AN ASSESSMENT OF THE STATUS OF SUGARCANE DISEASES IN SOUTH AFRICA

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Abstract

An attempt has been made to assess the status of different cane diseases in the South African sugar industry. Factors taken into account are present incidence, potential for further spread, estimated losses in yield and possibilities for control. It is shown that diseases are causing significant losses in yield but that the major proportion of present losses, that due to ratoon stunting disease, can be easily prevented by growers. Smut is becoming more important in the northern irrigated areas and in parts of Zululand and is now of great concern. Outbreaks of mosaic are occurring increasingly frequently in the southern and high altitude areas of production. Rust, red rot and basal stem rot are also more evident now than in previous seasons. The necessity for growers to regard disease control as an important and routine aspect of cane management is stressed.

Introduction

Sugarcane diseases have been associated with the South African sugar industry since its earliest days. Smut, for example, was an important problem on the North Coast in 1877. Since then the economic importance of diseases and the appreciation by growers of the need for control measures have fluctuated markedly over the years.

Between about 1910 and 1930 two virus diseases, first mosaic and then streak, caused serious decreases in yield. The mosaic problem was solved by the rapid increase in the use of the variety Uba. Uba, however, eventually became widely contaminated with streak and in turn was replaced by imported resistant varieties, such as Co 281, POJ 2725 and POJ 2878. More than a decade followed of apparent freedom from disease problems.

Smut reappeared on the North Coast and in Zululand in 1945 on variety Co 301 and was a serious problem until about 1955. Shortly after 1950 it was realised that ratoon stunting disease (RSD) was widely distributed in the industry. The severity of the smut and RSD problems led to a resurgence of interest in disease control. Co 301 was gradually withdrawn from production and the need to contend with RSD resulted in the rapid adoption of hot water treatment as the standard means of control and in the widespread introduction of nurseries, planted with heat treated stock, for the production of commercial seedcane. Consequently diseases again diminished in economic importance.

For about the last two decades disease control has been regarded as a relatively unimportant aspect of cane management. Several factors appear to have influenced the development of this situation. Initially it was a natural reaction to the apparently reduced incidence of previously important problems. The increasingly widespread planting of NCo 376 also contributed to the recent attitude to disease control. This vigorous variety has, until recently, been free of smut throughout Natal. NCo 376 also does not have conspicuous symptoms of RSD and a misleading impression of the importance of RSD appears to have developed.

Several diseases, including RSD, smut and red rot, are most severe when cane suffers stress and the relatively good growing conditions from about 1970, up to and including the 1977-78 season, have masked the expression of diseases and made the need for routine disease control measures less obvious.

During recent seasons only a small proportion of the seedcane planted has been produced in properly managed seedcane nurseries. The use of hot water treatment has declined in rainfed areas and high quality seedcane is in short supply in many areas. The role of the ubiquitous volunteer in the maintenance and dissemination of diseases is often underestimated. Economic necessities have taken precedence over the need for disease control, resulting in a shortening of the fallow period between ploughing out and replanting. The fallow period is now often too short to allow for adequate elimination of volunteer regrowth, which is difficult to detect when the same, predominant, variety is replanted in a field. In short, the industry has passed through a period when diseases have not been obviously important problems and growers have not been "disease-control conscious", although perhaps with some justification.

Over the last few seasons, since approximately 1974/75, evidence has accumulated indicating that the view that disease control requires little attention and that diseases have little economic importance is no longer appropriate.

The incidence of smut has increased substantially in recent seasons, both in NCo 376 in the northern irrigated areas and northern Zululand, and in more susceptible varieties elsewhere. Severe outbreaks of mosaic have occurred more frequently in recent years. New diagnostic techniques have shown that RSD is widespread and often unsuspected in NCo 376 and other varieties in all areas. Resurgences of rust, red rot and basal stem rot have occurred recently.

Some quantification of the incidence and effects of sugarcane diseases is necessary in order to determine the economic importance of individual diseases, thus providing guidelines for the grower and the research worker on the application of control efforts and the need for further research. However, quantifying losses due to diseases is difficult in most agricultural crops, not least in sugarcane. Systematic, widespread monitoring is a prerequisite for gauging trends in the incidence of diseases, which, together with an understanding of the effects of different diseases on yield, allows an estimate of crop losses to be made. Estimating disease incidence may be relatively easy for diseases with characteristic symptoms, such as smut, but is more difficult for diseases that lack conspicuous symptoms, such as RSD, mosaic and leaf scald. In sugarcane the expression and effects of different diseases are often markedly affected by the varieties being grown. They also vary geographically, and are affected by short term changes in the weather or changes in soil conditions. Interactions of these factors may further complicate the situation.

The carrying out of disease surveys in the northern irrigated areas since 1976 and in Zululand in 1978, has provided a fairly accurate picture of the smut problem facing the

industry. Changes in diagnostic procedures for RSD have enabled an accurate survey of RSD incidence to be undertaken for the first time. Localised surveys of mosaic, stem rot and leaf scald have been conducted recently. More data are now available from field trials on the effects of diseases on cane yield, from which extrapolations to commercial situations can be made.

Our knowledge of disease incidence and crop losses is still limited. However, sufficient information is available to illustrate the broad patterns and trends of the occurrence of different diseases and to present estimates of losses in yield due to these problems.

