

THE CURRENT DISTRIBUTION OF RATOON STUNTING DISEASE IN THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

Results from the diagnostic service for ratoon stunting disease (RSD) indicate that the incidence of infection in commercial cane fields and intended seedcane sources in most areas has declined significantly in the last decade. In 1990, a mean of 17% of commercial fields in all extension areas was estimated to be infested, compared with 25% in 1982 + 1983. The number of fields with RSD remains high in the coastal wards of the South Coast, and in the Natal Cane Growers, Zululand North, Umfolozi, Pongola and Eastern Transvaal areas. The number of intended seedcane sources with RSD has declined from a mean of 13% in all extension areas in 1982 + 83 to 6% in 1990, and the health of seedcane planted was probably much better than this. Seedcane produced in the Lower South Coast, Midlands, Zululand and Eastern Transvaal areas is now largely free from the disease. The results demonstrate a clear relationship between the incidence of RSD in seedcane produced in recent years and the current status of the disease in commercial cane fields in most parts of the industry.

Introduction

Ratoon stunting disease, caused by the bacterium *Clavibacter xyli* subsp. *xyli*, is one of the most widely distributed diseases of sugarcane, both internationally and in South Africa. The disease can cause substantial reductions in yield, the extent of which depends on varietal reactions to infection and the conditions under which the crop is grown. Reductions in yield of about 40% in the widely grown variety NCo376 and 20% in the increasingly popular variety N12 were recorded under typical conditions in the coastal rainfed areas of Natal (Bailey and Bechet, 1986). Notable losses have also been recorded in NCo376, N12 and N14 when grown under irrigation (Bailey and Bechet, unpublished data, Rossler, 1974). The disease is therefore capable of causing severe crop loss in all parts of the industry.

RSD is spread from field to field mainly by the planting of infected seedcane. It also persists in volunteers from the old crop when fields are replanted. Spread from plant to plant in the field is caused mainly by harvesting implements (Bailey and Tough, unpublished data, Hughes and Steindl, 1955). Control is therefore based mainly on preventing RSD from becoming established in the field. Appreciation of the need for the application of control measures was hampered in the past by the lack of easily recognisable symptoms in infected crops. A further consequence of the lack of symptoms was that the extent to which RSD occurred on individual farms and in the South African sugarcane industry as a whole was not fully realised.

Recognition in the mid-1970s that RSD was caused by a bacterium (Gillaspie *et al.*, 1973, Teakle, 1974, Bailey, 1976) soon led to accurate diagnosis based on microscopic identification of the bacteria in preparations from stalk tissues. Large scale, rapid diagnosis based on this technique was introduced in South Africa in 1977 (Anon). The first surveys soon established that RSD was common in certain areas.

For example, in 1978 RSD was found in 37% of fields and 60% of old ratoon fields in the North Coast area of Natal (Bailey, 1979).

An estimate of the incidence of RSD in each of the extension areas of the industry was first described for the two year period 1982 + 83 (Bailey and Fox, 1984). Later revision indicated that RSD occurred in about 25% of commercial cane fields and that approximately 13% of intended seedcane sources were infected. The first industry-wide evaluation showed that the incidence of RSD varied widely between areas, with a range of 7 to 55% of commercial fields infested. It was also estimated that total losses then amounted to some 3% of the annual crop.

Many thousands of samples from commercial cane fields and intended seedcane sources have been examined by the RSD diagnostic service since 1983 (Figure 1). The results provide an extensive database on the distribution of RSD in most parts of the industry. This paper describes the RSD situation in the industry as a whole and in individual extension areas since 1983, and gives examples where good progress has or has not been made in controlling this economically important disease.

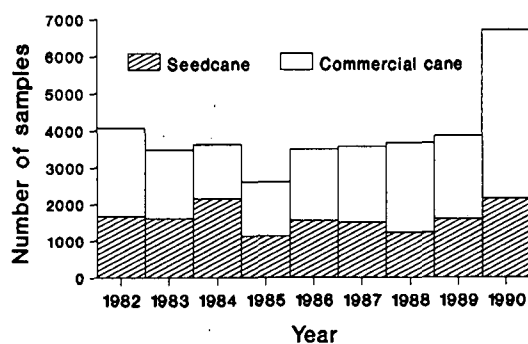


FIGURE 1 Number of samples (= fields) including KwaZulu tested for RSD, 1982 to 1990.

