SHORT, NON-REFEREED PAPER

PROGRESS IN REDUCING DISEASE INCIDENCE IN THE SOUTH AFRICAN SUGARCANE INDUSTRY

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Abstract

The disease situation in the South African sugarcane industry since the introduction of the ratoon stunt disease (RSD) diagnostic service in 1977 and the establishment of the Local Pest, Disease and Variety Committees (LPD&VCCs) in 1983 is discussed. Survey results indicate substantial decreases in the incidence of smut, mosaic and RSD over time, with associated economic losses for the 2011-15 period estimated to be R51 million per annum compared to losses in 1984-85 of approximately R412 million per annum in current Rand terms. Significant differences in smut and mosaic incidence between regions in the industry and in the varieties grown within these regions were evident. Smut incidence in commercial fields in the smut-prone northern irrigated region was higher (P=0.001) than the overall industry mean and more smut was observed in varieties N25 (P=0.0017) and N32 (P<0.0001) than other popular commercial varieties grown in this region. Similarly, mosaic incidence in the Midlands (P=0.0002) was higher than the industry mean, with varieties N12 (P=0.0022) and N36 (P<0.0001) showing higher mosaic levels than the regional mean. Results from RSD surveys conducted during the 2011-2015 period indicated that 1.2% of the stalks in commercial fields in the industry were infected, a marked decrease from 10% in 1977-1980. The Biosecurity-Extension-Researcher partnership provides a conduit for knowledge exchange with growers and has been integral to the improved disease situation in the industry. This partnership has facilitated the promotion of new varieties, raising grower awareness to relevant disease issues through regular monitoring and promoting the use of integrated disease management strategies to minimise losses.

Keywords: sugarcane diseases, disease surveys, smut, mosaic, RSD, Biosecurity

Introduction

The South African sugarcane industry covers approximately 360 000 hectares from southern KwaZulu-Natal to the Mpumalanga Lowveld (Anon, 2016/17), encompassing a wide range of environmental conditions that favour the development of different pests and diseases. The industry is currently divided into 14 mill supply areas, comprising approximately 21 900 independent large and small-scale growers (Anon, 2016/17), making centralised pest and disease management more difficult than in estate-based industries. Local Pest and Disease Control Committees (LP&DCCs), now known as the Local Pest, Disease and Variety Control Committees (LPD&VCCs) were introduced in 1982 (Thompson *et al*., 1983), mainly in response to a rapid increase in the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) in the 1970s (Carnegie, 1974; Paxton, 1982). However, the Sugar Act (Act 9 of 1978) and the Sugar Industry Agreement (2000) that make express provision for the establishment of the Committees, also provide a means of protecting the growers against the effects of other pests and diseases through routine monitoring of intended seedcane sources and commercial fields. In this paper, the results of surveys for ratoon stunt (RSD - *Leifsonia*

xyli subp. *xyli*), smut (*Sporisorium scitamineum*) and mosaic (s*ugarcane mosaic virus*) surveys conducted over more than three decades, provide an indication of progress made in reducing disease levels in the industry.

Procedures

Foliar and stalk symptoms make it is possible for the Biosecurity teams to inspect for important diseases such as smut (*Sporisorium scitamineum*) and mosaic (*Sugarcane mosaic virus*) in the field. Incidence in commercial fields is estimated by counting the number of infected stools in a specified number of 50 m lengths of cane row and expressed as percent stools infected. Results from surveys conducted between 1984 and 2015 were included in this study. Ratoon stunt does not have any obvious external or internal symptoms. For this reason, a diagnostic service based on the detection of the causal bacterium *Leifsonia xyli* subsp *xyli* in expressed xylem sap, was introduced at SASRI in 1977 (Bailey and Fox, 1984). Routine diagnosis is currently based on an evaporative binding-enzyme immunoassay (Croft *et al*., 1994; McFarlane *et al*., 1999). Samples for routine RSD surveys in commercial fields consist of 20 stalks selected from the poorer looking stools in field sections no greater than 5 ha (Bailey and Fox, 1984). Results from samples collected between 1977 and 2015 are presented as percent positive samples. Intensive RSD surveys, testing 100 randomly selected stalks from 400 to 600 fields per region were conducted from 2000 to 2006 (McFarlane and Subramoney, 2007) and 2011 to 2015 (unpublished) to provide an estimate of the percent stalks infected in each region. This information was used to estimate losses due to RSD. Data from the 14 mill supply areas were grouped into five distinct regions. Data from smut and mosaic surveys were analysed using Mixed Models of the Statistical Analysis System and RSD data were analysed using the General Linear Model Procedure with t-tests (SAS Institute, 2016).

