crops

Crop	Days after planting or harvest and date	Cultivar	CCS		Cane yield (t/ha)		Yield gain for 2.1-m beds		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	t/ha	%	1.5-m rows	2.1-m beds
Plant	359 28/10/00	Q124	13.4	13.2	138	153	15	11	18.5	20.2
		Q155	13.7	13.7	131	153	21	16	18.0	20.9
		RB72-454	12.3	11.5	119	162	43	37	14.6	18.7
		Mean	**13.1**	**12.8 ns**	**129**	**156***	**27**	**21**	**17.0**	**20.0 ns**
First ratoon	365 09/01	Q124	15.0	15.2	127	155	28	22	19.1	23.6
		Q155	15.4	15.0	135	152	17	13	20.8	22.8
		RB72-454	14.1	13.5	124	155	31	25	17.5	20.9
		Mean	**14.8**	**14.6 ns**	**128**	**154***	**30**	**23**	**19.1**	**22.4***
Second ratoon	335 09/02	Q124	15.2	15.2	108	104	-4	-4	16.4	15.7
		Q155	15.3	14.7	115	105	-10	-8	17.6	15.5
		RB72-454	13.8	13.5	87	94	7	8	12.1	12.7
		Mean	**14.8**	**14.4 ns**	**103**	**101 ns**	**-7**	**-4**	**15.4**	**14.6 ns**

* significant at P < 0.05; ns = not significant at the 5% level.

Table 47. Harwood trial - effect of planting configuration on yield parameters in a 2-year plant crop followed by a 1-year first-ratoon crop

Crop	Days after planting or harvest and date	Cultivar	CCS		Cane yield (t/ha)		Sugar yield (t/ha)	
			1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds	1.5-m rows	2.1-m beds
Plant 2-year	720 Oct 2001	Q124	13.7	10.4	240	260	32.9	36.4
		Q155	15.5	15.4	238	274	36.9	42.2
		RB72-454	12.4	13.3	235	266	29.1	35.4
		Mean	**13.8**	**14.2 ns**	**238**	**267 ns**	**33.0**	**37.9 ns**
First ratoon	335 Sept 2002	Q124	-	-	103	102	-	-
		Q155	-	-	82	94	-	-
		RB72-454	-	-	81	80	-	-
		Mean	**-**	**-**	**89**	**92 ns**	**-**	**-**

ns = not significant at the 5% level.

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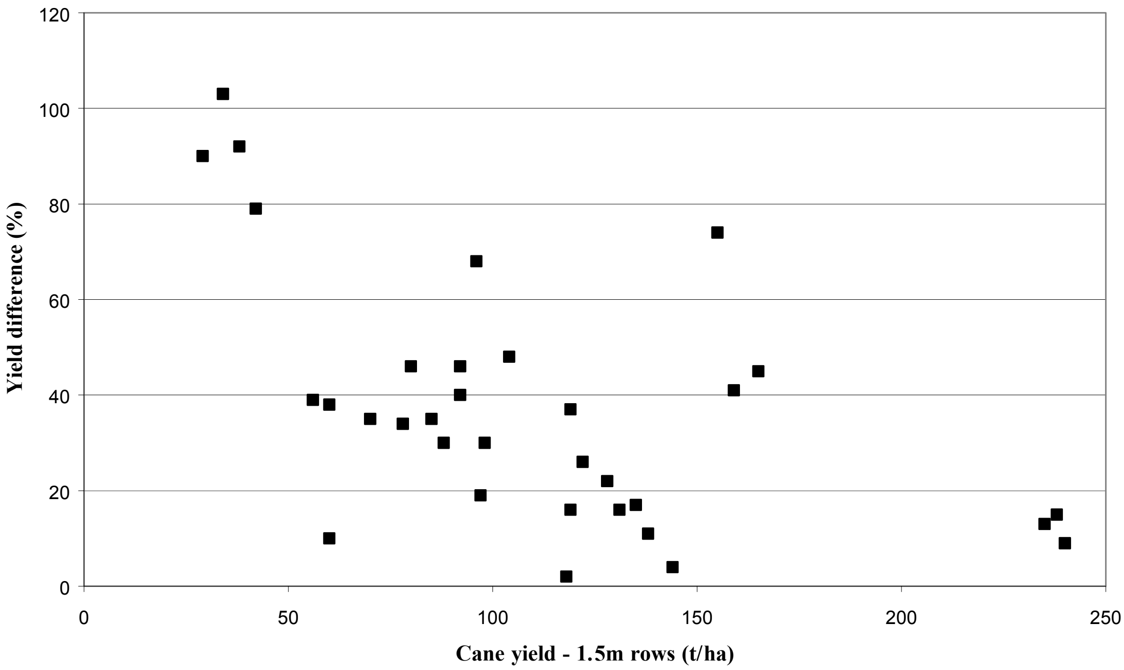