Ratoon Stunting Disease

RSD is generally regarded as the most important disease of sugarcane in terms of losses in yield, both in South Africa and many other sugarcane areas of the world. Although RSD has for a long time been thought to be widespread, the incidence of the disease has been a matter of conjecture until recently. Uncertainty regarding the incidence of RSD has been due to the lack of symptoms that can be easily recognised in the field, particularly in NCo 376. This variety constitutes some 65% of the national crop at present but does not develop readily recognisable nodal symptoms, even when severely affected.

The recent development of a simple diagnostic technique for RSD, based on microscopic observation of the characteristic bacteria that are present in infected plants, has made possible accurate surveys of RSD incidence. The presence or absence of the disease in cane fields can be determined readily and, depending on the extent of sampling, the intensity of infection can be estimated in affected fields.

During 1978/79, 423 samples of stalks were examined for advisory purposes. RSD was diagnosed in 28% of commercial fields and in 27% of fields to be used as sources of seedcane. Fields of NCo 376 were the most frequently affected, with 31% having RSD compared with 22% of fields of other varieties.

A survey of RSD incidence in the Durban-North Coast and North Coast extension areas has recently been conducted. The fields sampled were selected at random on 40 estates, so that all crop stages, from seedcane sources to old ratoon fields were represented. The severity of RSD in each field was rated on a scale of 0 (no RSD) to 4 (all stalks with RSD). The results of the survey were similar to those obtained from examination of the advisory samples, with 37% of the fields surveyed having RSD. The proportion of the fields with RSD and the severity of the disease in infected fields increased in progressively older ratoons. RSD was most common and most severe in NCo 376, which accounted for 155 (66%) of the 235 fields surveyed. In this variety the incidence of RSD increased from 25% of intended seedcane sources to 65% of old ratoon fields, with a mean of 43% of fields being affected (Figure 1a). The increasing intensity of RSD in affected fields of NCo 376 with ratooning is shown in Figure 1b.

These results show that RSD is more widespread than had been suspected, with approximately one third of fields having the disease. The high incidence of RSD in seedcane fields and in plant cane in commercial fields points clearly to the cause of the problem : poor quality seedcane that is often planted into fields containing infected volunteers.

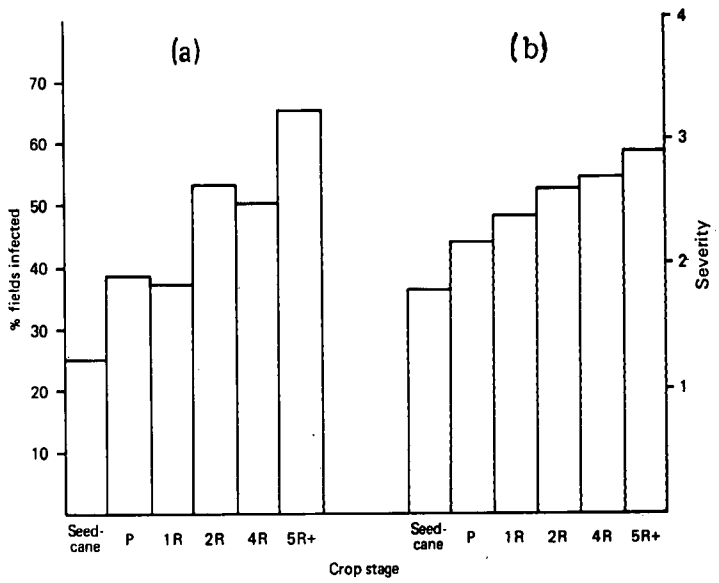

FIGURE 1 RSD incidence in various crop stages of NCo 376 on the Natal North Coast, 1978/79.
(*a*) proportion of fields affected
(*b*) severity of RSD in affected fields, 0 (nil) - 4 (all stalks infected).

It has been shown experimentally that RSD can cause severe losses in the yield of most varieties under rainfed conditions and that losses are greatest when cane suffers stress. The results of field trials conducted at Mount Edgecombe indicate that losses in yield of approximately 30% may be incurred in NCo 376 and other important varieties from a high intensity of RSD under rainfed conditions (Table 1). The effects of RSD on the growth of NCo 376, N53/216 and N55/805 in the third ratoon crop of a trial at the Experiment Station are shown in Figure 2.

FIGURE 2 Effect of RSD on cane growth. From left, NCo 376 healthy and diseased, N53/216 healthy and diseased, N55/805 healthy and diseased.

TABLE 1
Effect of ratoon stunting disease on the yield of six varieties under rainfed conditions on the Natal North Coast

Variety	Loss in cane yield (%)			
	Trial 1 P + 2R	Trial 2 P + 3R	Trial 3 P + 2R	Trial 4 P
CB 36/14	—	51	73	—
NCo 376	29	25	46	29
N53/216	—	—	37	16
N6	35	—	—	—
N8	25	—	—	—
N55/805	24	—	16	+11

Assuming that some 30% of fields have RSD and that in these fields the disease incidence is moderate to severe, causing a loss in cane yield of 15%, a simple calculation indicates that losses from RSD may be of the order of 5% of the industrial crop, or approximately one million tons of cane annually. The extent of losses will, of course, vary with seasonal rainfall and the extent to which the demand of the crop for water is met. Losses in the crop to be cut in the 1979-80 harvesting season, for example, are expected to be high, because rainfall during the 1978-79 summer was low over much of the industry.

