

THE INCIDENCE AND EFFECTS OF RATOON STUNTING DISEASE OF SUGARCANE IN SOUTHERN AND CENTRAL AFRICA

RA BAILEY AND SA MCFARLANE

South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe 4300

Abstract

Surveys have shown that ratoon stunting disease (RSD) is common in most sugar industries in southern and central Africa. In South Africa in 1998, approximately 12% of commercial cane fields contained some level of RSD infection, but the mean number of stalks infected was low. The most recent estimates of the numbers of infected fields in other industries are: Swaziland 30%; Zambia 50%; Kenya, Malawi, Uganda and Zimbabwe 60-90%; Tanzania and Mafambisse estate in Mozambique 100%. In some of these industries the majority of stalks within fields are infected. Field experiments have shown that RSD can cause reductions in yield of 15-30% under good irrigated conditions, and 20-40% under average rainfed growing conditions in varieties that are widely grown in Africa. By integrating survey data and experiment results, it is estimated that yield losses due to RSD in South Africa are equivalent to approximately 1% of current production, but that losses of 10-20% or even greater are probable in some of the other industries.

Minimising the effects of RSD on production should be a priority throughout the region. To achieve this, attention must be given to two main factors. Firstly, the consistent production of healthy seedcane through well-managed schemes incorporating hot water treatment and, secondly, improving the efficiency of stubble destruction before fields are replanted, to prevent RSD surviving in infected volunteer plants and spreading to new plantings. In many areas this will require longer breaks from cane before fields are replanted.

Key words: ratoon stunting disease, RSD, hot water treatment, yield loss, *Clavibacter*

Introduction

The South African Sugar Association Experiment Station (SASEX) has conducted large scale surveys of RSD incidence in the South African sugar industry since 1977. A number of other sugar industries in Africa have made use of the SASEX diagnostic service. Survey data from the mid to late 1990s are available from Swaziland, Malawi, Zambia, Kenya, Tanzania, Uganda and Mozambique. Information on the status of RSD in Zimbabwe from 1996 to 1998 is available from surveys by the Zimbabwe Sugar Association Experiment Station (ZSAES). From the time of the earliest surveys it was apparent that high levels of RSD occurred in

certain parts of the South African sugar industry and in most of the other industries.

In most sugarcane industries in Africa production is based mainly on SASEX-bred varieties. The effects of RSD on these varieties are routinely determined by SASEX in field experiments. The magnitude of losses in many varieties when infected by RSD is known to be large under both rainfed and irrigated conditions.

An important feature of sugarcane production in most African sugar industries is that, traditionally, only short breaks from cane, sometimes as little as two to four weeks, are applied between destroying old crops and replanting fields. Consequently, numerous volunteer plants survive from old crops into new plantings.

This paper summarises the status of RSD in industries where surveys have been conducted. By considering survey data together with estimates of yield loss in controlled experiments, estimates of the effect of RSD on production in different countries are possible. These estimates are presented and key factors necessary to reduce the economic effects of RSD are identified.

Survey methods

Surveys of RSD incidence in South Africa have been conducted by SASEX since 1977. Currently, samples from approximately 7 000 fields are tested annually. These include the majority of seedcane sources intended for planting. Additionally, in all mill supply areas large numbers of commercial fields are selected randomly for survey purposes.

Until recently, surveys of RSD in South Africa were based on the examination, by phase contrast microscopy (PCM), of xylem sap extracted from stalks collected in the field (Bailey and Fox, 1984). PCM is also used on a large scale in Zimbabwe. In early 1998, routine diagnosis in South Africa was changed to an evaporative binding-enzyme immunoassay (EB-EIA), based on a method developed in Australia (Croft *et al.*, 1994) and using a polyclonal antiserum to a local isolate of *Clavibacter xyli* subsp. *xyli* (Cxx).

RSD diagnosis in Zimbabwe in the period 1996-98 was based on PCM (Zvoutete, personal communication¹).

¹ P Zvoutete, ZSAES, P Bag 7006, Chiredzi, Zimbabwe

Samples from Swaziland and Mozambique were examined by either PCM or immunofluorescence microscopy (IFM). Material from all the other countries was examined by IFM, again using a polyclonal antiserum to C.x.x. For IFM, drops of xylem sap extracted from stalks are dried onto multi-celled slides. These are then delivered to SASEX for processing and examination.

In most cases, samples consisted of 20 stalks per field or section of field, chosen from weaker plants. This biased sampling was intended to increase the likelihood of detecting RSD, if present in the field. Larger, randomly collected samples of up to 100 stalks were used to determine the percentage of infected stalks in fields in South Africa. Estimates of the percentage of infected stalks per field were possible for several other countries, including Zimbabwe.