Figure 16. Yield increases in plant crops attributable to 2.1-m beds compared with 1.5-m rows. Trials with a significant difference between treatments presented (n=33)

Of the seven trials in the wet tropics (Mossman, Mulgrave – Turf farm, Mulgrave - Bacalakis, Babinda, Innisfail, Tully, and Ingham), no significant difference in yield between the two planting configurations was measured in the plant crop. Stalk-count data collected from these trials suggest that only the Tully and Mossman trials had acceptable germination. Adverse weather conditions in the 1999 season caused poor germination and establishment problems in many of the trials. In that season, widespread germination failures in commercial plantings in these districts were reported.

No difference in yield was measured in either of the two Ayr trials. Crop production in this district is fully reliant on irrigation. Due to the use of flood irrigation and poor lateral movement of water in the soil, uniformity of irrigation was very poor particularly in the dual rows and 2.1-m beds. Attempts were made to irrigate down the middle of the 2.1-m beds; however, at harvest, crop growth in the middle two rows of the 2.1-m beds was substantially reduced.

4.1.19.2 First-ratoon crops

Due to poor crop establishment or uncontrollable weed growth, six trials were ploughed-out after the harvest of the plant crop. Fifteen trials were harvested as first ratoon; the 2.1-m beds produced significantly more cane in eight of those trials. A significant reduction in yield was measured only in the Ayr-BSES trial. On average, the 2.1-m beds produced 16% more cane than the 1.5-m rows (Figure 17). The response varied from a 38% reduction in yield in the Ayr-BSES trial to a 46% increase in yield in the Ingham trial. A significant farming system by cultivar interaction was measured only at the Bundaberg-Bannister trial, where Q138 produced significantly more cane in the 2.1-m beds than did either Q155 or Q135.

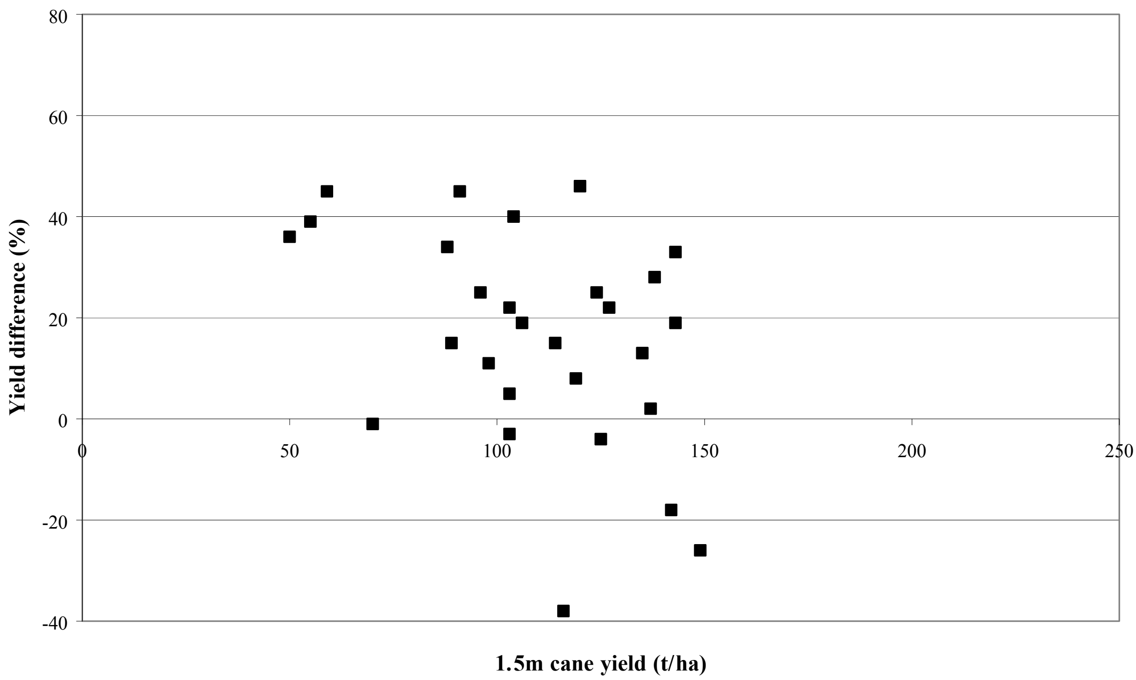

Figure 17. Yield increases in first-ratoon crops attributable to 2.1-m beds compared with 1.5-m rows. Trials with a significant difference between treatments presented (n=28)

4.1.19.3 Second-ratoon crops

After the harvest of the first-ratoon crop, the trials were inspected for gaps, weed infestation and harvester damage. Many of the trials were very gappy at this stage and were deemed to be of no further use to the program. Seven trials were considered acceptable and were ratooned. The second-ratoon harvest results showed no significant differences in CCS, cane or sugar yield in any of these trials.

