PROGRESS IN SCREENING FOR RESISTANCE TO SUGARCANE DISEASES IN SOUTH AFRICA

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Abstract

Methods currently used in South Africa for determining the reactions of new sugarcane clones to smut, mosaic, leaf scald and streak during the process of selection are described and results from recent trials are presented. Resistance screening procedures have been expanded and improved in recent years. The main changes have been the regional location of trials involving the different diseases, screening for resistance to smut and mosaic at earlier stages in the plant breeding selection programme, so that many more new clones are now tested, and the routine use of inoculation techniques in screening for resistance to smut and leaf scald. Numbers of new clones screened for disease resistance annually are approximately 560 for smut, 200 for mosaic, and 40 for leaf scald and streak. The reactions of advanced clones from all selection sites to the four diseases are assessed at least once before the clones are considered for release. Approximately 50% of the clones tested for response to smut and mosaic prove to be too susceptible for use in areas where these diseases are common. The proportion of clones in the final stages of selection that are resistant to smut has increased recently due to intensive screening at earlier stages in the plant breeding programme.

Introduction

The long term control of important sugarcane diseases is based on selecting and releasing for cultivation only those clones with satisfactory resistance to prevalent disease problems. In order to apply this strategy effectively the important diseases for which resistance is most desirable must be identified and adequate selection pressure applied. Important diseases in this context are not necessarily the most common or conspicuous or even the most damaging but are those that cause or are most likely to cause serious yield losses and cannot readily be controlled other than by satisfactory resistance. In South Africa these diseases include smut (*Ustilago scitaminea*), mosaic (SCMV), leaf scald (*Xanthomonas albilineans*), *rust* (*Puccinia melanocephala*) and gumming (*Xanthomonas vasculorum*).

As new clones progress through the various stages of the selection programme they are exposed to the prevalent diseases at the different selection sites (a total of six main and seven subsidiary sites in Natal, Transvaal and Swaziland). Clones at late stages of selection have been exposed to a wide range of diseases under different environmental conditions for perhaps ten to fifteen years. Any seriously diseased clones are discarded and thus some selection pressure for disease resistance occurs in the normal course of selection operations. Adequate resistance to minor diseases and also to certain common and highly infectious diseases is obtained in this way. These diseases include rust and gumming.

However, naturally occuring levels of inocula of some important diseases at South African sugarcane selection sites are too low for the reactions of new clones to be determined accurately or rapidly. The duration of individual selection trials is also often too short for determining reactions to diseases that build up with repeated ratooning, such as smut. Special disease resistance screening trials are therefore necessary. In these trials new clones are exposed to enhanced levels of inocula of important diseases, possibly in an artificial manner by inoculation. These screening trials are conducted at several sites and are closely integrated with the main selection programme.

In South Africa screening trials are conducted to determine clonal reactions to smut, mosaic, leaf scald and sugarcane streak. Smut and mosaic are common diseases, which are currently spreading and increasing in importance over large areas. High levels of resistance to smut and mosaic are therefore essential in many areas. Leaf scald is widely distributed in the irrigated areas of the Transvaal and has occurred sporadically elsewhere. Present varieties are generally resistant to leaf scald but environmental conditions are favourable for epidemic development of this disease in susceptible varieties. Screening ensures that only varieties resistant to leaf scald are released for production. Streak was extremely common and damaging in Natal on the susceptible variety Uba up to about 1940 but has rarely been observed in recent decades following a complete change to resistant varieties. Screening for streak resistance is still conducted in order to prevent a recurrence of this problem.

Before 1974 resistance screening in South Africa consisted of a single trial planted annually at Mount Edgecombe. In this series of trials a number of advanced clones were exposed to smut, mosaic and streak (Thomson[8]). Since then the disease screening programme has expanded considerably in size and scope. Separate series of trials for smut, mosaic, leaf scald and streak are now located regionally, in areas where environmental conditions favour the spread of the diseases and the expression of symptoms.

