INTENSITY OF RSD INFECTION IN DIFFERENT REGIONS OF THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

Surveys to determine the intensity of infection by ratoon stunting disease (RSD) within fields have been conducted in different regions of the South African sugar industry since 1990. The results show that levels of infection have declined in most parts of the industry. Intensive surveys conducted recently show that, in rainfed production areas, the number of infected stalks is low, with a mean of approximately 1% stalks infected in all fields. In the mainly irrigated northern production areas, there is an estimated mean of approximately 6% stalks infected. For the industry as a whole, it is estimated that a mean of approximately 2% of stalks is currently infected with RSD. Losses in production in most rainfed areas due to RSD are now estimated to be negligible, and in the northern areas to be equivalent to less than 2% of production. Over the entire industry, losses are likely to be equivalent to less than 1% of annual production. However, RSD continues to occur at low levels in most areas, presenting considerable potential for further spread, if current control measure were to be relaxed.

The surveys showed that variety N14 had a much higher mean level of RSD infection than other varieties. The unusual susceptibility of this variety must have been an important factor in the maintenance of high levels of RSD in those areas where it was widely grown. The most widely grown varieties in the rainfed region, N12 and N16, were both less infected than the former popular variety NCo376.

Keywords: ratoon stunting disease, RSD, *Clavibacter,* disease incidence

Introduction

Ratoon stunting disease (RSD), caused by the xylem-inhabiting bacterium *Clavibacter xyli* subsp *xyli* (proposed new generic name *Leifsonia*) is widely recognised as being the most economically important disease of sugarcane internationally. Recent reports show that it is by far the most serious disease of sugarcane in southern and central Africa (Bailey and McFarlane, 1999). RSD can cause serious reductions in yield in many varieties under a wide range of growing conditions (Bailey and Bechet, 1986; 1995). To date little progress has been made in limiting the effect of RSD through varietal resistance and control still depends on painstaking attention to the health of propagation material and the efficiency with which old crops are destroyed before fields are replanted.

A key feature of the RSD control campaign in the South African sugar industry has been the provision of information on disease incidence in different areas. Accordingly, a large-scale diagnostic service for RSD incidence has been provided for growers by the South African Sugar Association Experiment Station (SASEX) since 1977. The main purpose of the service is to identify RSD in commercial fields and potential seedcane sources. Results from the service permit an on-going assessment of incidence on individual farms and in different areas.

Table 1. Intensive RSD surveys: date, sample size and No. fields sampled per area.

Region & area		Year	Stalks sampled per field	No. fields sampled
Southern	South Coast (SC)	1997	100	200
	North Coast (SC)	1997	100	200
	Zululand S (ZS)	1995	20	142
	Zululand C (ZC)	2000	90	150
	Zululand N (ZN)	1997	100	200
Northern	Umfolozi (UF)	1996	100	200
	Pongola (PG)	1995* 1997* 2000	100 100 100	196 182 200
	Mpumalanga (MP)	1997	100	198
Total fields sampled (excl*)		-	-	1490

* Survey data not used in estimating current industrial incidence

This enables growers to make management decisions on such matters as variety choice, the replanting of fields and the selection of healthy planting material. Summaries of annual data have shown a steady decline in RSD incidence in most parts of the South African sugar industry (Bailey and Tough, 1991; Bailey and McFarlane, 1999).

In order to maximise the likelihood of detecting RSD, samples for routine diagnosis are taken from poorly grown stools; also, the serological method used for routine diagnosis utilises pooled samples. Therefore these data do not permit accurate estimation of the percentage of infected stalks within fields. To provide this, special "intensive" surveys have been conducted in selected areas since 1994. This paper reports on the results of these surveys and attempts a more accurate estimate of the economic effects of RSD in the industry. The survey results also provide additional information on infection levels within different varieties.

Survey methods

For intensive surveys, the stalks sampled from fields were selected at random. Initially the surveys were based on a sample size of 20 stalks per field, but in recent years the sample size was 90-100 stalks per field. Table 1 summarises the areas where intensive surveys have been conducted, the sample size and number of fields per area, and which are reported in this paper. Within any one area the farms were selected at random and the fields were selected so that the survey represented the variety and crop dispositions in the area. Farms and fields to be surveyed in the different areas were selected by staff of the Local Pest, Disease & Variety Control Committees (LPD&VCCs).

In all the intensive surveys RSD was diagnosed by examining xylem sap collected from individual stalks by phase contrast microscopy (PCM) for the presence of *C. xyli* subsp *xyli*. This method was used as it was considered to provide the best compromise between the need to examine individual stalks and the need for acceptable accuracy (McFarlane et al., 1999).