Despite its widespread distribution and substantial effect on yield RSD is the easiest of all diseases to control. All that is required is the adherence by growers to a policy of routine hot water treatment to produce healthy seedcane and the planting of this seedcane in fields that are free from volunteers. That RSD is so widespread is evidence that insufficient attention is given to these basic principles of sugarcane disease control. The absence of RSD from some large estates shows that the elimination of this disease is a realistic management objective.

Smut

Smut, caused by the fungus *Ustilago scitaminea*, was a serious problem in Zululand and on the North Coast in variety Co 301 during the early 1950's. This first widespread outbreak diminished with the replacement of Co 301 with other varieties. During the decade 1960-70 outbreaks of smut developed in NCo 310 in the northern irrigated areas of Pongola and the Eastern Transvaal, concurrently with the expansion of cane production. In these areas NCo 310 has now been almost entirely replaced by NCo 376.

It is now apparent from the results of surveys that the incidence of smut is increasing in many areas of the industry. In the northern areas the incidence of smut in NCo 376 has steadily increased since the systematic monitoring of the situation commenced in 1976 (Figure 3 and Table 2). This deterioration has occurred despite increased extension effort regarding the importance of smut control. The situation is particularly serious in the Komatipoort area, where a mean of 6,2% of stools of NCo 376 had smut during 1978/79. In this area 45% of fields had more than 5% smutted stools in the 1978/79 season compared with 13% of fields in 1977/78 (Figure 4).

The incidence of smut has also increased throughout northern Zululand. Smut was first recorded in the Monzi area in the summer of 1977/78 (Table 2). A survey at that time indicated a mean incidence of 1,3% smutted stools. In the summer of the 1978/79 season the mean incidence of the disease in the Monzi area rose to 8,6% smutted stools, with means of 11% in N55/805, 9% in NCo 310 and 5% in NCo 376. Smut is also becoming increasingly common on the Umhlatuzi and Felixton Flats and in the Hluhluwe, Empangeni and Nkwaleni areas. Infection is occurring not only in highly susceptible varieties, such as NCo 382, N55/805 and N8, but also in NCo 376. Whereas smut was unknown in NCo 376 outside Pongola and the Eastern Transvaal until 1977/78, it is now common in this variety in many areas of Zululand. Smut is now common in N55/805 on the North Coast, and since 1977/78 it has been found in NCo 293 in several Midlands localities and in N53/216 on the South Coast.

Smut is the most serious disease problem facing the industry with respect both to the ability of the disease to cause damaging losses and to the difficulty of controlling the disease once it becomes severe.

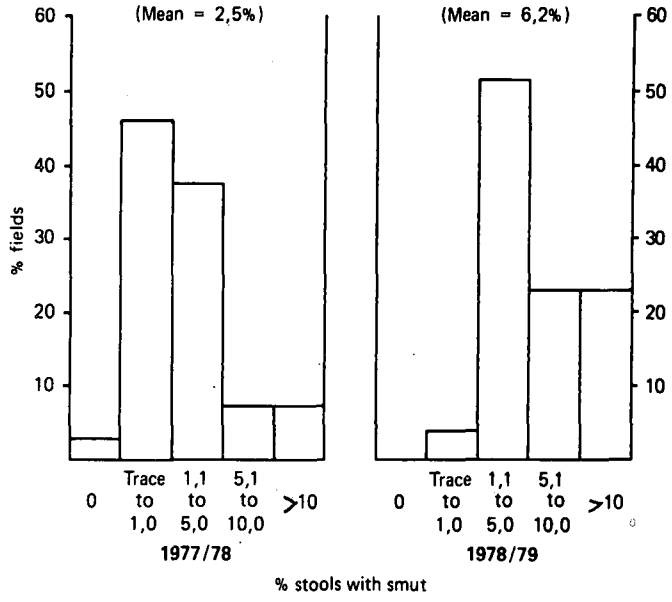

FIGURE 3 Proportion of fields of NCo 376 with different levels of smut in the Komatipoort area.

TABLE 2

Incidence of smut in the Komatipoort, Malelane, Pongola and Monzi areas of the South African sugar industry
(% stools with smut)

Area	Variety	Season		
		1976/77	1977/78	1978/79
Komatipoort . . .	NCo 376	1,2	2,5	6,2
Malelane	NCo 376	0,5	1,3	2,3
	NCo 310	2,1	2,8	—
Pongola	NCo 376	0,5	1,3	1,8
	NCo 310	3,9	6,1	10,1
Monzi	NCo 376	—	—	5,0
	NCo 310	—	1,3	8,9
	N55/805	—	—	10,6

FIGURE 4 A severe outbreak of smut in NCo 376 at Komatipoort.

It has been shown experimentally that a high incidence of smut can reduce yields of NCo 376 by approximately 20% under excellent growing conditions, although little damage may be apparent. Under poor growing conditions severe smut can reduce yields of NCo 376 to the point where little millable cane is produced (Figure 5). More susceptible varieties, such as N55/805, NCo 310 and N7, can be infected and succumb even more rapidly than NCo 376. The damage that smut can do to infected stools is shown in Figure 6.

