Proceedings of the Australian Society of Sugar Cane Technologists, volume 42, 13–16, 2020

Poster paper

Optimal pot size for growing sugarcane

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Abstract Under certain circumstances, the use of pots to grow plants becomes necessary, for example when plants need to be contained or treatments applied. Sugarcane is a large plant, growing as tall as 150–600 cm and, while most roots grow within the top 60 cm of soil, they can also extend up to and past 100 cm. While sugarcane can be propagated in small 1 L pots, the resulting plant is not comparable to field-grown cane. This experiment tested three different pot sizes to determine what size produced plants that were most comparable to field-grown plants. Pots containing 35, 52 and 70 L of soil were planted with varieties Q208$^{\phi}$, Q234$^{\phi}$ and Empire. The plants were grown outside to ensure that growth was not limited by light levels. Stalk number, height, diameter and weight were measured after 16 months growth. Differences in growth related to pot size were seen for some variety-pot size combinations. Where there was a similar result to field-grown plants, it was always with plants grown in the 52 L pots: stalk number for Empire was highest in the 52 L pots, stalk diameter was larger in the 52 L pots for Q113, the stalk weight of the Q113 plants grown in 52 L pots was similar to that seen in the field, and for Q208$^{\phi}$ grown in 52 L pots the stalk number was similar to that measured in the field. Hence, we conclude that the 52 L pots provide growth conditions that are the best proxy for field growth. Surprisingly, the larger root volume available in the 70 L pots did not improve plant growth. The ranking of the varieties remained the same for each phenotype regardless of the pot size, demonstrating that pots can provide an acceptable model for field-grown research.

Key words Pot, field, growth conditions

Plant growth is affected by the environmental conditions that it has experienced. These growth conditions, including temperature, moisture, growth medium, humidity and light, may disrupt interpretations of results if plant varieties respond to differences in these conditions in different ways (Poorter *et al.* 2016). The use of glasshouses and growth chambers can reduce the environmental variations seen in the field as well as providing a manageable and repeatable system for researchers.

As part of the research into sugarcane stool architecture (Sugar Research Australia project 2015/004), a field trial was established and a series of pot-based experiments in glasshouse and controlled environment facilities were planned. Initial comparisons among eight varieties grown in the field and the controlled facilities showed a significant difference in the number of tillers and mature stalks produced for all varieties (Table 1).

Table 1. Average number of above ground stalks in sugarcane plants grown in the field, in a controlled environment facility (CEF) and in a glasshouse. Values in brackets are standard errors.

Variety	Average stalk number			
	Field	Glasshouse	CEF	Sig. diff
Comus	6.01 (0.5)		3.4 (0.4)	0.028
Empire	16.0 (0.5)		4.4 (0.3)	<0.001
Q208$^{\phi}$	22.9 (0.7)		6.6 (0.6)	<0.001
Q234$^{\phi}$	24.1 (0.8)		4.0 (0.6)	<0.001
Q113	18.3 (1.6)	2.7 (0.33)		<0.001
Q138	20.5 (0.8)	2.5 (0.22)		<0.001
Q96	25.7 (0.7)	1.2 (0.2)		<0.001
QBYC05-20853	20.9 (0.8)	3.7 (0.4)		<0.001

Plants grown in CEF – N = 5, glasshouse – N = 6, Field – N = 24.

We considered that the main explanation for the difference in stalk number between the controlled and field-grown plants is the availability of light. While the level of light in the glasshouse was not measured, the CEF provides lighting to approximately 40% of natural daylight. However, a second factor that may influence the differences seen is the size of the pot; with field-grown plants under no root confinement. Since pot-grown plants may be required for experiments where containment is important (e.g. for a rhizomatous *S. spontaneum*) or to impose a specific treatment, we set out to define the influence of pot size. Three varieties were grown in three pot sizes to determine if there was a size that would produce plants more equivalent to those grown in the field.