Loss of stool and harvester damage is one of the contributing factors to the lack of response in the older ratoons. In large, well-grown crops, the harvester driver found it very difficult to find the wheel track and keep the machine on track. As a result, substantial physical damage to the stool and soil compaction problems were evident, particularly in the outside rows (Figure 18). By installing a vehicle guidance system such as DGPS or similar on the harvester it could be possible to minimise this damage.

Figure 18. Stool damage evident in the 2.1-m beds after the second-ratoon harvest of the Bundaberg-Qunaba trial (October 2002)

4.2 Design and fabrication of multi-row equipment

4.2.1 Bed former

To assist with feeding the harvester, the bed former was designed to form beds with a similar profile to that of the harvester's ground-engaging equipment. Due to the extensive nature of the trials, the bed former needed to perform on a large array of soil types. The final design consisted of a set of hilling-up boards followed by a shaped crumble roller (Figure 19).

Figure 19. Bed former and tactile guidance system in operation

To ensure the formation of a consistent profile, the bed former needed to be finely adjusted according to soil and field conditions. The need to complete planting within the available 'window' meant that a technician was not present at some sites during bed forming and planting operations. This situation had several implications:

- In some cases, it was not possible to allow the desirable 4-6 week period between bed formation and planting. Consequently, beds at many sites were still unconsolidated at planting, leading to less than perfect soil conditions and some soil loss from the shoulders of the beds. Particularly during extended dry conditions and in well-drained soil types the lack of moisture in the beds reduced germination of cane in the beds.
- Some beds were formed when soil moisture conditions were too moist (leading to unduly 'cloddy' soil conditions in the bed), some beds were too shallow because they were formed after insufficient field preparation (not enough tilled soil to form beds), and some beds were formed with an incorrect profile (due to misunderstanding about the shape of bed required).
- In some cases, the bed-forming equipment was incorrectly adjusted, which led to incorrect bed shape and/or irregular track widths. The cane planted on the beds suffered disproportionately higher stool damage at harvest compared to the 1.5-m rows.

These reduced germination and crop establishment in the 2.1-m beds in some of the trials. However, under commercial farming conditions, it would be expected that the operator of the bed former would be more familiar with its adjustment for a particular soil type and, as a result, produce a more accurate and consistent profile. It may also be possible to increase the amount of time the bed is allowed to settle and accumulate moisture prior to planting.

The beds were beneficial in reducing the period of waterlogging and as a result improved crop establishment and growth. Heavy rainfall soon after planting at three sites caused waterlogging damage in the 1.5-m rows planted conventionally in furrows. However, the 2.1-m beds shed the excess water and the controlled-traffic tracks between beds improved field drainage so that the beds avoided any such damage. Under waterlogged conditions, preformed beds have been shown to have an enormous potential to increase germination and crop growth. The use of preformed beds should be considered, particularly in the Queensland wet tropics and northern New South Wales.

4.2.2 Planter

The multi-row planter was designed using results from SRDC project BSS208 'Improved planting systems for sugarcane' and with assistance from P&H Rural. Queensland Rail funded the construction of two multi-row double-disc-opener whole-stick planters (Figures 20 and 21).

Figure 20. Multi-row whole-stick planter in operation

Figure 21. Double-disc-opener planter

The planter was hydraulically driven and the chopper boxes were regulated via a Rimik® controller. This system allowed the driver to adjust the length of billets and spacing between billets. It is also possible to adjust the distance between the rows and even reduce the number of rows planted by moving the planters; it could be used to plant two and three rows of cane on the 2.1-m beds.

Stalk counts taken after germination show that, when the multi-row planter is supplied with good-quality planting material and operated correctly, it performs as well as conventional whole-stick planter, but with more accuracy and a much lower tractor power requirement (Figure 22).