Results and Discussion

Rainfed areas

In estimating current mean levels of RSD in the southern rainfed region, only the results of surveys conducted since 1997 have been used, except for a survey of Zululand South conducted in 1995. It is assumed that in this region RSD levels have not changed appreciably over the last five years. This assumption is confirmed by the relatively uniform incidence of infection in different crops (see later).

Table 2. Percent fields with RSD and mean incidence (% stalks infected) in different areas in the rainfed production region.

Area	% fields with RSD	% stalks with RSD
South Coast	11	0.8
North Coast	17	1.5
Zululand South	5	0.8
Zululand Central	19	2.3
Zululand North	12	1.3
Means	12.8	1.3

The incidence of infection in the five areas surveyed on a percent stalk basis varied from area to area and had a mean of 1.3% (Table 2). Levels of infection were lowest in the South Coast and Zululand South areas (0.8%) and greatest in Zululand Central (2.3%). The estimated mean percentage of fields in which some level of RSD was detected, 12.8%, was similar to that obtained from the results of the RSD Diagnostic Service, in which samples from thousands of fields are examined annually (Bailey and McFarlane, 1999).

Up to the fifth ratoon crops, RSD incidence did not change appreciably from crop to crop, the means for individual crop stages falling within the range of 0.7 – 2.0 percent stalks infected and with a mean of 1.3 percent (Table 3). However, in certain areas somewhat higher levels in terms of both infected fields and stalks occurred in crops older than fifth ratoon. The approximate uniformity of infection across crops is evidence that the RSD situation has been relatively stable in the areas surveyed for at least six years.

Estimates of the incidence of RSD in different varieties was somewhat confounded by their varying occurrence in different areas. However, there was good evidence that RSD was less common in N12 and N16 than in NCo376, this being consistent in all areas (Table 4). In the one area in which N14 was widely grown, Zululand North, this variety had a much higher rate of infection than other varieties. These results are consistent with those of the RSD Diagnostic Service and are also consistent with the relative magnitude of the effects of RSD on the yield of different varieties (Bailey and Bechet, 1995; Bailey and McFarlane, 1999).

Northern region

The surveys used to estimate the current incidence of RSD in the northern region were those conducted in Umfolozi in 1996,

Table 3. Incidence of RSD in different crop stages in different areas in the rainfed production region.

Crop stage	Fields with RSD (%)						Stalks with RSD (%)					
	SC*	NC*	ZS	ZC	ZN*	Means	SC	NC	ZS	ZC	ZN	Means
P	2	18	0	9	8	7.4	0.2	1.4	0	1.3	1.6	1.1
1R	10	20	13	18	11	14.4	0.7	3.2	2.5	0.4	0.9	0.7
2R	7	33	0	21	10	14.2	0.5	2.2	0	2.6	0.9	1.5
3R	4	28	0	9	14	11.0	0.3	4.2	0	0.8	1.6	1.7
4R	12	20	0	15	14	12.2	0.8	1.3	0	4.,1	1.9	2.0
5R	27	10	9	7	0	10.6	2.0	0.8	1.8	0.7	0	1.2
Older R	-	-	7	27	-	17.0	-	-	1.1	3.0	-	2.1
Means	11	17	5	19	12	12.8	0.8	1.5	0.8	2.3	1.3	1.3

* limited to fifth ratoon

Table 4. Incidence of RSD in different varieties in rainfed production areas (% stalks infected).

Variety	SC	NC	ZS	ZC	ZN	Means
N12	0.5	1.0	0.9	2.3	0.3	1.0
N14	-	-	0	0	7.9	7.9
N16	0	-	0	1.3	-	0.7
N17	-	-	0	0	0.7	0.7
N19	-	-	0	-	0.2	0.2
N21	0.3	-	0	-	-	0.3
NCo376	2.0	2.0	1.3	3.9	1.7	2.2
Others	-	-	0	0	-	0
Means	0.8	1.5	0.8	2.3	1.3	1.3

Table 5. Incidence of RSD in different crop stages in different areas in the northern, irrigated production region.