A trial was established at Gatton (Queensland) to test three genotypes (Q113, Q208$^{\phi}$ and Empire) in three sizes of pots (35 L, 52 L and 70 L, Table 2 and Figure 1). All pots sat in 50 cm saucers to ensure that roots did not extend into soil. Pots were filled with garden mix soil (Brooks Quarries, Gatton) and supplemented with Osmocote controlled-release all-purpose fertiliser (as per directions). Nodes were supplied by SRA Meringa and had undergone CWSHW treatment (cold water 48 h, hot water 50°C 3 h). Before planting into trays for germination in the CEF, the nodes were soaked in fungicide (Yates 150 g Mancozeb). While the plants were exposed to natural rain, the pots were watered daily to capacity.

Table 2. Dimensions of pots.

Diameter (cm)	Height (cm)	Volume (L)	Colour
30	50	35	White
30	100	70	White
50	38	52	Black

Plants were harvested after approximately 16 months growth. Phenotypes measured included stalk number, stalk height, stalk diameter, weight of all stalks and number of large suckers. Results were compared to measurements collected from the same varieties grown in the field trial located adjacent to the pot experiment.

Figure 1. Pots set up outdoors at Gatton showing the three sizes being tested: 35 L, 52 L and 70 L.

There was a difference in the shape of the pots examined. The 35 L and 70 L pots had the same diameter but different heights, while the 52 L pot was shorter than the 35 L pot, but wider.

There was a significant reduction in stalk number between the field and pot-grown plants (Figure 2). The stalk number in the 52 L pot compared to the field-grown plants was lower by 23, 45 and 48% (Empire, Q113 and Q208$^{\phi}$, respectively). The 35 and 70 L pots had reductions of 46–56% across the different varieties compared to the field-grown plants. Despite the reduction in stalk number, the ranking of the varieties was the same for all pot sizes compared to the field, except the 52 L pots where Empire produced slightly more stalks than Q113.

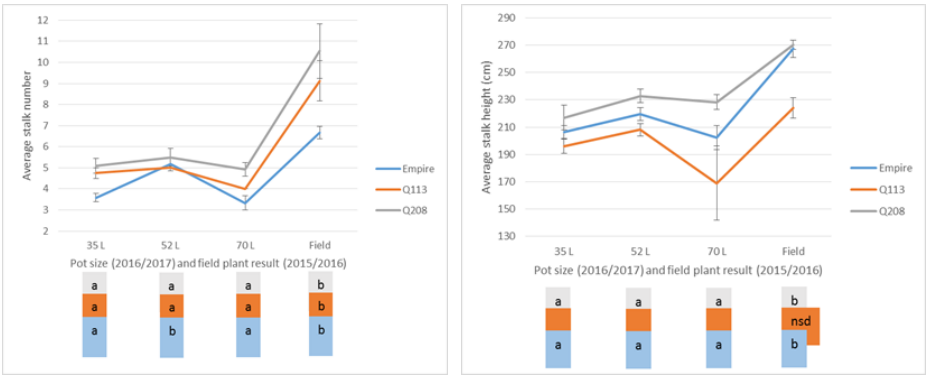

Figure 2. Average stalk number and height, left and right respectively. N = 6 for Q208Φ and Empire, n = 2 for Q113 plants grown in pots, n = 24 for field-grown plants, error bars are standard errors. Least significant difference letters were determined using Fisher's protected LSD for *P<0.05*, and have been denoted below the graph in colours corresponding to each variety. LSD letters can only be compared for individual varieties.

Similar results were observed for stalk height for Empire and Q208Φ. Stalk height was reduced by 13 to 24% from the field-grown plants, across all pot sizes for varieties Empire and Q208Φ, while variety Q113 was not significantly different between the pot sizes and the field (Figure 2). The rankings of the varieties were maintained across all pot sizes and field-grown plants.

Stalk diameter was significantly lower in pot-grown plants compared to field-grown plants for all varieties (Figure 3). Interestingly stalk diameter was higher in the 52 L pots than the other pot sizes for Q208Φ. For variety Q113 in the 52 L pot, the diameter was larger than in the 70 L pot but not significantly different from the 35 L pot (Figure 3). The ranking of the varieties at each pot size altered between the varieties Q113 and Q208Φ, though there was no significant difference between these varieties.