Extent of the Screening Programme

As is the case with other selection criteria which limit productivity, the more serious the disease and the greater the need for resistance in new varieties, the earlier in the selection programme should new clones be evaluated. This principle provides for the most effective use of plant breeding resources by increasing the likelihood of new clones with suitable resistance as well as with the other necessary qualities being detected. Early evaluation is particularly important for those diseases to which large proportions of unselected clones are susceptible. The selection stages at which disease screening is practised are also partly determined by the problems involved in screening large numbers of clones sufficiently accurately and rapidly. Improvements in techniques are important in this regard and it is a pre-requisite for any screening test that results be available for selection purposes without impeding the flow of new clones through the selection programme.

High levels of resistance to smut and mosaic are necessary for new varieties for most areas of cane production in South Africa. In addition, high proportions of new clones are unacceptably susceptible to these diseases (see later). Screening for smut and mosaic resistance is therefore conducted as early as possible during selection, subject to the limitations of techniques and resources. Only small proportions of new clones are susceptible to leaf scald and streak; screening for resistance to these diseases can therefore take place at a relatively late stage of selection.

The timing of screening trials for specific diseases in relation to selection based on other criteria differs in the northern and southern selection programmes, reflecting the variable distribution of diseases in the industry. Screening for smut resistance, for example, takes place relatively earlier in the breeding programme for the northern areas, where smut is most common, than in the south. The converse situation applies to mosaic, which is most serious in the south.

The points at which disease screening takes place in the northern and southern selection programmes and the number of clones tested annually are shown in Table 1. Amendments to screening procedures for smut and mosaic have been particularly extensive since 1980, partly in response to the continuing spread of these diseases and also made possible by new techniques. Screening for resistance to smut and mosaic now consists of a three-stage and a two-stage series of trials respectively. Eight separate screening trials are planted annually and approximately 20 are in progress at any one time. All clones which reach an advanced stage of selection at all selection sites have been tested at least once for resistance to the four diseases included in the screening programme.

Screening Procedures

All assessments of the disease reactions of new clones are based on the results of field trials. Methods of testing include both the natural exposure of clones to high levels of inocula from infected "spreader" plants in the trials and artificial inoculation. Details of the procedures are described in the sections on the specific diseases. All screening tests are based on the principle that assessments of varietal reactions must be similar to those obtained under naturally severely contaminated field conditions.

Standard varieties with a range of known disease reactions are included in screening trials for smut, mosaic and leaf scald (Table 2). These varieties enable the success of inoculation or the extent of natural infection to be judged and permit the effect of seasonal differences in environmental conditions to be considered. Because the extent of disease development may differ considerably from season to season in any one series of screening trials, new clones are not given resistance ratings solely according to predetermined levels of disease. The extent of disease incidence in the standard varieties is used as the main guide in determining the relative reactions of new clones in each trial.

Abbreviated versions of the commonly used 1 - 9 scale of disease resistance ratings (where 1 = highly resistant and 9 = highly susceptible) are used in all screening trials in a manner similar to that recently suggested by Ricaud[7]. A simple scale of 2 (resistant), 5 (intermediate) and 8 (susceptible) is usually adequate for selection purposes in many of the trials. A highly resistant category of clones, rating 1, may be differentiated in trials that are based on very stringent methods of testing.

TABLE 1

Disease screening in the sugarcane variety selection programme in South Africa (numbers of clones at each selection stage annually in parentheses)

Northern selection programme			Southern selection programme		
Selection stage	Duration (years)	Disease screening	Selection stage	Duration (years)	Disease screening
1(45 000)	1	—	1(90 000)	1,5	—
2 (4 000)	2	—	2 (8 000)	2,5	—
3 (420) *	1	Smut-1	3 (800)	1,5	—
4 (100)	2–3	Smut–2	4 (140)	3–4,5	Mosaic–1
5 (30)	2–4	Smut–3 Leaf scald Mosaic-1	5 (30)	3–4,5	Streak Mosaic-2 Smut–2
6 (7)	1,5	Streak Mosaic–2	6 (10)	3	Smut–3 Leaf scald
7† (1–2)	1	—	7‡ (1–2)	1	—

* Includes approximately 20 imported varieties
† Bulking for release, 10–13 years after crossing
‡ Bulking for release, 15–19 years after crossing

TABLE 2

Standard varieties in resistance screening trials for smut, mosaic and leaf scald