Effect of RSD on yield

Numerous field experiments have been conducted by SASEX to determine the effects of RSD on cane and sugar yields. In the widely grown variety NCo376, which is the main variety in a number of African sugar industries, losses in sugar yield of 20-40% under average rainfed conditions and up to 20% under good irrigated conditions have been recorded. Some varieties, such as N17 and N14, are more intolerant than NCo376 and substantial losses have been recorded in most of the large number of varieties that have been tested (Bailey and Bechet, 1986; 1995). The results of two recent trials are shown in Figure 1.

Rainfall in southern and central Africa is mainly seasonal and often erratic. When infected crops are subjected to moisture stress from drought or inadequate irrigation, losses due to RSD can be dramatic. Reductions in sugar yield of 76% were recorded in variety NCo376 in the drought season of 1980-81 (Bailey and Bechet, 1986).

Incidence of RSD and effects on production

South Africa

Surveys in the late 1970s showed that approximately 30% of fields in the southern, rainfed part of the South African industry contained some level of RSD. The incidence was greater in the northern production area, where the crop is grown under full irrigation, similar to conditions in most of the other industries discussed. In this northern area in the early 1980s, 62% of fields in Mpumalanga and 40-50% of fields in the Pongola mill area were infected (Bailey and Fox, 1984; Bailey and Tough, 1991).

In the last two decades in most parts of the South African industry, the mean number of fields in which RSD was detected has declined steadily. In 1997, RSD was detected in 21% of fields in the northern area and 6% of fields in the southern area, and the industry mean was 9%. This was the lowest ever recorded. The situation in the industry as a whole in 1997 is illustrated in Figure 2. Using EB-EIA, the mean number of fields infected in 1998 was estimated to be 12%.

In the southern, rainfed area (approximately 78% of total South African sugar production), intensive surveys have shown that the mean number of infected stalks in fields where RSD is present is low, approximately 1%. With this mean level of stalk infection, yield losses in most parts of the southern area are now thought to be negligible. The estimated mean number of stalks infected in the northern production area in 1997 was 7%, and the industry mean was 2%. In the South African industry as a whole, losses in 1979 were estimated to be approximately 5% of annual production (Bailey, 1979), but current losses are estimated to be equivalent to approximately 1% of production.

Swaziland and Zimbabwe

A number of RSD surveys based on IFM (1992-96) and

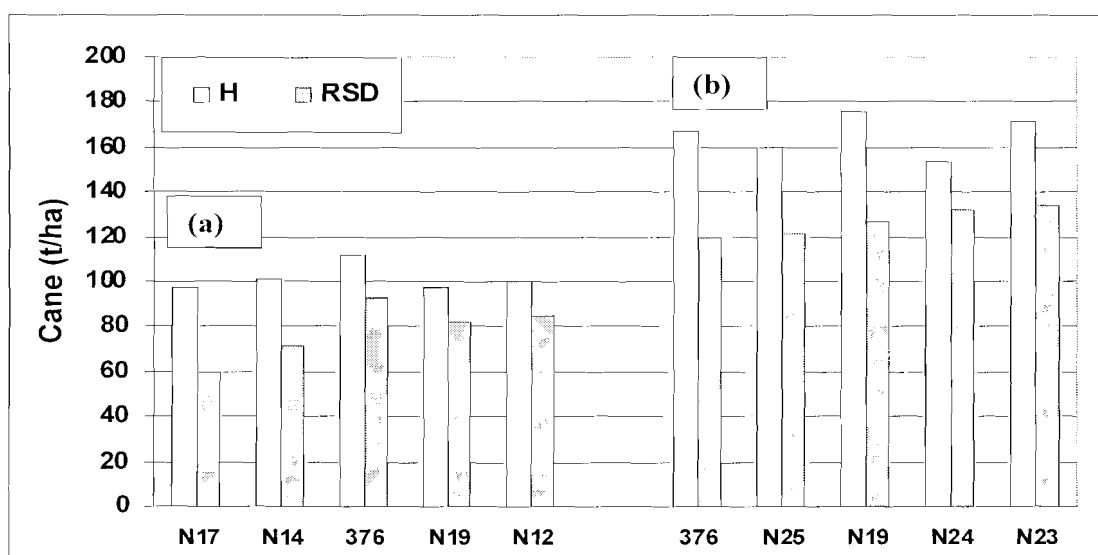


Figure 1. Effect of RSD on cane yield under (a) rainfed conditions at Mount Edgecombe (2R, 13,5 months, 1996); (b) irrigated conditions at Pongola (2R, 11,7 months, 1997; H = healthy seedcane, RSD = infected seedcane).

