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IMPLEMENTING A PROGRAMME OF RECURRENT SELECTION FOR YIELD IN SUGARCANE

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Abstract

Crosses were made, in most of the possible combinations, within groups of local and foreign varieties. Approximately 5 000 progeny seedlings were grown as single stools at four sites. Approximately 800 stools were selected for growing in single lines (8 m rows) and of these more than 300 were selected to be screened for disease response. Finally more than 100 clones were selected to be crossed with a tester variety. The crosses have been made and their progeny will be planted in yield trials in 1987.

Introduction

The merit of a sugarcane clone as a parent in breeding work depends on its ability to produce good varieties in crosses with other clones, rather than on its own qualities as a commercial variety. (Results from local trials have shown, however, that good varieties generally give good progeny in crosses.) Similarly, the value of a maize inbred depends on its ability to give a high yield in hybrid combinations, ie on its 'combining ability'.

Several recurrent selection programmes to improve progressively the combining ability of breeding material have been carried out in maize (Josephson[2]; Sprague and Eberhart[4]), with a considerable degree of success. Maize breeders now believe that such a programme should be undertaken to supplement the main commercial breeding programme to provide parental material with improved combining ability for the future. No similar trend has as yet emerged in sugarcane breeding (Nuss and Allison[3]). Experience and experimental studies (Bond[1]) have shown substantial variation in the yield potential of 16 parent varieties when used in cross combinations in the Mount Edgecombe breeding programme. However, the best of these varieties were not primarily selected for use as parents. It should, therefore, be possible to improve the combining ability of the parental material by means of a recurrent selection programme similar to that used for maize.

In this paper the initial stages of the implementation of a recurrent selection programme to produce improved parental varieties, using as starting material a range of the better existing parents, both of local and foreign origin, are described.

Procedure

Genetic material

Nine of the 10 possible crosses were made between five varieties of South African origin: NCo376, N52/219, N55/805, N7 and N11, and in addition N52/219 and N11 were self-pollinated. Five of the six possible crosses were made among four varieties of foreign origin: CB40/35, F152, CP57/614 and B42231; in addition the foreign variety J59/3 was self-pollinated.

First selection

The resulting 17 progenies were grown as single plants in the normal first stage of selection on four sites on the field stations of the South African Sugar Association Experiment Station, three in the southern rainfed area (Experiment Station and Shakaskraal, shallow sandy loam soil, with an impervious clay or iron concretion layer; Central Field Station, coastal sands), and one in the northern irrigated area (Pongola, deep clay-loam soil). Approximately 95 seedlings of every progeny were grown at each site, giving a total of 5 400 plants; 1 600 at Pongola and 3 800 at the three rainfed sites.

At this stage 811 seedlings (261 at Pongola and 550 at the rainfed sites) were selected (see Appendix I for details) for planting in 8 m rows, the equivalent of the second or single line stage of selection. Selection rate was about 15 %. A similar number of clones were selected in each progeny at every site. The 261 clones selected at Pongola were grown as single lines at the same site, while the 550 clones selected at the other three sites were grown as single lines on the Shakaskraal farm. The Shakaskraal site was used for growing all the clones from the southern rainfed sites because of the availability of land and other resources.

Second selection

At the single line stage of selection the material is normally grown as a plant and first ratoon crop. Details of observations made during the plant crop are given in Appendix II.

When the plant crop was approximately 12 months old, 330 clones (228 from Shakaskraal and 102 from Pongola) where selected for planting in a screening trial at Pongola which was inoculated with smut (*Ustilago scitaminea*). Details of the trial are given in Appendix III.

Assessments of susceptibility to smut from this trial were used, together with observations in both the plant and ratoon crop of the single lines, (see Appendix II) to select 115 clones, 35 from Pongola and 80 from Shakaskraal, for crossing for assessment of combining ability. At the same time, the 115 clones were planted in a nursery to serve as propagation material for future use.

Assessment of combining ability

The 115 clones to be assessed for combining ability were crossed in 1986 with the variety CB40/35. About 100 crosses were successful. The progeny of these crosses will be grown in yield trials, both at Pongola and Shakaskraal. It is envisaged that clones whose cross-progenies perform best in these trials could be used directly in crosses with CB40/35 for the normal breeding programme. For the purposes of the recurrent selection programme, the approximately 10 clones which perform best will be intercrossed to produce a new 'gene-pool' to serve as starting material for a second cycle of recurrent selection for combining ability.