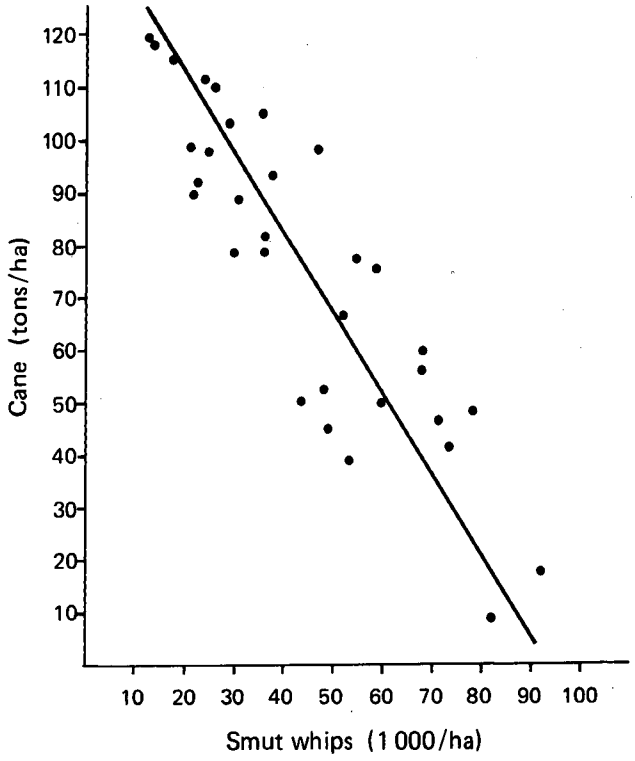

FIGURE 5 Relation of yield of NCo 376 to smut intensity (IR after inoculation of seedcane before planting, Big Bend, 1977/78).

FIGURE 6 Smut in NCo 376. Severely stunted stools in the foreground.

Severe damage from smut is still the exception rather than the rule in commercial fields. However, severely affected fields are being observed more and more frequently in areas such as Komatipoort, Mkuze, Hluhluwe and Umfolosi. An estimate of current losses due to smut throughout the industry can so far only be tentative. A mean incidence of 3% smutted stools would be a conservative estimate for the area from Empangeni northwards, which produces approximately 27% of the annual industrial crop. If it is assumed, again conservatively, that this level of infection causes a loss in yield of 1%, then smut would be responsible for an annual loss of 50 000 tons of cane. This estimate does not include losses in yield that occur in varieties such as N55/805 as a result of scattered outbreaks in southern Zululand and on the North Coast.

Although the increase in smut incidence in many areas during 1978/79 may have been partly due to the poor growing conditions, there is now ample evidence that the northern third of the industry is in the early stages of a general smut epidemic. The threat of smut extends to all areas, as a severe epidemic in any one part of the industry will inevitably increase exposure to the disease in other parts. Already scattered outbreaks of smut have occurred in susceptible varieties in the central and southern areas.

Moreover, it is pertinent to recall that smut has been a serious problem over much of the industry in the past. The problem is compounded by the present almost total dependence of the industry on varieties which are susceptible to smut (Table 4). Although the new smut resistant varieties N52/219, J59/3 and N11 are now available and have partially eased the variety situation, they are not yet widely planted and are not satisfactory replacements for smut susceptible varieties under all conditions.

The consequences of a major general smut epidemic need little emphasis. The economic effects of substantial yield losses are obvious but indirect effects are likely to be of equal importance. As the level of infection increases so the cost of control measures, such as roguing, will increase. Fields will require ploughing out prematurely, both for reasons of low yield and as a control measure, so that the costs of more frequent replanting will be incurred. Equally important, high yielding, susceptible varieties may have to be abandoned before equivalent or superior alternatives are available for all situations.

On the other hand there is much scope for improvement of the situation, particularly in the early stages of epidemic development, through the general adoption of sound field control measures. Thus, smut has been successfully contained in NCo 376 in the Rhodesian lowveld for a number of years. All growers in that area participate in a control scheme that includes the production of clean seedcane, the roguing of smut from fields and the ploughing out of severely smutted fields. The adoption of a similar approach in the Mhlume-Tambankulu area of Swaziland is currently maintaining smut at a low level in NCo 376, despite severe outbreaks immediately to the north at Komatipoort and to the south at Big Bend. Encouraging progress towards the implementation of control measures, including the production of healthy seedcane, is now taking place in the Umfolosi area There is an urgent need for the adoption of a similar approach to the smut problem in all parts of the industry where the disease now occurs.

Unless adequate field control measures are applied at this early stage, when control is most likely to be achieved, the smut situation will deteriorate in most of the currently widely grown varieties. Without control, enforced changes in the range of varieties available to growers may be necessary.

Mosaic

This virus disease (Figure 7) caused widespread and severe losses throughout the industry up to about 1920 but the importation of resistant varieties successfully controlled this first major epidemic of mosaic.

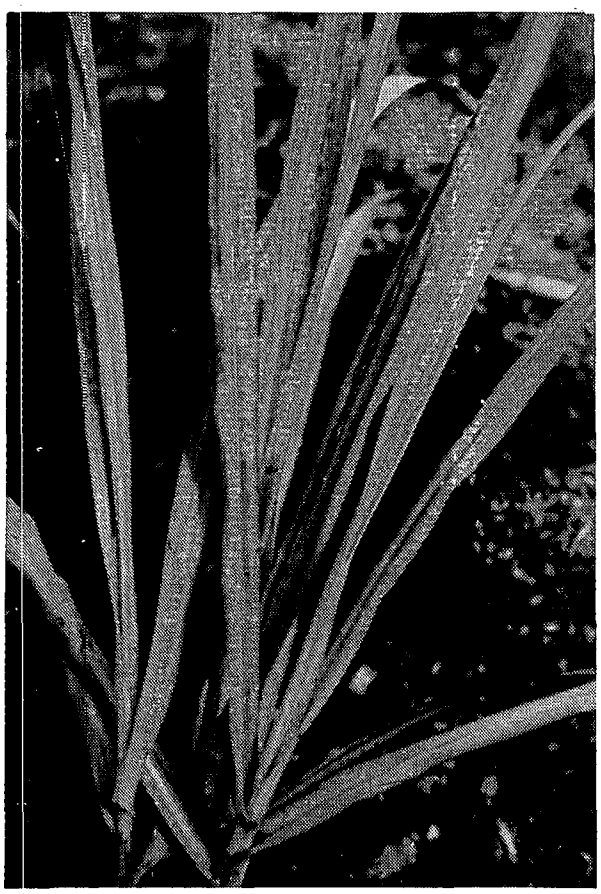

FIGURE 7 Symptoms of mosaic on NCo 376.