Smut		Mosaic		Leaf scald	
Variety	Resistance* rating	Variety	Resistance rating	Variety	Resistance rating
NCo 310	9	NCo 339	9	69W359	9
N55/805	9	NCo 376	8	L76	7
NCo 376	8	NCo 293	8	N6	7
N11	3	NCo 310	6	N53/216	5
N52/219	1	N11	1	NCo 376	2

* On the scale 1 (highly resistant) to 9 (highly susceptible)

Streak

Screening for resistance to streak is conducted at Mount Edgecombe under rainfed conditions. Approximately 40 clones, mostly at the fifth selection stage in the southern areas breeding programme, are tested annually. Each clone under test is represented by five single-row plots, each 5 m long. Infection occurs by natural spread of streak from infected plants of the susceptible variety Uba, planted between every two rows of test clones. (Spreader plants infected with mosaic are planted in equal proportions in this trial, which also serves for screening for mosaic resistance).

Symptoms of streak are more apparent in ratooning cane. Records are taken from the plant and first two ratoon crops. In the five trials planted from 1975 to 1979 the proportion of susceptible new clones (any showing symptoms) has ranged from nil to 8%, with a mean of 2,8% (Table 3). Approximately half of the infected clones have been imported varieties.

TABLE 3

Proportions of new clones* with symptoms of streak in screening trials, 1975–1979

Trial established	Percentage of clones with streak symptons	
	P	1R and 2R
1975	0	3
1976	0	0
1977	4	8
1978	0	0
1979	0	3
Mean	0,8	2,8

* Clones at the 5th and 6th stages of selection in the southern and northern breeding programmes respectively.

Leaf Scald

Screening for resistance to leaf scald was introduced in 1976 following the development of severe leaf scald in two imported varieties at the final stage of bulking before release. This series consists of one trial planted annually under irrigation at Pongola.

Up to 40 clones at the fifth and sixth stages of the northern and southern selection programmes are tested by means of artificial inoculation. The trials are established in autumn (March-April) with each clone represented by two single-row plots, each 5 m long. All the tillers are cut back by hand to a height of 10 to 15 cm in August and the cut shoots are immediately inoculated by spraying with a bacterial suspension of *Xanthomonas albilineans* using a pressurised garden sprayer.

TABLE 4

Reactions of standard varieties in leaf scald screening trials (% stalks with symptoms)

Standard varieties	1976	1977	1978	1979	Mean
NCo 376	0	0	0,5	0	0,1
N53/216	9	—	6	9	8,0
N6	13	29	26	6	18,5
L76	23	24	16	29	23,0
69W359	72	—	50	95	72,3

Inoculum is prepared from plate cultures on Wilbrink's agar, freshly isolated from infected plants for each trial. Cultures from approximately 100 plates (90 mm dia) suspended in 25 litres of water are used to inoculate about 500 m of cane row in each trial. Inoculation is most likely to be successful if conditions are cool and it is therefore done in the late afternoon.

Symptoms are best expressed and the trials are most easily assessed if the young cane is cut back again in November so that the cane begins to mature in the winter months. Reinoculation on cutting back in November may be necessary, depending on the success of the first inoculation. Poor results in two of the plant crops established up to 1979 necessitated cutting back and inoculating the new growth of the first ratoon crops. The expression of symptoms tends to be masked under good growing conditions; irrigation is therefore reduced for several months before evaluation.

The reactions of the clones are assessed in winter (July), 8-11 months after inoculation, from the proportion of stalks with symptoms and the severity of symptoms.

By reinoculating, continuing the trials in the first ratoon crop when necessary and by manipulating environmental conditions, acceptable consistency in the reactions of the standard varieties has been obtained (Table 4). The proportions of clones falling into five categories of resistance have varied somewhat from trial to trial (Table 5). The proportion of unacceptably susceptible clones (susceptible and highly susceptible categories) has varied from 6% to 38% over the four trials, with a mean of 19%. More than 50% of the clones have proved to be resistant or highly resistant.