Discussion and Conclusion

It had been intended to cross all the selected clones originating from the South African group of varieties with at least one variety from the foreign group for the assessment of combining ability. Similarly, selected clones from the crosses of the foreign varieties were to be crossed with one or more South African varieties, for the same reasons. The intended long term objective was to shift both the South

African and foreign 'gene-pools' in such a way that clones derived from the South African gene-pool would be expected, on average, to form exceptionally good crosses with clones derived from the foreign gene-pool. This procedure could be regarded as a form of 'reciprocal recurrent selection' (Sprague and Eberhart[4]).

However, because of the variation that can be expected in degree and timing of flowering of sugarcane clones, it was decided to use the outstanding parental variety CB40/35 (Nuss, personal communication) as a 'tester parent' for all the selected clones, both South African and foreign. The object will to be to identify those clones carrying genes making for superior crosses with CB40/35 itself. It can be expected however that the genes in the South African material which determine high combining ability with CB40/35 will differ from the genes in the foreign material also determining good combining ability with CB40/35.

Probably, therefore, a second cycle of improvement should be conducted to combine 'superior' genes from the two original sources. The initial step would be to make crosses in the various combinations between clones originating from the South African material, and clones derived from the foreign material.

Only limited progress can be expected in each cycle of recurrent selection so if the cycle is shorter, progress will be more rapid. It had been intended to make crosses to measure combining ability immediately after the single stool stage of selection. Considering, however, the greater reliability of selection at the single line stage for comparatively highly heritable characteristics such as sucrose content, agronomic merit, and disease response, as well as yield *per se* of a clone, the test-crosses were delayed so as to select more effectively the small number of clones that it would be practicable to assess for combining ability.

The initial crosses among clones were made approximately six years ago. If only two crops (plant and first ratoon) are harvested in the yield trials for assessing combining ability, it will be another four years, making a total of 10 years, before the best-combining clones can be intercrossed to produce starting material for a second cycle of recurrent selection. This is not an unduly long period considering that maize, which completes a generation every year, would have a period of 6 years for the equivalent procedure. It should, however, be possible to obtain a preliminary indication of the potential (as parents) of the clones being tested within 12 to 18 months, when the plant crops of the yield trials are harvested. However, substantial progress is unlikely until a second cycle of recurrent selection is completed.

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APPENDIX I

First stage of selection (single stools)

The seedlings originating from every cross were grown in three randomised plots at each site, with rows spaced at 1,4 m and plants spaced at 1,0 m in the row.

Plants were rated during the first 9 months of growth, for erectness, number of stalks, thickness of stalks, and diseases. At 9 months of age the plants were cut back and the harvested tops and cane stalks were weighed in each plot. During the following 9 months of 'ratoon' growth, the plants were again rated. These data, together with weight when the plants were cut back, were used to select 811 clones for the next single line stage (550 were selected in the southern area and 261 in the northern area).

APPENDIX II

Second stage of selection (single lines)

The 811 selected clones were planted in 8 m rows (550 at Shakaskraal and 261 at Pongola). During the plant crop, growth was rated, on a scale from 2 to 8 (2 being poor and 8 being good), as follows:

speed of germination (3 months)
primary population (3 months)
erectness of cane (4 months)
population (4 months)

Stalk growth was measured at approximately 5 months. Using this information approximately 40% of lines were selected and sampled for sucrose content at 11 months of age. The lines were then harvested and allowed to ratoon.

Lines were rated for the same attributes as above during the ratoon crop, but in addition flowering and symptoms of drought stress (at Shakaskraal) were noted.

Using the plant crop sucrose content data, as well as the ratoon crop ratings, together with the results of the smut-screening trial (Appendix III) a total of 115 clones were selected for assessment of combining ability; 80 at Shakaskraal and 35 at Pongola. It was interesting to note that of the 80 clones selected at Shakaskraal, 29 had not seemed exceptionally promising during the plant crop and were selected for apparent ratooning ability during the ratoon crop.

APPENDIX III

Screening for susceptibility to smut

The trial was carried out by the Plant Pathology department of the SASA Experiment Station, on the Pongola farm.

No. of clones tested:	330 grown in unreplicated plots
Plot size:	one 5 m row, each consisting of 10 3-budded setts, plus 10 control plots of variety NCo376
Inoculation:	setts dipped for 15 minutes in inoculum, formed from one whip per litre of water
Duration of trial:	one year
Records:	four inspections for counts of smutted shoots and numbers of whips. Results were expressed as % stools infected and number of smut whips per hectare
Comment:	inoculation was very successful. A wide range of smut incidence was observed
Results:	clones - without smut 71
	- with slight smut 38
	- with moderate smut . . . 48
	- with severe smut . . . 173