Today mosaic is a major problem only in certain restricted localities in the cooler, southern and inland areas. Severe outbreaks have occurred regularly in the Glenrosa to Dumisa and Eston to Mid-Illovo areas for a number of years. Since 1976/77 scattered, severe outbreaks have occurred in NCo 376 and NCo 293 in the Melmoth, Dalton, Shongweni, Pietermaritzburg and Nquabeni areas. These outbreaks indicate that the general incidence of mosaic is increasing. Where mosaic is common, for instance at Dumisa, very high levels of infection can occur shortly after the planting or cutting of susceptible varieties in the summer months. Fields in which all stools are infected with mosaic are not uncommon. On some severely affected farms annual losses in cane yield due to mosaic are probably of the order of 10% or more, while losses in some fields may be as high as 50%. Although individual field and farm losses may be substantial in some areas, industrial losses are evidently still relatively small, probably of the order of 40 000 tons of cane annually.

Mosaic poses what is probably the second most important disease hazard facing the industry. It is the most important potential disease problem in the southern and inland areas, which account for approximately 25% of cane production. As with smut, the mosaic problem is compounded by the dependence of areas that are climatically favourable for development of the disease on highly susceptible varieties. NCo 376 and NCo 293, which are the most susceptible of our widely grown varieties (Table 4) comprise approximately 75% of the cane produced in the Melmoth, Umvoti, Midlands South, South Coast and Lower South Coast areas.

Mosaic infects grasses and field crops such as maize as well as sugarcane. This feature of mosaic is one of the reasons why the disease tends to be most common in areas of mixed farming. A further consequence of the wide host range is that the control of an established, severe mosaic problem is extremely difficult. This is because all sources of infection cannot be eradicated by management of the sugarcane crop alone. The containment of a deteriorating situation at an early stage, before outbreaks are widespread, is therefore, more necessary with mosaic than with most diseases.

The solution to the mosaic problem will eventually be found in the development of resistant, agronomically suitable varieties to replace NCo 376 and NCo 293. New clones under selection in the breeding programme exhibit resistance but the proving of new varieties in the field to the point where the present varieties can be replaced will take time. Until suitable new varieties are available efforts must be made to prevent mosaic spreading further in areas which are favourable for development of the disease. Practical steps include the provision of disease-free seedcane, the roguing of mosaic-infected plants from fields and the early planting of susceptible varieties to avoid the mid-summer period when the rate of infection is maximal.

Rust

Widespread outbreaks of rust (*Puccinia melanocephala*) have occurred on variety N55/805 ever since the resurgence of this disease in 1974/75. Although rust symptoms can be seen on other varieties, notably N6 and CB36/14, N55/805 is by far the most susceptible of our released varieties (Table 4 and Figure 8). Rust is most obvious in young crops of N55/805. The most severe outbreaks tend to occur in the cooler areas of the industry, particularly after long periods of humid or wet weather. However, rust can occur in young cane in all areas at all times of the year. In the 1978/79 season rust was common on N55/805 in all areas following the long period of cool, wet weather during the spring months.

FIGURE 8 Rust sori on the lower surface of a leaf of N55/805.

Yield losses from rust are generally likely to be small, particulary where the crop grows away quickly from an early infection and is being grown on a long cycle. However, significant losses may occur after very severe outbreaks have seriously affected the crop early in its development. Mean losses in yield of N55/805 due to rust are probably of the order of 5% (losses may be higher than this but will often be less). Since N55/805 contributes approximately 10% of total production, the annual loss of cane from rust is likely to be no more than 100 000 tons. Nevertheless, such losses would make rust currently the second most important disease in South Africa in terms of yield loss. However, it seems unlikely that rust will increase in severity and so cause further damage. The disease is largely restricted to the one variety, N55/805, which is likely to diminish in importance in the future. Rust is a wind-borne pathogen, the incidence of which is greatly influenced by seasonal climatic conditions, and has probably already reached its maximum stage of development in N55/805.

Field experiments have shown that rust can be controlled by intensive fungicide spray programmes. The investigation of fungicidal control is continuing but it does not appear that the application of fungicides is economically worthwhile. The solution to the rust problem will be found in the production of resistant, alternative varieties to N55/805. There is abundant resistance to rust at present among clones undergoing selection in the breeding programme.

Other Diseases

Numerous other diseases occur on sugarcane in South Africa. Brown spot (*Cercospora longipes*) is often conspicuous on NCo 376, particularly in the winter months and in the cooler areas. This disease often appears to cause severe leaf necrosis but in fact occurs largely on senescing leaves

FIGURE 9 Symptoms of leaf scald: side shooting, dead and chlorotic leaves and an upright habit.