Figure 29. Establishment of four rows on 2.1-m beds (left) compared with 1.5-m rows (right)

A conventional single-row whole-stick planter allows for overlap between stalks and results in a planting rate of 4-5 billets per metre of row. The multi-row planter has been set up to provide a gap of about 5 cm between billets and should result in a planting rate of about 3.5 billets per metre. At early crop establishment phase, competition effects should be minimal. Therefore, the number of stalks should closely reflect the number of eyes planted, ie 25-35,000/ha at 1.5-m and 70-80,000/ha in 2.1-m beds.

At some sites the planter settings were changed to accommodate perceptions of local conditions leading to incorrect depths of planting across the beds, planter blockages and consequent gaps in planted material.

The double-disc opener was highly effective at planting cane into beds with minimal soil disturbance. It has been shown to have applications under reduced and minimum-till planting systems.

4.2.3 Cultural equipment

To effectively manage irrigation and weed control, it was necessary to modify or construct new equipment and use different technology. The rapid canopy closure in the 2.1-m beds dramatically reduced the need for further weed control. Weed control proved to be difficult; cultivation between the rows or using directed sprayers proved to be almost impossible, particularly without an accurate guidance system. Weed control was achieved successfully through the use of a pre- and post-emergence herbicide program. The recently registered sunlight-stable long-residual herbicides, Balance® and Flame®, were used successfully at many of the trials to control weeds.

The installation of trickle tape between the rows was performed with a specially constructed implement (Figure 30).

Figure 30. Trickle-tape installer for four rows on 2.1-m beds

4.2.4 Harvester and haulouts

A conventional sugarcane harvester was modified with the assistance of Austoft to enable the mechanical harvesting of the trials (Figure 31). Two high-lift haulout tractors and trailers were modified to 2.1-m wheel spacing.

Figure 31. Multi-row harvester and haulout cutting cane - Qunaba trial 2000. Average yield from 2.1-m beds was 245 tonnes cane per hectare

Figure 32. Four base cutters and spirals fitted to the multi-row harvester (August 2002)

Four base cutters and modified spirals were installed to enable the harvesting of four rows of cane at once (Figure 32). During the project, significant modifications were made to the machine to improve the feeding characteristics and machines performance. Feeding problems were experienced during the harvesting of small crops. A topper was never fitted due to a lack of hydraulic capacity and because many of the crops were heavily lodged at harvest. Cane loss and extraneous matter was measured in some of the trials. Under some conditions, the multi-row harvester had higher cane loss and extraneous matter than a conventional machine. The installation of a three-blade chopper box prior to the start of the 2002 season reduced the cane loss problem. The lack of guidance equipment on the harvester and haulouts caused some problems with navigation particularly in heavily lodged 2.1-m beds. Considering the conditions, the harvester and haulout equipment performed extremely well.

4.3 Develop an extension package and protocols for HDP

Two booklets 'Manual for dual rows in sugarcane' and 'A high density farming system for improved sugarcane production' have been published and made available to growers.

The first defines what is meant by 'dual rows', discusses why some growers might adopt dual rows, outlines the management practices required, assesses the benefits that might be expected, and considers the problems that need to be addressed. Dual rows are seen as an 'intermediate' step in moving to high-density farming systems.

The second considers what is wrong with the current farming system and what is required for an improved system. It then shows how an improved farming system can be developed, outlines the likely operations for the quad-row [2.1-m beds] system, and assesses the expected benefits from an improved system.

In addition, throughout the project, extension officers have arranged regular field visits to the trials for growers and industry personnel to view planting and harvesting of the trials and the equipment used.

5.0 OUTPUTS

The SRSTs were successful in comparing the performance of the two farming systems under field conditions in all the major sugarcane districts of Queensland and New South Wales. A significant yield response was measured in 9 of the 21 plant-cane trials and 8 of the 15 first-ratoon trials. Where a response was measured, the 2.1-m beds produced an average of 37% and 16% more cane than the 1.5-m rows in the plant and first-ratoon crops, respectively. No significant CCS, cane or sugar yield response was measured in any of the second-ratoon crops. The 2.1-m beds had significantly higher whole-stalk CCS at harvest in the first-ratoon Qunaba trial. A significant cultivar by row spacing interaction was measured only in the first-ratoon of the Bannister trial where Q138 out performed Q135 and Q155 in the 2.1 m beds. The stalk counts and associated cane yield data collected from the trials highlight the importance of good establishment.