Crop stage	Fields with RSD (%)				Stalks with RSD (%)			
	UF*	PG	MP**	Means	UF	PG	MP	Means
P	23	17	10	17	2.3	1.2	0.5	1.3
1R	28	16	4	16	3.2	0.8	0.7	1.8
2R	36	31	19	29	7.9	8.5	1.2	3.9
3R	50	-	9	30	11.3	0	0.5	4.0
4R	-	50	36	44	-	15.5	11.9	13.7
5R	-	40	35	38	-	16.8	15.5	16.2
Older R	-	61	-	61	-	16.9	-	16.9
Means	36	33	17	29	6.5	8.1	4.2	6.3

* limited to 3R, ** limited to 5R

Mpumalanga in 1997 and Pongola in 2000. All were based on 100 stalks per field. The mean incidence in terms of fields with RSD was 29% and in terms of stalks infected 6.3% (Table 5), both much higher than in the southern rainfed areas.

In contrast to the southern region, RSD incidence increased with ratooning in all three areas (Table 5). This was particularly marked at Umfolozi after second ratoon and at Pongola and Mpumalanga after third ratoon. At Pongola, 55% of fields older than third ratoon were infected. The number of infected stalks also increased rapidly in second ratoon and older crops at Umfolozi and Pongola, and after fourth ratoon at Mpumalanga (Table 5). In some of these older, more severely infected ratoon crops, substantial losses in production must still occur.

The most striking feature of the data from the northern region when examined according to variety was the much greater incidence of infection in N14 compared with other varieties (Table 6). Variety N14 is clearly extremely susceptible to RSD infection. The susceptibility of N14 correlates well with the greater effect of infection on the yield of this variety compared with others (Bailey and Bechet, 1995, Bailey and McFarlane, 1999).

Table 6. Incidence of RSD in different varieties in the northern production region (% stalks infected).

Variety	UF	PG	MP	Means
N14	43.4	29.5	8.7	27.2
N17	5.1	16.9	-	11.0
N19	3.3	1.2	2.2	2.2
N22	-	1.8	0	0.9
N24	-	0	1.0	0.5
N25	-	1.0	1.0	1.0
N26	-	0	-	0
NCo376	3.0	-		3.3
Others	-	4.2	-	
Means	6.5	8.1	4.2	6.3

The results of three different surveys at Pongola during the period 1995-2000 illustrate the progress that can be made in reducing serious levels of RSD under irrigated production conditions. In this period the number of fields in which RSD was recorded declined from 55 to 33%. However, the mean number of stalks infected is a more accurate indicator of disease infection, and this was reduced from 29 to 8% (Table 7). The low incidence in plant and first ratoon crops in this area, reduced to only 1% in the 2000 survey, is particularly encouraging. The progress made at Pongola has been due to both reducing the area planted to highly susceptible N14 and a marked improvement in the health of seedcane, the latter motivated by the Pongola LPD&VC.

Conclusions

The results of surveys, together with those from controlled experiments on the effect of RSD on yield (Bailey and Bechet, 1995, Bailey and McFarlane, 1999), permit an estimate of the effect of current levels of the disease on production. In the southern, mainly rainfed areas, the incidence of RSD has been stabilised at a low mean level for several years. When other areas in this region where RSD is known to be rare are taken into account (Lower South Coast and Midlands), it is estimated that a mean of less than 1% of stalks is infected. This is likely to be having a negligible impact on production.

Good progress in reducing the incidence and impact of RSD has been made in the northern areas compared with the extremely high levels of 10-20 years ago, particularly at Pongola and Mpumalanga. Much of the credit for this progress should go to the respective LPD&VCCs. This success is pointer to what can be achieved in other sugarcane industries in southern and central Africa, where losses due to RSD are high.

With a current mean incidence of 6.3% infected stalks, significant losses due to RSD are still likely in some fields in the northern areas, and it is estimated that the loss in this region amounts to approximately 2% of production.

The estimated current reduction in production in the South African industry due to RSD, probably less than 1%, contrasts with the conservative estimate of 5% made two decades ago (Bailey, 1979). This is substantial progress. However, further progress remains to be made in a number of areas and the continuation of control methods is essential throughout the industry.

Table 7. Estimated incidence of RSD at Pongola, 1995, 1997 and 2000.

Year	1995	1997	2000
% fields with RSD	55	34	33
% stalks infected	28.7	11.9	8.1
% infected stalks in P and 1R crops	11.0	4.8	1.0

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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 McFarlane SA (1999). The incidence and effects of ratoon stunting disease of sugarcane in southern and central Africa. *Proc S Afr Sug Technol Ass* 73:118-122.

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.

McFarlane SA, Bailey RA and Subramoney D (1999). Introduction of a serological method for large scale diagnosis of ratoon stunting disease in the South African sugar industry. *Proc S Afr Sug Technol Ass* 73: 1123-127.