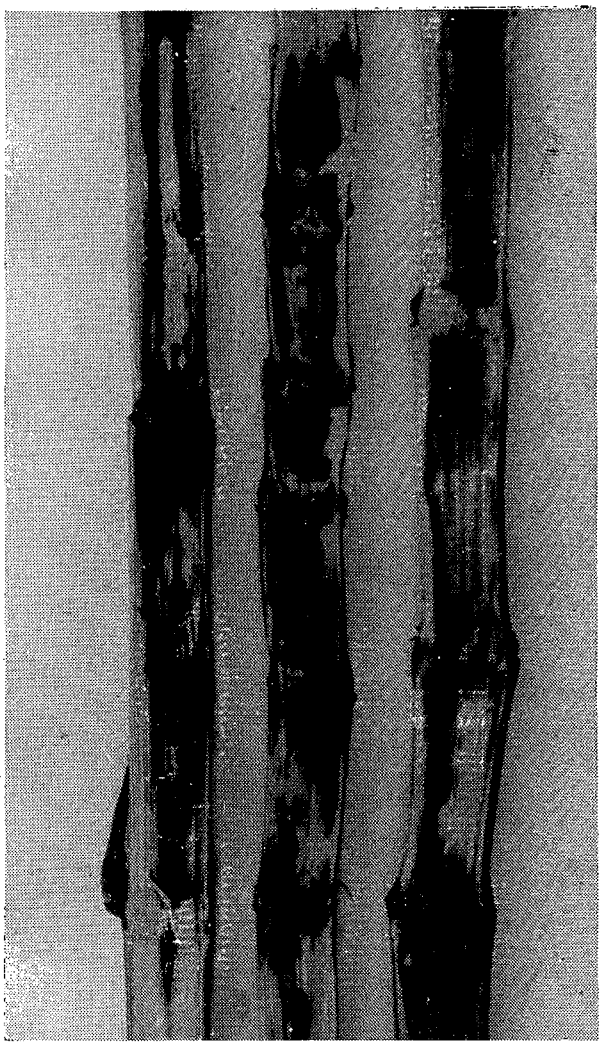

FIGURE 10 Symptoms of red rot seen in stalks cut longitudinally.

and has little effect on growth. Symptoms of gumming (*Xanthomonas vasculorum*) can often be seen in NCo 310 and N55/805 after wet weather in spring and summer but this disease is now of little importance. Under poor conditions for germination, pineapple disease (*Ceratocystis paradoxa*) can severely affect the germination of seedcane. However, this problem can be largely alleviated by the application of seedcane fungicides. Only a few other diseases are either capable of seriously affecting the growth of presently released varieties or seem likely to be of much potential importance.

Leaf scald

This bacterial disease (*Xanthomonas albilineans*) is the most recent of the world's more important cane diseases to have been found in South Africa. It was first recorded here in 1968. Since then isolated cases have occurred in susceptible varieties throughout the industry and the disease is now endemic in the northern irrigated areas. Most cane areas appear to be favourable for leaf scald development and several instances of severe damage to susceptible varieties have occurred.

Leaf scald often lacks clear specific symptoms and can spread unnoticed in a latent form. If this disease became widespread, susceptible varieties would be prone to unpredictable and severe losses when environmental conditions, such as long periods when cane suffers stress, favoured expression of the disease. Fortunately, most of the currently released varieties are resistant to leaf scald and only two minor varieties, N6 and N53/216 are susceptible (Figure 9). In 1975 and 1976 two varieties that had reached the final stage of

selection, L76 and Co 1001, were withdrawn after developing severe leaf scald symptoms in the field. Careful testing of all new varieties is now undertaken to ensure that only resistant varieties are released.

Red rot

Occasional outbreaks of the fungal disease red rot (*Colletotrichum falcatum*) occur in most seasons in susceptible varieties. However, during 1978/79 red rot was widespread in the cooler central, southern and inland areas of the industry and often caused severe damage. The seasonal incidence of red rot is closely related to weather conditions. The disease is most common in the cooler areas and losses are most likely when the crop suffers from either excessive or deficient soil moisture. Varieties NCo 376, N6 and NCo 382 can be severely damaged and during 1978/79, N55/805 and NCo 293 were also often seriously affected.

Red rot (Figure 10) can progress rapidly in mature standing cane, once the stalks are infected. The most serious aspect of the disease is the loss in stalk mass and sucrose content, which can reach serious proportions. Almost total losses of recoverable sugar can occur in susceptible varieties. Furthermore, many of the buds of apparently sound stalks can be infected. This may result in poor germination if such stalks are used as seedcane, particularly if planting takes place during cool weather.

Although serious losses can occur on individual farms and fields, red rot is unlikely to develop into a widespread problem of major importance in the future. However, fluctuations in economic importance are likely with seasonal variations in weather and the extent of the problem in the cool, upland areas of production should not be underestimated. The extent of present losses is uncertain but it may be of the order of 40 000 tons of cane annually (1% of production in the upland areas).

Practical steps that growers can take to minimise outbreaks of red rot are to plant healthy seedcane, to improve conditions for seedcane germination as far as is possible, to cut infected fields before serious stalk deterioration occurs and to destroy crop debris after infected fields are harvested.