Methods

The diagnosis of RSD in cane samples is carried out mainly by phase contrast microscopy. Procedures for sampling fields and preparing slides for examination have been reported previously (Bailey and Fox, 1984). Briefly, a sample from a field or section of a large field consists of the basal portions from 20 stalks of maturing cane (crops nine months or more old): these constraints are based on the bacteria being more abundant in older tissues (Bailey, 1977, Gillaspie and Teakle, 1989). The stalks are usually not collected at random but are selected from the poorer stools in order to improve the likelihood of detecting the disease. Xylem sap is blown from a 100 to 120 mm section of each stalk piece, collected on a microscope slide and examined directly by phase contrast microscopy at a magnification of x1000. Processing of the samples is completed by at least the day following collection from the field, since the bacteria are more easily detected in

fresh samples (Bailey and Fox, 1984). The characteristic bacteria are readily observed in fresh preparations from infected mature stalks.

Samples from most areas are delivered to the Experiment Station at Mount Edgecombe for examination but the distance from the three most northerly extension areas, Umfolozi, Pongola and the Eastern Transvaal, often precludes this. Accordingly, diagnostic teams travelled to each of those areas, usually for one week in each year, to examine samples.

From 1988 to 1990 samples from the Eastern Transvaal were examined by immunofluorescence microscopy (IFM). In this process the xylem sap from five of the 20 stalk pieces was pooled and a droplet dried and fixed on a slide using mild heat. Each field was therefore represented by four slide preparations. The prepared slides were then sent to the Experiment Station and examined by IFM using an antiserum prepared from a local isolate of *C. xyli* subsp *xyli*. IFM is recognised as a highly accurate method of diagnosing RSD (Harris and Gillaspie, 1978, Gillaspie and Teakle, 1989) but is relatively expensive and laborious and does not lend itself to the rapid diagnosis of thousands of samples.

Samples for diagnosis are submitted by individual growers and large estates to check on the status of RSD in their fields, and also by extension staff and Local Pest and Disease Control Committees as part of area surveys and as checks on seedcane schemes. The number of samples from commercial cane fields and intended seedcane sources obtained from different extension areas varied widely, ranging from few to more than a thousand per year (Appendix 1). Presentation of results on an annual basis would be possible for those areas from which many samples were received. However, to provide sufficient numbers for an estimate of the incidence of RSD to be made for most areas, the data from successive years were combined (1984 + 85, 1986 + 87, 1988 + 89) as was done for the first industry-wide survey in 1982 + 83. Substantial numbers of samples of both seedcane and commercial cane were received from most areas in 1990. Results from 1990 can therefore be directly compared with those from the preceding periods of two years.

Samples from intended seedcane sources provide a reasonably unbiased estimate of the incidence of RSD in those fields. Most of the commercial fields sampled were selected at random but biased sampling was intentionally conducted in some areas, i.e. farms where RSD had been identified were sampled more intensively to locate infested fields. This occurred in the Natal Cane Growers area in 1984 + 85 and in the Eastern Transvaal and Zululand North areas in 1988 + 89. Where samples are known or suspected not to have been representative, the estimate of RSD incidence for the area was based on an extrapolation from results in other years. Original data are presented in Appendix 1.

The mean incidence of RSD in the industry as a whole for each period of two years and for 1990, for both intended seedcane sources and commercial cane, was estimated as the mean of the percentages of fields with RSD (adjusted where necessary) in the 13 extension areas. Cane grown by KwaZulu growers is excluded from this estimate because of limited sampling and because this represents only a small proportion of the total crop. The estimate is also based on the assumption that the 13 extension areas are uniform in the area of cane grown.

Trends in the incidence of RSD and the current situation

Seedcane

The health of seedcane in the industry as a whole has improved steadily in the period under review. A mean of

6,0% of intended seedcane crops was infected in 1990 compared with 13,2% in 1982 + 83, a reduction of more than 50% (Figure 2). The estimated mean for 1990 can also be compared with an estimate of 25% infected seedcane crops in the Durban-North Coast and North Coast areas in 1978 (Bailey, 1979).

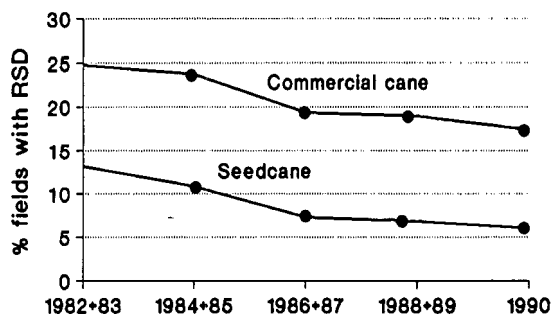


FIGURE 2 Estimated incidence of RSD in commercial cane and intended seedcane sources in the South African sugar industry, 1982-90.