Mosaic

The screening programme for mosaic resistance consists of four trials planted annually under rainfed conditions. One trial is planted at Mount Edgecombe and three are planted at Dumisa (South Coast hinterland) to form a two-stage series of tests. The trials are all based on the principle of natural infection, using infected spreader plants. Approximately 200 clones are tested annually. Individual clones

TABLE 5

Proportions of new clones* in five categories of resistance to leaf scald

Resistance category	Resistance rating	Percentage of clones				Mean
		1976	1977	1978	1979	
Highly resistant (no leaf scald)	1	50	36	10	51	36,8
Resistant	3	10	20	10	26	16,5
Intermediate	5	33	20	42	15	27,5
Susceptible	7	3	8	25	3	9,8
Highly susceptible	9	3	16	13	5	9,3

* Clones at the 5th and 6th selection stages in the northern and southern breeding programmes respectively

are represented by three or five single-row plots, each 5 m long, in the stage-1 and stage-2 trials respectively.

In the trials at Mount Edgecombe, spreader plants of infected NCo 339 are planted between every two rows of clones under test. Maize plants, cv Hickory King, inoculated with SCMV are interplanted in the trials to serve as an additional source of virus and vector insects. The clones in this series of trials are simultaneously screened for resistance to streak. In the trials at Dumisa the spreader plants consist of infected NCo 376. Three of the four trials are planted in spring (late November), so that the cane is at a young stage of development in mid-summer, conditions when rapid spread of mosaic is most likely to occur (Bailey & Fox[4]). One first-stage trial that is planted in autumn (March), because of the availability of seed material, is cut back in the following November to synchronise it with the other trials. The trials are cut annually.

Relatively little change in mosaic incidence occurs after the plant crop and useful results are therefore rapidly available for selection purposes. Records are taken up to the second ratoon crop in trials planted at Mount Edgecombe and up to the first ratoon crop in trials at Dumisa. The recording of mosaic incidence and the allocation of clones to resistance categories was previously based on the proportions of stools infected. Since 1980 records have been taken of the proportion of shoots or stalks with symptoms in order to improve the accuracy of assessment.

The incidence of mosaic in the series of trials conducted at Mount Edgecombe has generally been low, except with extremely susceptible varieties. For example, little infection has occurred in NCo 376 (Table 6), although this variety is often severely infected in many areas of production. However the occurrence of mosaic in the standard varieties and the proportional distribution of new clones in the various categories of resistance (Table 7) has been fairly consistent from trial to trial. At Mount Edgecombe a mean of approximately one-third of new clones has been assessed as susceptible.

The relatively low levels of mosaic in NCo 376 and NCo 293 had indicated for some time that the Mount Edgecombe trials were not a sufficiently accurate or stringent test for clones intended for those parts of the industry where mosaic is a serious problem. The suitability of the Mount Edgecombe site was therefore tested in 1980 by planting a group of standard varieties and new clones in another trial at Dumisa where mosaic is widespread. There were large differences in mosaic incidence in the plant crop between the two sites (Table 8). Eleven new clones that were free or almost free of mosaic at Mount Edgecombe were infected at Dumisa and eight of these could be regarded as susceptible or highly susceptible. If the results of this first trial at Dumisa are representative, more than 50% of advanced clones from the southern areas breeding programme are unacceptably susceptible to mosaic.

TABLE 6
Reactions of standard varieties in mosaic screening trials at Mount Edgecombe

Standard variety	% plants infected					Mean
	1976	1977	1978	1979	1980	
N55/805 ..	8	—	0	—	—	4,0
NCo 310 ..	8	0	0	0	—	1,0
NCo 293 ..	—	—	4	4	16	8,0
NCo 376 ..	16	2	4	12	4	7,6
NCo 339 ..	44	100	28	80	100	70,4

These data and the continuing spread of mosaic in many areas led to a reassessment of the priority given to screening for mosaic resistance and resulted in the introduction of the present two-stage system in 1981. Stage-1 consists of two trials planted at Dumisa. It contains approximately 140 southern and 30 northern clones from the fourth and fifth selection stages respectively, both one selection stage earlier than before. Stage-2 consists of the Mount Edgecombe trial, duplicated at Dumisa. The first results from the plant crops of the new stage-1 trials will be available in late 1982.