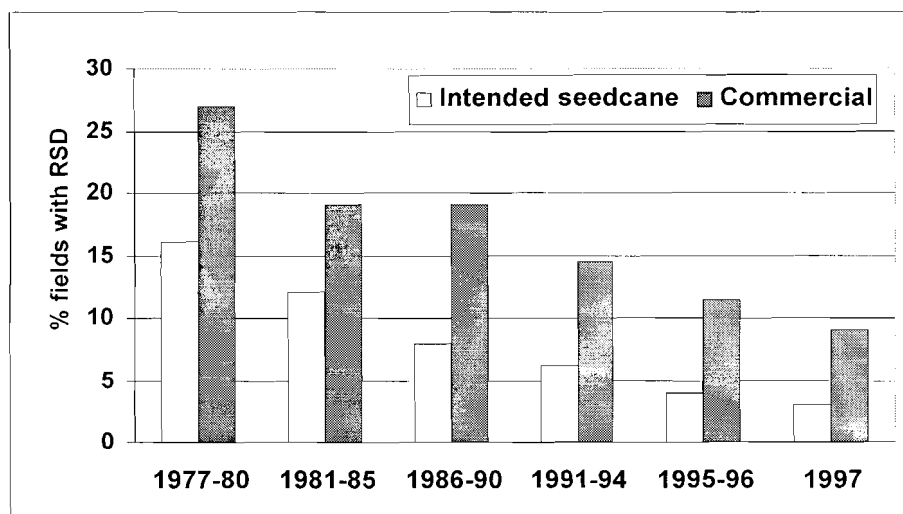


Figure 2. Mean incidence of RSD in intended seedcane sources and commercial fields in the South African sugar industry, 1977-1997 (% fields in which RSD was detected); any intended seedcane found to have RSD is not planted.

Table 1. RSD incidence in Swaziland, 1992-1998 (% fields with RSD).

Year	No. fields tested	% fields with RSD
1992	159	22
1993	291	15
1995	315	15
1996	247	30
1998	330	28

PCM (1998) have been conducted in Swaziland by SASEX. The mean number of commercial fields in which RSD was recorded ranged from 15 to 30% (Table 1), partly depending on the areas surveyed, but the two latest surveys gave similar results – means of approximately 30% infected fields (Table 1). Losses in production due to RSD are estimated to be approximately 4% of current production.

Until recently there had been little use of hot water treatment (HWT) in Zimbabwe for many years. After a devastating drought in the early 1990s the entire industry was re-established, starting in 1993. Unfortunately, the scarce seedcane stocks that were available had high levels of RSD and the replanting exercise served to spread RSD throughout the industry. Surveys of RSD incidence have been conducted by ZSAES since 1995 using PCM (Zvoutete, personal communication). Survey data from 1998 show that more than 80% of commercial cane fields were infected with RSD, and that approximately 60% of stalks were infected (Table 2). Reductions in yield in Zimbabwe due to RSD are estimated

to be approximately 10% of annual production. The situation with regard to seedcane offers some encouragement, with 20% of intended sources being infected.

Other countries

Surveys in other countries have been less frequent, but it is likely that the data recorded are representative of the current situations. Extremely high levels of RSD were recorded at both Dwangwa and Nchalo in Malawi, at Nakambala in Zambia, at both Mumias and South Nyanza in Kenya, and at Kinyara in Uganda (Table 3). The results indicated that the majority of stalks in fields where RSD was identified were infected. In all these industries, the use of HWT to eliminate RSD from seedcane stocks has been sporadic. A feature of cane production in most of these industries is the relatively short break from cane before fields are replanted. Losses in yields in these industries probably amount to 10-20% of production.

Samples from 24 fields at Kilombero in Tanzania were

Table 2. RSD incidence in Zimbabwe, 1996-98 (% fields infected and mean % stalks infected for all fields).

Year	No. fields tested	% fields with RSD	% stalks infected (all fields)
1996	612	92	71
1997	1 372	64 ¹	51 ¹
1998	867	82	58

Note: ¹ the apparent lower incidence in 1997 was due to many samples being from seedcane and plant cane fields.

Table 3. Incidence of RSD in Zambia, Malawi, Kenya and Uganda, 1993-1998 (% fields with RSD).

Country, area & year	No. fields tested	% fields with RSD
Zambia (Nakambala,)		
1994	196	98
1996 + 1997	161	54
1998	50	46
Malawi		
Dwangwa (1993)	36	67
Nchalo (1995)	62	74
Kenya		
South Nyanza (1993)	196	96
Mumias (1993)	391	57
Uganda		
Kinyara (1997)	50	82
Tanzania		
Kilombero (1998)	24	100
Mozambique		
Mafambisse (1998)	21	100

examined in 1998. All were found to be infected and the results indicated that most stalks were infected. Information on the status of RSD at Mafambisse in Mozambique was obtained by one of the authors (RAB) on a visit in 1991. Prior to that there had been no HWT on the estate for many years. On inspecting fields, the internal nodal symptoms of RSD were invariably found. Samples from a number of fields were brought to SASEX for confirmation by PCM. All were found to be infected and it was concluded that RSD was ubiquitous on the estate. These results were confirmed by further sampling in 1998. If the survey results are representative, it is estimated that reductions in production at both Kilombero and Mafambisse exceed 20%. In contrast, no RSD was found in stocks of N19 on a visit to Maragra estate in southern Mozambique in 1997. This estate is now being rehabilitated.