The frequency with which RSD has been detected in seedcane in certain individual areas is illustrated in Figure 3 and estimates for all areas are contained in Table 1. The incidence of RSD in intended seedcane crops in 1990 was considerably greater than the industrial mean on the South Coast (15%), and the Natal Cane Growers on the North Coast (16%). Good progress in improving the quality of seedcane has been achieved in most of the other areas, notably the Zululand region (10,2% in 1982 + 83 to 2,7% in 1990) and

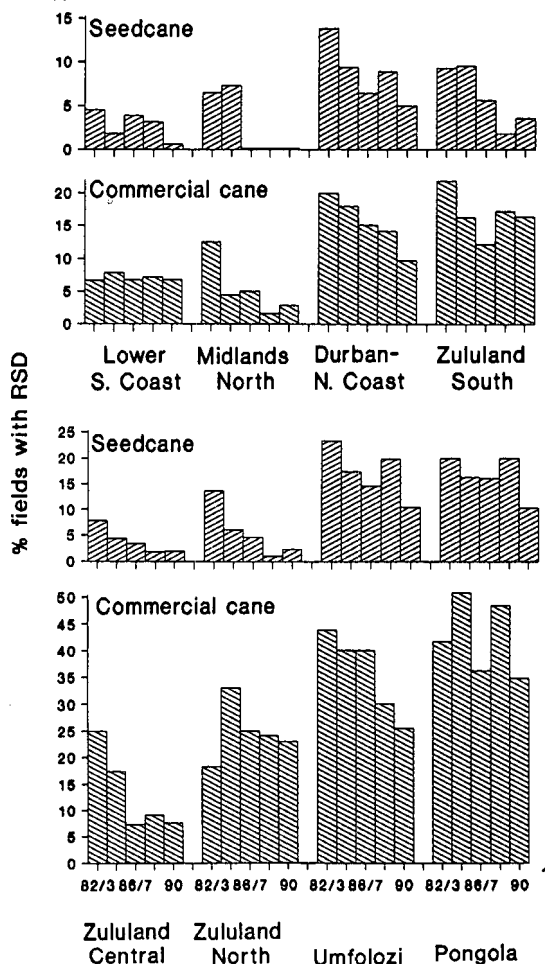


FIGURE 3 Incidence of RSD in intended seedcane and commercial cane in selected extension areas, 1982-90.

the Durban-North Coast area (13,8% in 1982 + 83 to 5,0% in 1990). In the Eastern Transvaal, what were undoubtedly high levels of RSD in seedcane in the early 1980s (when more than 50% of commercial fields were infested) have been completely reversed and seedcane produced there in recent years through the local seedcane scheme is thought to have been largely free from the disease. A similar improvement has occurred more recently in the Pongola area, where the newly established transplant-based seedcane scheme is now 'on-stream'; this is expected to result in a marked improvement from the high to very high levels of RSD that were recorded in seedcane at Pongola throughout the 1980s. Areas where consistently low levels of RSD have been maintained in seedcane since the early 1980s are the Lower South Coast and the Midlands region.

Commercial cane

The estimated mean incidence of RSD in commercial cane in the industry declined from 24,8% in 1982 + 83 to 17,4% in 1990, a reduction of 30% (see Figure 2). In 1990 there was a range of 4 to 35% fields infested in different extension areas and the mean for the 11 southern rainfed areas was 14%.

The situation in certain extension areas is illustrated in Figure 3 and estimates for all areas are shown in Table 1. Particularly marked or consistent reductions in the incidence of RSD between 1982 + 83 and 1990, demonstrating steady progress in controlling the disease in commercial crops, occurred in the Durban-North Coast area (20% in 1982 + 83 to 9,7% in 1990) and in Midlands South and Midlands North.

Estimates from the Durban-North Coast area can be regarded with confidence as they are based on a total of almost 8 000 fields sampled. Progress in controlling RSD is also evident in the records from the North Coast and Zululand Central areas. Areas with the least RSD in 1990, appreciably less than the industrial mean, were the Lower South Coast (3,8%), Midlands South (8,3%), Midlands North (2,9%), Durban-North Coast (9,7%), North Coast (8,8%) and Zululand Central (7,6%).