TABLE 8
Mosaic incidence in new clones and released varieties at Mount Edgecombe and Dumisa, 1980

Clone or variety	% stalks with mosaic	
	Mount Edgecombe	Dumisa
New clones		
72L1263	0	0
73H258	0	0
74L775	0	0,3
74M1468	0	0,7
74M1143	0	1,0
74L416	0	10
74M411	0	15
72E517	0	16
74M659	0	16
72E1050	0	18
74L1096	0	35
72E1045	0	88
72M903	0,4	63
72M905	2	40
73H357	6	54
74L1372	11	57
72W784	21	82
74L195	22	71
73H277	80	100
Released varieties		
N11	0	0
N13	0	30
N14	2	32
N12	5	33
NCo 293	2	37
NCo376	0,5	57

TABLE 7
Proportions of new clones,* in three categories of resistance to mosaic, at Mount Edgecombe

Resistance category	Resistance rating	Percentage of clones					Mean
		1976	1977	1978	1979	1980	
Resistant (no mosaic)	2	24	44	28	24	48	33,6
Intermediate	5	45	28	33	45	15	33,2
Susceptible	8	31	28	39	31	37	33,2

* Clones at the 5th and 6th selection stages in the sourthern and northern breeding programmes respectively

TABLE 9
Constitution of the smut resistance screening programme

Smut screening stage	Selection stage at which clones are tested	No. clones screened annually	Method of screening
1	3rd selection stage, northern programme Imported varieties	400 20	Inoculation
2	4th selection stage, northern programme 5th selection stage, southern programme	100 30	Inoculation and natural exposure
3	5th selection stage, northern programme 6th selection stage, southern programme	30 10	Natural exposure

Smut

Smut screening has been conducted under irrigated conditions at Pongola since 1974. This programme has had a high priority for some years and now consists of a three-stage series of trials with one trial in each stage being planted annually (Table 9). The stage-1 and stage-3 trials are planted in autumn, when seedcane of the clones to be tested becomes available. Stage-2 trials are planted in early summer, a period that has proved more favourable for the expression of smut symptoms than autumn planting.

The screening techniques used include both natural exposure to high levels of smut and artificial inoculation. In the natural exposure method high levels of smut inoculum are obtained by planting a spreader row of infected NCo 310 between every two rows of clones being tested. Smut symptoms appear relatively slowly in these trials and only rarely in the plant cane crops, even of susceptible standard varieties. Records are therefore taken up to the second ratoon crops.

Screening by inoculation involves soaking the seedcane setts of the clones to be tested in a suspension of smut spores for 15 minutes. The spore suspension is prepared in a 400 litre tank in the field and contains the equivalent of one freshly collected smut whip per litre of water, giving a concentration of approximately 8-10 million spores per millilitre These standardised inoculation conditions have been chosen empirically so that the development of smut in the plant crop following inoculation is similar to and highly correlated with that developing after several ratoon crops under conditions of natural exposure to high levels of smut (Anon[1] & unpublished data). The method has proved suitable for the rapid and uniform inoculation in the field of the large number of clones (up to 420) included in each trial. With inoculation useful results for selection purposes are available within one year after planting. In particular the technique enables both highly susceptible and highly resistant clones to be rapidly identified.

In trials planted up to 1978 smut reactions were assessed from the proportions of plants with symptoms. Reactions are now also assessed from the maximum number of smut whips present at any one time and from the loss of millable cane caused by the disease (severely affected stools may produce few conspicuous smut whips).

Screening of very advanced clones, in what are now stage-3 trials, was introduced in 1976. This series of trials is based on natural exposure to smut. Up to 40 clones are each represented by five randomly distributed plots, consisting of a single row 5 m long. The trials are planted in autumn (March) and continue up to the second ratoon crop.

The reactions of standard varieties in the stage-3 trials have been acceptably consistent (Table 10). However, the amount of smut developing in NCo 376, for example, has been appreciably lower than that occurring in this variety in the areas where smut is most serious. The reactions of the clones under test have been grouped into three categories of resistance in Table 11. A mean of 33% of these advanced clones was unacceptably susceptible to smut in the trials planted from 1976 to 1979 but in the 1980 trial only 12% of the clones were found to be susceptible. This significant improvement was due to earlier screening of those clones from the northern selection programme by inoculation in the 1977 and 1978 stage-2 trials, so that most of the susceptible clones had been discarded.