A major part of this project was the design and construction of equipment to enable the management of the trials. Due to the extensive nature of the trials, the equipment needed to perform under a large array of conditions and soil types. The distance between trials caused logistical problems, particularly to movement of equipment and timeliness of operations. Consequently, the performance of some of the trials suffered. Under commercial farming conditions these logistical problems may be reduced substantially, and the operator should also be more familiar with the correct adjustment of the equipment according to soil conditions. When correctly adjusted, the bed-forming and planting equipment worked well in most soil types. Many of the design features incorporated in both pieces of equipment have applications in other row-spacing configurations.

During the project, significant modifications were made to the harvester to improve the feeding characteristics and overall machine performance. The installation of a three-blade chopper box minimised the cane loss problems experienced early in the project. The very narrow traffic area in the 2.1-m beds caused some harvester navigation problems, particularly in large heavily lodged crops. The cumulative stool damage caused after successive harvests increased gaps and reduced stool vigour. Stool damage at harvest was one of the factors that contributed to lack of response in the second-ratoon crop. The installation of a guidance system (DGPS or similar) on the harvester would have overcome most of this problem. Considering the vast range of harvesting conditions experienced, the equipment performed extremely well.

6.0 EXPECTED OUTCOMES

This project has successfully demonstrated the potential yield increases obtainable from the 2.1-m bed farming systems. The benefits of higher-density planting, good crop establishment, minimum tillage and controlled traffic have already been recognised by many growers throughout the industry. Compared to the current 1.5-m single row system, the 2.1-m beds system requires much more precision in all farming operations. The harvesting and haulout equipment, at least, must have some form of precision guidance system to keep the equipment off the beds. Currently, the cost of guidance equipment is high, but this may reduce over time. Because of the high cost of modifying equipment to suit the 2.1-m beds and the requirement for a high degree of precision, it is unlikely that the system will become a commercial reality in the near future.

The project has been an excellent conduit for initiating grower and industry interest in different farming systems. It has identified a range of deficiencies in the current conventional farming system and developed methods to over come them. Growers in the Bundaberg, Mackay, Maryborough, and Ingham districts are presently investigating new farming systems consisting of two and three rows on 2-m wheel spacings. Due to the wider traffic area, the need for precision guidance equipment has been reduced and most existing planting, fertilising and weed control equipment can be modified to suit these systems. The major cost has been modification of the harvesting equipment. Significant cost savings associated with less turning and shorter travelling distance per hectare; reduced cultivation costs and increased rainfall infiltration rates make these farming systems economically viable options.

Much of the equipment used in this project has applications in reduced and minimum-till planting systems. The double-disc opener was highly effective at accurately planting cane into beds with minimal soil disturbance. The concept of matching mound shape to the harvesting equipment and planting into mounds, is thought likely to increase germination in waterlogged conditions and reduce soil in the cane supply and harvester 'pickup' losses.

7.0 FUTURE RESEARCH NEEDS AND RECOMMENDATIONS

The trials in this project did not provide enough information about the performance of the 2.1-m beds over the entire crop cycle. The second-ratoon trials showed no difference in yield between the 1.5-m rows and the 2.1-m beds. When they were ploughed out as third ratoons, the 2.1-m beds in many of the trials appeared very gappy compared to the single rows. There is no doubt that the harvester caused substantial stool damage, due to a lack of appropriate vehicle guidance system. However, this may not be the only effect. Cane grown in the 2.1-m beds appears to have a smaller stool, which may make plants more vulnerable to stool damage at harvest. Alternatively, due to its design and operation, the high-density harvester may have caused excessive stool damage and as a result needs to be redesigned. Either way, the 2.1-m beds do not seem to be as robust and may not perform as well under commercial conditions. Methods of reducing stool damage at harvest need further investigation.

Many of the trials in this project suffered from poor establishment in both treatments. Many of the factors controlling germination are difficult to control or as yet unknown, but climatic conditions prior to and immediately after germination can have a significant effect on planting success. In many areas where sugarcane is grown, the climate can be highly unpredictable and even the best farmer finds it hard to ensure good establishment. Growers tend to plant much more cane than is required as insurance against adverse conditions. A more scientific approach to assessing if a cane sett will germinate is required.

8.0 PUBLICATIONS

Throughout the project, extension officers have arranged regular field visits to the trials for growers and industry personnel to view planting and harvesting of the trials and the equipment used. The potential of the 2.1-m beds was presented in four papers at the 2000 ASSCT Conference (Bull and Bull 2000a,b; Norris *et al.* 2000; Bull and McLeod 2000) and a paper was presented at the 2001 ISSCT conference in Brisbane (Bull *et al.* 2001). Two booklets 'Manual for dual rows in sugarcane' and 'A high density farming system for improved sugarcane production' have been published and made available to growers.

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