Areas with appreciably higher levels of RSD than the industrial mean in commercial cane in 1990 and where little progress has apparently been made include the Natal Cane Growers (30,5%), Zululand North (23,0%), Pongola and the Eastern Transvaal (both approximately 35%). A high level apparently persists in coastal wards of the South Coast extension area (24% infested fields in 1990), but the majority of infested samples from this area were submitted from a few, severely infested farms.

Discussion

It is readily apparent from the records of the diagnostic service (Appendix 1) and as illustrated in Table 1 and Figures 2 and 3 that an important factor in reducing the incidence of RSD in commercial fields is the consistent production of healthy seedcane. The good progress made in many areas in improving seedcane quality has been achieved largely through the efforts of extension staff and LP & DC committees, in establishing successful seedcane production schemes. The long term economic benefits to be gained from this cannot be over-emphasised.

Table 1
Percent samples with RSD in different extension areas, 1982 + 83 to 1990

Intended seedcane sources

Area	1982 + 83	1984 + 85	1986 + 87	1988 + 89	1990
Lower South Coast	4,5	1,8	3,9	3,2	0,6
South Coast	14,2	19,2	14,6	10,9	14,6
Midlands South	3,8	4,2	6,7	6,3	4*
Midlands North	6,5	7,3	0	0	0
Durban-North Coast	13,8	9,4	6,4	8,9	5,0
North Coast	15,0	6,6	6,6	8,4	9,8
Natal Cane Growers	19,1	29,4	7,1	5,6	15,6
Zululand South	9,3	9,5	5,6	1,8	3,6
Zululand Central	7,8	4,4	3,5	1,9	2,0
Zululand North	13,6	6,1	4,7	1,0	2,4
Umfolozzi	23,3	17,3	14,6	19,8	10,5
Pongola	20*	16,3	16,0	20*	10,3
Eastern Transvaal	20*	10*	5*	0*	0*
Estimated industrial mean	13,2	10,9	7,3	6,8	6,0

Commercial cane

Area	1982 + 83	1984 + 85	1986 + 87	1988 + 89	1990
Lower South Coast	6,7	7,8	6,8	7,2	3,8
South Coast	25*	26,3	28,4	23,9	20*
Midlands South	12,9	13,4	11,0	6,0	8,3
Midlands North	12,5	4,5	5*	1,6	2,9
Durban-North Coast	20,0	18,0	15,1	14,2	9,7
North Coast	14,3	15,6	10,3	10*	8,8
Natal Cane Growers	25,3	25*	24,4	25*	30,5
Zululand South	21,9	16,3	12,2	17,2	16,4
Zululand Central	25,0	17,4	7,3	9,1	7,6
Zululand North	18,2	33,0	25*	24,1	23,0
Umfolozzi	43,8	40*	40,0	30*	25,5
Pongola	41,6	50,8	36,2	48,4	34,7
Eastern Transvaal	55,4	40*	30*	30*	34,8
Estimated industrial mean	24,8	23,7	19,4	19,0	17,4

* Incidence extrapolated because samples insufficient or considered unrepresentative of area.

Samples from approximately 5 000 ha of seedcane are now tested annually and this supplies the bulk of the replanting needs of the industry. Seedcane sources found to be infected are invariably rejected, with the result that the quality of seedcane planted must be appreciably better than indicated by the results of diagnosis. Whereas an industrial mean of 6% of intended seedcane crops was found to be infected in 1990, the incidence of infection in seedcane planted may have been as low as 2 to 3%.

The area of commercial cane sampled in 1990 was approximately 25 000 ha (6% of the area under cane). The estimated industrial mean of 17% infested fields in 1990 compares favourably with the situation in 1982 + 83. It is to be expected that the rate of progress in eliminating the disease from commercial fields lags behind the rate of improvement in seedcane health in most areas. A major factor contributing to this is the slow rate at which fields are replanted in South Africa. However, it is also likely that many newly planted fields are re-infested by volunteers surviving from old crops. Recent research has clearly demonstrated the rapid rate of spread that occurs from such initial foci of infection during harvesting.

The pattern of distribution of RSD in the industry (Table 1) demonstrates an apparent association between the incidence of the disease and temperature, with higher levels in warmer areas. This may simply reflect the previous history of control measures in different areas or it may be evidence that the transmission of *C. xyli* subsp *xyli* occurs more readily at higher temperatures. Investigation of this phenomenon seems warranted.

The maintenance of high levels of infection in a number of areas, particularly the Natal Cane Growers, Pongola and Eastern Transvaal areas, is cause for concern. This persistence can be at least partly ascribed to problems in the supply of healthy seedcane, and it is in these and other areas where improvements must be made if the economic effects of RSD on industrial production are to be further reduced.

