OBSERVATIONS ON THE INTERACTION BETWEEN SELECTED SEEDLINGS AND THE SELECTION STAGE

By D. W. THOMAS

South African Sugar Association Experiment Station, Mount Edgecombe

Abstract

Of 300 clones selected at the widely spaced Single Stool stage of selection, 20 appeared to be exceptionally vigorous. These clones and 84 of the ordinary selected clones were grown both as widely spaced single stools, and in the normally spaced single rows of the next stage of selection. The two groups of clones yielded similarly in the single rows, while the vigorous clones produced nearly 20 percent more cane than the ordinary clones in the single stool planting.

Twelve of the seemingly most vigorous of the 139 clones selected at the single row stage, were again grown in single rows together with a number of less vigorous clones, and also in plots with guard rows, to represent the crop environment. When grown in guarded plots the mean yield of cane of the vigorous clones was only slightly greater than that of the 127 selected clones as a whole. However, when grown in single rows the vigorous clones produced a greater yield than they did in the guarded plots.

Introduction

Breeding material is commonly exposed to three contrasting environments at successive stages of a selection programme, and a different type of plant is likely to be best adapted to each of the respective environments (Donald and Hamblin[3]). The isolation type is most likely to do well when the material is grown at wide spacing at an early stage of selection. This type will be a free tillering, open leafy plant, able to exploit the space available. The competition type, a tall, leafy free-tillering plant, able to shade neighbouring plants, should succeed at stages of selection where different genotypes are grown in a mixed community. Genotypes producing erect, moderate tillering plants, with small erect leaves, the crop type, are likely to be best suited in the dense monoculture of the crop itself.

The three types of plants differ so much that a plant which gives a high yield in one of the environments, may not yield well in either of the others. For example, Hamblin and Donald[5] obtained a significant negative correlation ($r = -0,57$) between plant heights of barley, in a mixed community at an early stage of selection, and grain yield in a pure crop.

Tovey *et al*[9] showed that differing canopy heights caused great variation in the radiation received by small plots of sugarcane. The effects of competition are well known and have been studied by many. Galvez and Empig[4], Hogarth[6] and Skinner[8] have shown the danger of relying on yield in small plots, which unfortunately are a necessity in selection programmes.

The first stage of the selection programme practised at the Experiment Station, Mount Edgecombe, is that of single stools where the plants differ genetically and are grown at much wider than normal spacing. An isolation type of plant should do well in these conditions, and in addition there is likely to be some competition between the plants. In the second, the single line stage, the clones are each grown in a single eight metre row, and here they can be expected to compete to some degree with each other.

This paper presents information, obtained at Mount Edgecombe, to suggest that apparent superiority at the first and second stages of selection, could be partly due to ability to exploit the isolation environment or to competitive ability.

Methods

Experiment I

Out of approximately 300 selections in the first single stool stage of selections in 1974, 20 exceptionally vigorous stools, as well as 84 of ordinary vigour, were chosen. The 104 clones were grown, in random order, in the second single row stage of the programme. The rows were harvested at the usual 16 months of age and yield measured.

Three single-budded setts were taken from the ratoon crop of each row and pregerminated. The germinated setts were used to establish three single stools of each clone, arranged so that stools of the 20 apparently vigorous clones were separated by four randomly chosen stools of ordinary clones. The stools were harvested at 12 months of age and the cane weighed.

Experiment II

Twelve supposedly highly vigorous clones were chosen from the 139 clones selected in 1977 at the second single row stage of the programme. The criterion for vigour was a high yield with a smaller than average yield by the clone in one of the two adjacent rows. Thus, the chosen clones were those which had apparently benefited from competition, at the expense of a neighbour. The vigorous clones were planted both in unreplicated four-row plots, to represent the crop environment, and in single rows bounded on both sides by at least one row of a clone or clones which had appeared to lack vigour at the single row stage. This represented the competitive environment. The experiment was harvested at 14 months of age and cane mass determined. Only the middle two rows were weighed in the four-row plots. The remaining 127 of the 139 selected clones were grown in the normal third stage of the programme with cane mass also being determined after 14 months. For this stage clones are grown in two row plots, replicated twice.

Results and Discussions

Experiment I

When grown at the wide spacing of stage one, the 20 clones which had been chosen for exceptional vigour produced nearly

Table 1
Comparisons of yield from two groups of selections in stages one and two

Stage one, Single Stools		
Number of selections	Selection groups	Mean cane yield per stool
20	Vigorous selections	20,6 kg
84	Ordinary selections	17,3 kg
Stage two, Single Rows		
		Mean cane yield per row
20	Vigorous selections	99,1 kg
84	Ordinary selections	98,8 kg

a 20% higher mean yield than that of the ordinary selection, although the difference in yield was not statistically significant. However, there was no apparent difference in yield between the two groups of clones when grown in the single rows. This suggests that part of the apparent superiority of selected clones at stage one of the selection programme, is due to ability to exploit the relatively large space which each plant has at its disposal at this stage. Accordingly it would seem that there could be a tendency for genetic progress, between the first and second stages of the breeding programme, to be somewhat depressed by differences between clones in ability to benefit from wide spacing.