Basal stem rot

Since 1975/76 this disease, caused by an unidentified soil-inhabiting fungus, has occurred more and more frequently. Basal stem rot is now a common disease in the cooler production areas. The disease can weaken and kill cane stools at a young stage of growth, causing a decrease in stalk population (Figure 11). Most outbreaks have been minor but several cases of severe damage to individual fields have been observed. Basal stem rot is so far largely restricted to NCo 376 and control will eventually be achieved with the development of resistant, alternative varieties. The occurrence of this disease is related to climatic and perhaps soil conditions. Dissemination in the field occurs only slowly and it is unlikely that basal stem rot will develop into a major problem.

Discussion

Present losses

Losses in the yield of sugarcane that are estimated to be due to diseases can be expressed in various ways (Table 3). The estimated annual losses of approximately 1,2 million tons of cane in 1978/79 are equivalent to 6,4% of all cane crushed — the capacity of a large mill. If these estimates are realistic, the value of cane lost annually would be approximately R16 million to growers , while the value to sugar lost to the industry would be some R35 million (based on values of R13/ton cane and R260/ton sugar respectively). By far the major proportion of these losses, that due to RSD (approximately 80% of total losses), is preventable at little cost by simple, well-proven methods of control.

Potential for further disease development

In addition to the current losses in production all areas are favourable for the further development of at least one of the important diseases that are already widespread or are increasing in incidence. Substantial losses from RSD can occur in all rainfed areas. Losses will be greatest in dry years, when some losses may even occur in irrigated areas if contaminated crops suffer stress. All areas north of central Zululand are favourable for the development of smut epidemics, even in

FIGURE 11 Gaps in the row and weakened stools of NCo 376 caused by basal stem rot.

TABLE 3

Estimated losses from sugarcane diseases in South Africa, 1978/79

Disease	Tons cane lost (1 000's)	Tons sugar lost (1 000's)	Value of loss (R million)	
			As cane	As sugar
RSD	1 000	109,6	13,0	28,5
Smut	50	5,5	0,7	1,4
Mosaic	40	4,4	0,5	1,1
Rust	100	11,0	1,3	2,9
Red rot	40	4,4	0,5	1,1
Total	1 230	134,9	16,0	35,0

(Estimates based on 9,1 t cane: 1 t sugar and cane and sugar values of R13 and R280/ton respectively).

such varieties as NCo 376. There is also a considerable risk of severe smut developing in highly susceptible varieties in Zululand South and on the North Coast. All cool and high altitude areas, including the high altitude areas of central Zululand and the Umvoti, Midlands South, South Coast and Lower South Coast extension areas appear to be favourable for the development of mosaic in NCo 376 and NCo 293. In these same areas basal stem rot on NCo 376 and red rot in a wide range of varieties are most likely to occur. There is also good evidence that many areas would be favourable for the development of leaf scald in susceptible varieties.

The relationship between cane health and potential disease problems is delicately balanced and is capable of rapid change. The relationship is also complex, involving interactions between the three components of sugarcane varieties, climatic and management factors, and sugarcane pathogens. A result of the complexity of this relationship is that changes towards greater disease incidence may be difficult to predict or prevent. New diseases can arise, perhaps due to change in the virulence of a pathogen, resistance to which may be absent in existing varieties. The rust epidemic in N55/805 is an example of this. The build-up of a disease over a period of years may also threaten varieties which once were adequately resistant, as is now the case with smut and mosaic in many areas. The present high incidence of RSD is probably at least partly the result of a decrease in the rigour with which control measures have been applied in recent years. Even where changing disease situations can be detected at an early stage, immediate changes of varieties to meet the threat are rarely possible.

The variety situation

Current losses from diseases and the threat of an increase in the severity of several diseases is largely a result of the dependence of the industry on varieties that are susceptible to damaging diseases (Table 4). Some of the reasons for the development of such a situation during a period when diseases were apparently quiescent have been pointed out in this paper. Varieties NCo 376, NCo 310, N55/805, NCo 293 and NCo 382, which together comprised more than 86% of the cane crushed during 1977/78 are all susceptible to serious losses from more than one important disease.

The long term and most satisfactory solution to disease problems in a field crop like sugarcane is the breeding of disease resistant varieties. The development of such varieties is one of the main functions of the Experiment Station. In recent seasons increased selection pressure for disease resistance has been applied throughout the plant breeding programme and attention is also given to the suitability of parents used for crossing purposes. Additionally, the screening of potential new varieties to determine their reaction to smut, leaf scald and mosaic is conducted in a series of trials planted annually. It can be seen in Table 4 that the three most recently released varieties, N52/219, J59/3 and N11, have a high degree of resistance to most diseases now thought to be important, notably smut, mosaic, leaf scald and rust. This general resistance of the new varieties, in recognition of the seriousness of the present disease situation and in comparison with the susceptibility of many of the older varieties, illustrates the point that a breeding programme can only be directed towards recognised problems.

The development of new varieties which combine adaptability, vigour and a high yielding ability together with resistance to a number of diseases is a lengthy process (the average period from initial crossing to final release is approximately 12 years). The more factors that require incorporation into new varieties, such as resistance to a range of different diseases, the more difficult is the process. For example, a very high degree of resistance to smut, such as that exhibited by N52/219, is an elusive characteristic. In the case of RSD, a high degree of resistance or tolerance is almost unknown. The inclusion of resistance to RSD as a criterion for selection would impose severe restraints on the breeding programme and is not justified in view of the simple and effective control measures that are available for this disease.

The nature of the sugarcane crop also makes it difficult to change quickly to a new variety. The crop can be regarded as a perennial, which is expensive to replant. There is also the practical problem of bulking-up adequate supplies of seed cane with which to replace established varieties. The scale of the problem can be appreciated by considering the implications of attempting to replace NCo 376.