Assuming that 17% of commercial fields are infested with RSD, that reductions in yield in those fields amount to between a third and a half of that which occurs when all the stalks are infected, and considering the variety disposition, it is estimated that current losses in cane production due to RSD amount to 2,0 to 2,5% of the annual crop. Losses in areas or on farms where the incidence of infection exceeds the industrial average, or where the intolerant variety NCo376 still predominates, may greatly exceed this.

Conclusions

Considerable progress in reducing the incidence and economic effects of RSD has been made in many parts of the industry in recent years. The full benefits from introducing seedcane schemes in some areas have still to be realised and there is considerable scope for improving seedcane quality in other areas. However, the evidence provided by the diagnostic service demonstrates that the elimination of RSD from individual farms and entire areas is a realistic goal.

Acknowledgements

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APPENDIX I

Number of samples examined annually and number with RSD in different extension areas, 1982 to 1990

Intended seedcane sources

Area	1982		1983		1984		1985		1986		1987		1988		1989		1990	
	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD
Lower South Coast	228	13	127	3	161	2	65	2	165	8	120	3	85	3	164	5	176	1
South Coast	110	9	157	32	234	56	220	31	182	31	196	24	192	18	313	37	493	72
Midlands South	42	2	11	0	60	3	11	0	11	1	4	0	12	1	4	0	10	0
Midland North	41	3	21	1	45	4	10	0	26	0	14	0	5	0	5	0	31	0
Durban-North Coast	274	39	348	47	414	40	291	26	338	27	353	17	310	17	288	36	358	18
North Coast	192	18	241	47	189	15	83	3	132	8	96	7	84	5	143	14	255	25
Natal Cane Growers	15	4	74	13	169	50	42	12	92	9	120	6	108	5	35	3	64	10
Zululand South	221	21	68	6	181	21	102	5	248	18	213	8	129	2	96	2	167	6
Zululand Central	200	10	145	17	236	7	79	7	96	4	75	2	28	0	75	22	99	2
Zululand North	305	50	252	26	244	19	136	4	146	8	198	8	150	7	259	3	247	6
Umfolozzi	39	10	81	18	177	29	48	10	52	9	106	14	68	14	99	19	152	16
Pongola	2	0	1	1	11	2	38	6	22	3	3	1	29	11	112	33	58	6
Eastern Transvaal	0	—	0	—	0	—	10	0	0	—	0	—	0	—	0	—	0	—
Totals	1 669	179	1 526	211	2 121	248	1 135	106	1 510	126	1 498	90	1 200	77	1 593	174	2 110	162

APPENDIX I (Continued)

Number of samples examined annually and number with RSD in different extension areas, 1982 to 1990

Commercial cane

Area	1982		1983		1984		1985		1986		1987		1988		1989		1990		
	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	Total	RSD	
Commercial cane																			
Lower South Coast	143	6	20	5	39	4	90	6	55	5	91	5	52	4	31	2	52	2	
South Coast	159	21	60	9	71	35	169	28	71	25	137	34	105	12	129	44	271	33	
Midlands South	97	6	42	12	161	19	63	11	83	10	26	2	131	8	3	0	205	17	
Midland North	51	8	13	0	65	3	1	0	7	0	0	—	62	1	2	0	205	6	
Durban-North Coast	1 616	313	998	210	477	102	795	127	832	122	913	141	617	76	665	106	955	93	
North Coast	135	15	158	27	300	62	149	8	395	44	196	17	219	22	317	75	674	59	
Natal Cane Growers	41	19	105	18	136	58	40	12	163	58	202	31	248	48	17	1	446	136	
Zululand South	73	17	78	16	89	19	40	2	43	4	153	20	243	39	403	72	518	85	
Zululand Central	4	1	36	9	2	0	21	4	19	0	145	12	101	6	107	13	185	14	
Zululand North	60	8	30	12	6	2	21	7	50	1	151	18	226	36	260	81	366	84	
Umfolozi	8	6	72	29	4	2	1	1	52	21	8	3	148	16	9	4	196	50	
Pongola	27	13	127	51	129	65	1	1	55	20	1	1	161	62	151	89	124	43	
Eastern Transvaal	0	—	74	41	0	—	42	3	125	26	0	—	92	48	157	97	178	62	
Totals	2 414	433	1 813	439	1 479	374	1 433	210	1 950	336	2 025	284	2 405	378	2 251	584	4 375	684	