An experiment by Boyce[1], on the relationship between stool density and yield, lends support to the above observations. Two commercial varieties were planted on the square at eight stool densities. He found a significant population x variety interaction for tons cane per hectare, variety CB36/14 yielding considerably more than variety NCo 376 at low stool densities.

Boyce[1] attributed the greater yield of CB36/14 at low stool densities, to the more open growth habit and broader leaves of this variety than those of NCo 376. He suggested that these features would promote light interception at low densities, but would be of little advantage at higher stool densities. Considering the outline of variety forms described in the introduction, CB36/14 should be suited to stages one and two of the selection programme. NCo 376 is an erect variety of medium height, so seems likely to be better suited to the crop situation. Indeed Shimabuku and Higa[7] who studied light extinction in the canopies of a number of different varieties, found NCo 376 to have a relatively low light extinction coefficient. A low light extinction coefficient is characteristic of varieties with erect, narrow, and short leaves, that should be advantageous in the crop situation (Donald[2]).

Experiment II

The average yield of the 127 ordinary selections at stage three of the programme is probably a good measure of their performance as a group in the crop environment. On this assumption the 12 vigorous clones, yielded only slightly more on average than did the ordinary selections in crop conditions, but yielded about 12% more when grown in single rows.

TABLE 2

The yield of vigorous selections in both the competitive and crop environments, compared to ordinary selections in stage three of the programme

No. of selections	Selection groups	Yield t cane/ha	Stage
12	Vigorous selections	116,4	Stage two, single row
12	Vigorous selections	107,6	Four row plot
127	Ordinary selections	103,7	Stage three, replicated 2 row plot

Thus the apparent vigour of the 12 clones was evidently due in part to their competitive ability. Perhaps, therefore, it is advisable, when selecting in the competitive situation, to exercise caution in choosing apparently vigorous clones which have characteristics likely to be beneficial in competition, such as tallness and an open canopy (Hamblin and Donald[5]).

A probable example of this type of clone is N50/211, which was used, with NCo 376, as a standard variety at stage two of the selection programme between 1967 and 1971. N50/211 and NCo 376 produced similar yields when compared over a large number of variety trials. However, at stage two N50/211 produced substantially greater yields than did NCo 376.

TABLE 3

The yield responses of N50/211 relative to NCo 376 in a mixed and a pure community

Variety	Number of 8 m rows	Percentage yield of NCo 376	Environment
NCo 376	305	100	Competition
N50/211	260	124	
	No. of trials		
NCo 376	57	100	Crop
N50/211	57	99	

Moreover, the two rows situated on either side of each N50/211 row at stage two of the programme, between 1967 and 1971 had a mean yield eight percent smaller than that of the stage two populations as a whole.

It would appear that selection for yield in the early stages will always be influenced by the complex interactions of the genotype with the many parts of the environment, including the selection stage. Some future work should perhaps be devoted to studying the characteristics likely to enable a clone to gain an advantage at the respective selection stages, plus their magnitude and frequency, to determine whether it is possible to take account of such clones in practice in the selection process.

Acknowledgements

I thank Messrs. R. S. Bond, M. G. Murdoch and R. L. Harding for their advice, and Dr. J. C. S. Allison for helping with the script.

REFERENCES

1. Boyce, J. P. (1970). Stool populations and yield of sugarcane under irrigated conditions at Pongola. SASTA Proc **44:** 136-141.
2. Donald, C. M. (1968). The breeding of crop ideotypes. Euphytica **17:** 385-403.
3. Donald, C. M. and Hamblin, J. (1976). The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Adv Agron **28:** 361-405.
4. Galvez, A. M. and Empig, L. T. (1977). Interclonal competition in two sugarcane hybrid populations. ISSCT Proc **16:** 187-201.
5. Hamblin, J. and Donald C. M. (1974). The relationships between plant form, competitive ability and grain yield in a barley cross. Euphytica **23.** 535-542.
6. Hogarth, D. M. (1977). Quantitative inheritance studies in sugarcane III. Aust J Agric Res **28:** 257-268.
7. Shimabuku, M. and Higa, K. (1977). Studies on the yield of sugarcane varieties with particular reference to the efficiency of utilization of sunlight. Part 3. The effects of light extinction coefficient on some yield components in some sugarcane varieties. ISSCT Proc **16:** 177-183.
8. Skinner, J. C. (1961). Sugarcane selection experiments. 2. Competition between varieties. Tech Commun Bur Sug Exp Stns Qd. No. 1 26pp.
9. Tovey, D. A., Glasziou, K. T., Farquhar, R. H. and Bull, T. A. (1973). Variability in radiation received by small plots of sugarcane due to differences in canopy heights. Crop Sci **13;** 240-242.