TABLE 4

Disease resistance ratings of South African sugarcane varieties

Variety	Year of release	% of crop 1977/78	*Field resistance ratings							
			Smut	Mosaic	Rust	Red rot	Basal stem rot	Leaf scald	Gumming	**RSD
NCo 376	1955	63,5	7	8	3	8	8	3	2	VI
N55/805	1965	10,4	9	5	8	5	5	2	7	FT
NCo 293	1952	5,8	9	8	3	5	2	2	2	VI
NCo 310	1945	5,0	9	6	3	2	2	2	7	I
NCo 382	1957	2,2	8	3	3	5	2	2	2	I
CB 36/14	1965	0,6	7	1	6	5	2	3	2	VI
NCo 334	1957	0,4	7	2	3	2	2	2	2	VI
N53/216	1964	0,4	8	3	2	2	5	6	2	VI
N6	1968	0,2	9	2	5	8	2	7	2	VI
N7	1973	<0,1	9	3	2	2	2	2	2	VI
N8	1973	0,1	9	2	4	2	2	2	3	I
N52/219	1975	<0,1	1	2	3	2	2	2	3	FT
J59/3	1976	<0,1	2	2	2	2	2	3	3	I
N11	1978	<0,1	3	2	3	2	2	2	2	FT

* Resistance ratings: 0, immune to 9, extremely susceptible.

** RSD ratings: VI — very intolerant; I — intolerant; FT — fairly tolerant.

The difficulty of responding rapidly to changes in the status of diseases by changing varieties necessitates the identification of developing problems as early as possible. Once a problem is identified control measures should be applied early in the course of a developing epidemic. Prompt action at an early stage is usually cheap and is the most likely to succeed. If successful, early control may allow high yielding but susceptible varieties to remain in production.

Control

Owing to its vegetative mode of propagation, sugarcane is prone to infection by systemic pathogens. Diseases caused by systemic pathogens tend to be important problems and these include RSD, smut, mosaic and leaf scald. Some features of red rot warrant its inclusion in this category. As systemic diseases occur within the cane stalk an important means of spread is the planting of infected seedcane. These diseases also persist in the stubble after harvest, usually becoming more severe as fields are ratooned. They also persist in infected volunteers after fields are ploughed out, so contaminating newly planted crops.

Because of their persistence and modes of dissemination the systemic diseases are controlled by similar means. Foremost among these is the production of healthy seedcane for planting in commercial fields. There is at present a shortage of high quality seedcane in many areas and the provision of disease-free, varietally pure seedcane from well managed nurseries should be regarded as a high priority. Healthy seedcane must be planted into fields that are free from volunteer regrowth. Infected volunteers can rapidly contaminate new crops and so detract from the benefits of planting healthy seedcane. For mosaic and particularly for smut the inspection and roguing of diseased stools from both seedcane nurseries and from commercial fields is necessary to ensure that seedcane is healthy and to reduce the intensities of disease in outbreak areas. The availability of effective systemic herbicides provides a simple cheap and effective means of killing diseased and volunteer stools in crops.

The more general application of the basic principles of cane disease control will lead to an immediate decrease in the losses now occurring in the industry. These control methods include hot water treatment and roguing to produce disease-free nurseries, the eradication of volunteers before replanting and the inspection for and roguing of plants infected with serious diseases, such as smut, from fields. The further spread of mosaic and smut is highly likely in the near future unless the presently deteriorating situation in respect of these diseases is stabilised or improved. Smut epidemics, in particular, could develop beyond the stage of being easily controlled by the application of field management practices. In that event the only recourse might be to withdraw highly susceptible varieties from production.

Monitoring of the disease situation

An objective assessment of the present disease situation in the South African sugar industry has only been possible because of the increase in the number of disease surveys that have been conducted since 1976, supplemented by experimental data on the effects of diseases on cane yields. The introduction of routine surveys in smut-affected areas and of surveys of RSD incidence have been particularly valuable.

This assessment of the potential situation and of the scale of present losses is somewhat tentative. The continuation and expansion, where necessary, of disease monitoring activities must be regarded as essential to any attempt to assess accurately the economic effects of diseases and to detect any changes in disease incidence.

Conclusions

It has been shown that substantial economic losses are being caused by sugarcane diseases in South Africa. Most areas of cane production are favourable for the development of one or more important pathogens and there is a distinct danger that more serious disease epidemics will develop. In the northern third of the industry the incidence of smut is increasing from season to season and in the southern and high altitude areas outbreaks of mosaic are becoming more frequent.

The extent of present losses and the potential for increased damage from diseases show that the control of sugarcane diseases in South Africa is a matter of importance. The evidence presented here indicates that disease control should be accorded a high priority in the management of the sugarcane crop, particularly in areas where the hazard of damage from diseases is already large. A greater adherence to the fundamental principles of disease control — the production of healthy seedcane and the eradication of volunteer regrowth — will do much to redress the present situation. Such an improvement would rapidly reduce the substantial losses due to RSD. Without an improvement in the application of field control measures the disease situation is likely to continue to deteriorate. Although present production is largely based on varieties that are susceptible to one or more important diseases, a more intensive application of field control measures will assist greatly in the maintenance of the productivity of these varieties, pending their eventual replacement by superior alternatives.

Routine monitoring of diseases can play an important role in assessing the economic importance of disease problems and in detecting changes in disease incidence.

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