Discussion and conclusions

Except for South Africa, RSD is estimated to be having a significant impact on sugar production in all the countries in southern and central Africa from which survey data are available.

Good progress has been made in reducing the incidence and economic significance of RSD in South Africa. The main factor that has contributed to the improved situation in all parts of the industry has been the widespread use of seedcane production schemes based on HWT. Most of the seedcane now planted is obtained from sources that have been tested for freedom from RSD. In all areas, there has been a close correlation between the RSD status in commercial fields and the quality of the seedcane planted. Further contributing factors include the improved attention given by growers to stubble destruction and the greater use of longer breaks from cane between plantings. It is recommended that fields have a break from cane of at least three months before replanting.

An important factor that contributed to RSD control in South Africa was the widespread publicity given to research results on the effect of RSD on yields and on the rate at which RSD

can spread (Bailey and Tough, 1992). The diagnostic service has provided valuable information on the RSD situation at farm, area and industrial levels, as well as providing specific information to aid growers in making practical management decisions concerning seedcane sources and plough-out fields.

Sugarcane in Swaziland is produced mainly on large miller-cum-planter estates. As in most other industries in the region, the period between stubble destruction and replanting is usually short, sometimes only a few weeks. The industry has had a national seedcane scheme since the late 1970s, operated by the Swaziland Sugar Association. In this, elite seedcane is produced after HWT in an area remote from the main production areas and is used to establish commercial nurseries on the estates. This has been the main factor in achieving substantial control of RSD compared with most other industries in the region. Further progress in Swaziland below the current level of approximately 30% fields infected requires greater attention to stubble destruction. This will necessitate longer breaks between plantings than is currently practised.

In Zimbabwe, control of RSD has been identified as a high priority within the last three years, and a major drive to improve seedcane quality by greater use of HWT is now in progress on most estates. The diagnostic service provided by ZSAES will be a key factor in achieving success.

Major factors impeding an improvement in the RSD situations in the other industries mentioned are the current lack of HWT facilities and the lack of local services for large scale diagnosis. SASEX can provide further assistance with diagnosis but the development of local expertise would assist the situation.

In all the industries where RSD occurs at high levels, attention must be given to increasing the duration of the break between plantings to minimise the survival of infected volunteer regrowth. This recommendation is likely to meet some resistance until its value is supported by local survey and research results.

Acknowledgements

Petros Zvoutete of ZSAES, provided information on the incidence of RSD in Zimbabwe. Assistance with surveys in other countries was provided by GL James (Kenya and Uganda), J Sifunza (Swaziland) and estate staff at Dwangwa and Nchalo in Malawi, Nakambala in Zambia and Kilombero in Tanzania. D Subramoney and R Munsamy of the SASEX Pathology department provided valuable technical assistance.

REFERENCES

Bailey, RA (1979). An assessment of the status of diseases in the South African sugar industry. *Proc S Afr Sug Technol Ass* 53: 120-128.
Bailey, RA and Bechet, GR (1986). Effect of ratoon stunting disease on

the yield and components of yield of sugarcane under rainfed conditions. *Proc S Afr Sug Technol Ass* 60: 143-147.

Bailey, RA and Bechet, GR (1995). The effect of ratoon stunting disease on the yield of some South African sugarcane varieties under irrigated and rainfed conditions. *Proc S Afr Sug Technol Ass* 69: 74-78.

Bailey RA and Fox, PH (1984). A large scale diagnostic service for ratoon stunting disease. *Proc S Afr Sug Technol Ass* 58: 204-209.

Bailey, RA and Tough, SA (1991). The current distribution of ratoon stunting disease in the South African sugar industry. *Proc S Afr Sug Technol Ass* 65: 25-29.

Bailey, RA and Tough, SA (1992). Rapid spread of ratoon stunting disease during manual harvesting of sugarcane and the effect of knife cleaning on the rate of spread. *Proc S Afr Sug Technol Ass* 66: 78-81.

Croft, BJ, Greet, AD, Leaman, TM and Teakle, DS (1994). RSD diagnosis and varietal resistance screening in sugarcane using the EB-EIA technique. *Proc Aus Soc Sug Cane Technol* 16: 143-151.