TABLE 10
Reactions of standard varieties to smut in late, stage-3, screening trials

Standard variety	% plants infected					
	1976	1977	1978	1979	1980	Mean
N52/219	0	0	0	0	0	0
N11	—	0	—	0	0	0
NCo 376	8	8	8	6	7	7,4
N55/805	—	—	20	14	—	17,0
NCo 310	36	—	44	28	30	34,5

TABLE 11
Proportions of clones* in three categories of resistance to smut in late, stage-3, screening trials (natural exposure to smut)

Resistance category	Resistance rating	% clones					
		1976	1977	1978	1979	1980	Mean
Resistant (no smut)	2	40	32	40	37	60	41,8
Intermediate	5	30	28	35	26	28	29,4
Susceptible	8	30	40	25	37	12	28,8

* Clones at the 5th and 6th selection stages in the northern and southern breeding programmes respectively

The trials that now constitute the stage-2 screening test were started in their present form in 1977 by adding an inoculation treatment to what was previously a series of natural exposure trials. These trials are planted in early summer (November). Approximately 130 clones are subjected to both natural exposure and inoculation, a clone being represented by a 5 m row in each case. With inoculation results from the plant crop can be used for selection purposes but the trials are maintained up to the second ratoon crop for greater accuracy. This series of trials has been used to determine the value of inoculation for rapid screening for resistance to smut (Anon[1]).

After inoculation the numbers of smut whips in the plant crops were similar to those in the second ratoon crops after natural exposure. Although many more smut whips occurred in the first and second ratoon crops after inoculation (Table 12), results from the plant crops enabled most of the highly resistant and susceptible clones to be identified within 12 months of planting. The proportions of new clones in different categories of resistance to smut and the amount of smut in the standard varieties were fairly consistent in the trials planted from 1977 to 1979 (Tables 12 and 13). A mean of 13,7% of clones did not develop smut in the plant or ratoon crops while more than half of the clones were found to be unacceptably susceptible.

Table 12

Reactions of standard varieties to smut in intermediate, stage-2, screening trials, after inoculation

Standard variety	Smut whips/ha (1 000's)					
	1977		1978		1979	
	P	1R	P	1R	P	1R
N52/219 ..	0	0	0	0	0	0
N11 ..	—	—	0	0	0	6
NCo 376 ..	21	93	24	122	42	155
NCo 310 ..	3,6	180	34	104	40	161

The earliest stage of smut screening, the stage-1 series of trials, was introduced in 1980. These trials are planted in autumn (March). Each of approximately 400 clones is represented by a single row 5 m long. Screening is carried out by inoculation with preliminary results being obtained from the plant crops and final results from the first ratoon crops.

Results from the first two trials in this series showed that approximately 55% of these early stage clones were resistant to smut and approximately 30% were susceptible (Table 14). However, less smut occurred in standard variety NCo 376 after inoculation in these autumn-planted trials than in the summer-planted stage-2 trials and it is possible that some intermediate or susceptible clones were not identified. Any such clones will be detected at subsequent stages of screening.

Discussion

Recent changes have made the disease screening programme more pertinent to the prevailing disease situation in the sugar industry. Some additional, relatively minor changes can be foreseen but it is unlikely that the programme will change radically in the immediate future.

The value of screening for streak resistance must be questioned as only a small proportion of the clones tested prove to be susceptible. However these trials will continue in their present form while also being used for mosaic screening at Mount Edgecombe.

Screening trials for resistance to leaf scald are difficult to conduct and evaluate. This series of trials, however, greatly reduces the risk of leaf scald developing into an economically important problem in South Africa and will therefore continue in its present form.

The greater accuracy with which mosaic susceptibility can be identified in much larger numbers of clones than have previously been tested should contribute significantly to the prospects of reducing the problem of mosaic in the long term. The different results obtained at Dumisa and Mount Edgecombe may be due to more suitable conditions for spread of the disease at Dumisa, but may also be due to differences in the strains of SCMV at the two testing sites. It is known that several strains of the virus occur in South Africa (Anon[2]). The predominant strain in areas where mosaic is a serious problem appears to be strain D, while only strain A has so far been identified at Mount Edgecombe. Further work on strain identification and distribution will clarify this situation. If the superiority of the Dumisa site is confirmed in trials planted in 1981 and 1982, consideration will be given to conducting all future mosaic screening in that or a similar area.