The combination of stalk height and stalk diameter influence the stalk weight of the plant. As with each of the other measured attributes, the stalk weight was significantly lower in the pot-grown plants compared to the field-grown plants (Figure 3); the Q113 52 L was most similar to the field-grown plants despite a 14% reduction. The other pot sizes saw a reduction in stalk weight of 21 to 46% compared to field-grown plants, across all varieties. As seen in the stalk diameter, the rankings at each pot size altered due to differences in Q113 and Q208Φ, although again at those points there was no significant difference among the varieties.

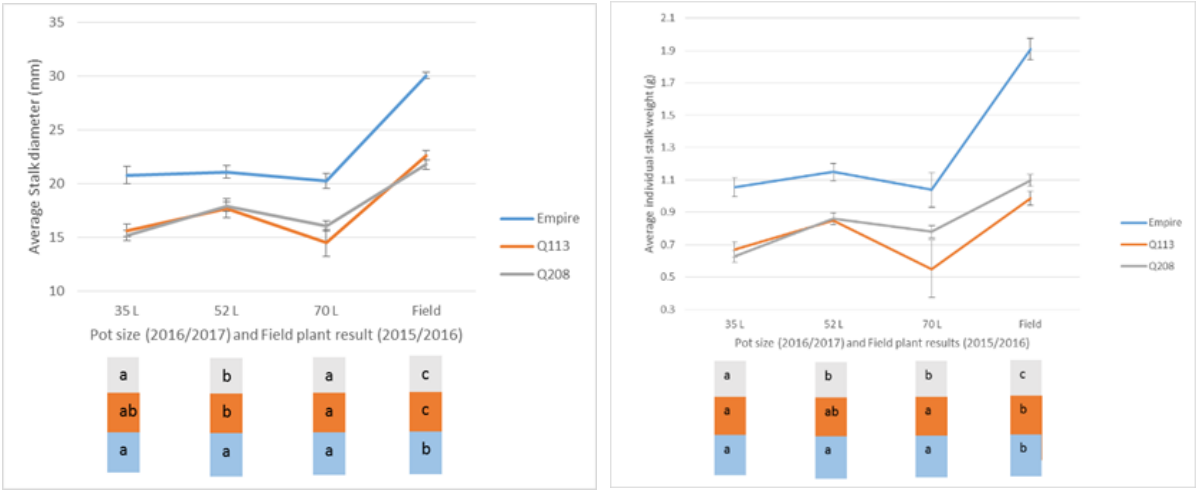

Figure 3. Average stalk diameter and weight, left and right respectively. N = 6 for Q208Φ and Empire, n = 2 for Q113 plants grown in pots, n = 24 for field-grown plants, error bars are standard errors. Least significant difference letters were determined using Fisher's protected LSD for *P<0.05*, and have been denoted below the graph in colours corresponding to each variety. LSD letters can only be compared for individual varieties.

The extra root depth available in the 70 L pots did not improve plant growth and in some cases these plants were the least like field-grown plants. While pots have not replicated field growth, the 52 L (50 x 38 cm) pot resulted in plants that trended to be better than the 35 L and 70 L pots. The observation that rankings were generally maintained for each parameter means that useful comparative results can be obtained from pot trials.

In summary, our experiments showed that:

- The 52 L pots were optimal over the 35 and 75 L pots.
- Pot experiments can be a useful model for field growth as variety rankings are maintained.

ACKNOWLEDGMENT

We thank Sugar Research Australia Limited for funding of the Impact of Stool Architecture on Ratooning, project 2015/004.

REFERENCES

Poorter H, Fiorani F, Pieruschka R, *et al.* (2016) Pampered inside, pestered outside? Differences and similarities between plants growing in controlled conditions and in the field. *New Phytologist* 212: 383–855.

Rae AL, Glassop D (2018) *Impact of stool architecture on ratoon ability*: Final Report 2015/004. Sugar Research Australia Limited, Brisbane.