TABLE 14

Proportions of new clones* in three categories of resistance to smut in early, stage-1 screening trials, after inoculation

Resistance category	Resistance rating	% clones	
		1980	1981
Resistant (no smut)..	2	47	66
Intermediate	5	19	10
Susceptible	8	34	24
Standard variety NCo 376	% plants infected	33	32
	Smut whips/ha	40 000	8 100

* Clones at 3rd selection stage, northern breeding programme.

TABLE 13

Proportions of clones* in four categories of resistance to smut in intermediate, stage-2, screening trials, after inoculation

Resistance category	Resistance rating	% clones			
		1977	1978	1979	Mean
Highly resistance (no smut)	1	8	15	18	13,7
Resistant	2–3	11	14	11	12,0
Intermediate..	5	21	19	17	19,0
Susceptible	8	60	52	54	55,3

* Clones at the 4th and 5th selection stages in the northern and southern breeding programmes respectively

Recent changes to smut screening procedures were introduced to increase the numbers of smut resistant clones at late stages of selection in the breeding programme. Benefits from the changes were apparent for the first time in the late, stage-3 screening trial planted in 1980. In this trial the proportion of clones resistant to smut increased to 60% from a mean of 37% in the previous four trials. Improvements of this order should contribute to the prospects of long term control of this disease. No further major changes to smut screening procedures are likely to take place in the near future. However, with increasing incidence of smut in the southern parts of the industry earlier screening of clones from the southern breeding programme should be beneficial. The testing of the southern clones at the fourth rather than the fifth stage of selection is therefore being considered.

One problem of present procedures is the small plot area used for each clone in the present stage-1 and stage-2 smut screening trials, a consequence of the large numbers of clones being tested. Thus some inaccuracy in the assessment of individual clones with intermediate or low levels of susceptibility is inevitable (one smut whip in a row of 5 m at a spacing of 1,4 m is equivalent to 1 400 whips/ha). No significant improvements to the stage-1 trials can easily be made. However, from 1982 the stage-2 smut trials will be based solely on inoculation. This will allow a doubling of the area of each clone planted with inoculated seedcane to 14 m^2, with a corresponding increase in precision.

Except for extremely susceptible varieties, conditions at the Pongola trial site are not conducive to the rapid spread of smut in natural exposure screening trials, despite the planting of infected spreader plants. Attempts are made to maximise the spread and expression of smut by restricting irrigation and by early cutting to synchronise young stages of growth with the summer months, so creating conditions in which smut whips are most likely to develop (Bailey[3] and unpublished data). Consideration is now being given to including an inoculation treatment in addition to the natural exposure test in the final, stage-3 series of smut trials.

The disease screening programme, presently based entirely on the field testing of new clones, is demanding in terms of time and resources. This is a limitation to the routine screening of significantly more clones than are presently tested. However, the high proportions of new clones that are susceptible to smut and mosaic indicates that testing at still earlier stages of selection would be desirable. Any large scale changes of this nature depend on the development of new techniques suitable for the rapid, mass screening of new clones.

Recent work on the biochemical aspects of resistance to smut in South Africa (Lloyd & Pillay[6]) shows promise as a basis for a new laboratory method of determining smut resistance by biochemical assay. A critical evaluation of this method of screening on previously untested sugarcane clones will commence in the near future. The prospects of using new techniques for the mass screening of new clones for resistance to mosaic are good. The ELISA (enzyme-linked immunosorbent assay) technique is already being used for detecting mosaic resistance in sugarcane (Devergne[5]) and this, or a similar technique may prove suitable for mass use in South Africa. The successful evaluation of these techniques would allow substantial changes to be made to disease screening methods for sugarcane in South Africa.

Conclusion

As the incidence and spread of economically important diseases in South Africa has increased during the past decade, it has become necessary to reassess variety screening procedures and to implement more comprehensive programmes. This has been accomplished to a large extent but the process is still continuing.

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