The following assumptions were made to estimate economic losses due to diseases:

- Average cane yield for the industry for 2014/15: 65 tons cane/hectare (Anon, 2016/17).
- Cane price (2015): R 443.50 per ton (Anon, 2016/17).
- Yield loss when 100% stalks infected: RSD - 40%; mosaic - 40%; smut - 75% (Rutherford *et al*., 2003).

Results and Discussion

A total of 128 770 commercial fields were inspected for smut and mosaic from 1984 to 2015, while 129 616 samples were tested for RSD from 1977 to 2015.

An average of 3% of the stalks tested for RSD in the early 1980s were infected (Rutherford *et al*., 2003), with associated yield losses of approximately R280 million in current Rand terms (Table 1). This decreased to 2.5% stalks infected in 2001-2005. Results from the most recent intensive surveys conducted between 2011 and 2015 indicated an average infection of 1.2%. Current losses in the industry due to RSD are estimated to be approximately R37 million.

Overall RSD incidence was higher in the northern irrigated region than the rest of the industry ($P<0.05$). Significant varietal differences in percent infection were evident with higher levels in NCo310, NCo376, N14, N17 and N25 than other varieties that were commonly grown during the period under review ($P<0.0001$).

Table 1: Ratoon stunt (RSD), smut and mosaic incidence and estimated associated losses for 1984-85 (Bailey and Fox, 1984; Bailey et al., 1994; Rutherford et al., 2003), 2001-05 (McFarlane and Subramoney, 2007) and 2011-15. Estimates given in current Rand values.

Period	Disease	Incidence (%)	Yield loss (%)	Total loss (R/annum)	Total loss (R/annum)
1984-85	RSD	3	4.00	R 279 262 955	
	Smut	2	1.50	R 104 723 608	
	Mosaic	1	0.40	R 27 926 296	R 411 912 859
2001-05	RSD	2.5	1.00	R 92 446 688	
	Smut	0.4	0.30	R 27 734 006	
	Mosaic	0.3	0.11	R 11 093 603	R 130 349 830
2011-15	RSD	1.2	0.48	R 36 608 888	
	Smut	0.2	0.16	R 11 440 278	
	Mosaic	0.1	0.03	R 3 050 741	R 51 099 907

Surveys conducted between 2011 and 2015 indicated a mean smut incidence of 0.2% stools infected for the industry compared with approximately 2% stools infected in 1984-85 when routine inspections were first introduced (Table 1). Varieties with improved resistance to smut replaced NCo376, a smut and mosaic-susceptible variety that represented 70% of the industry's crush in the late 1970s and early 1980s (Bailey *et al*., 1994) and smut levels decreased in the industry as a whole as the area planted to NCo376 declined. More smut was recorded in the northern irrigated region where the disease is endemic ($P=0.001$) and significant varietal differences in smut incidence were evident ($P=0.0012$). Of the more popular commercial varieties grown in this region, incidence was higher in varieties N32 ($P<0.0001$) and N25 ($P=0.0017$) than the regional mean of 0.57%. Variety N32 has since been degazetted due to its susceptibility to smut and mosaic, making it illegal to plant this variety in the industry. N25 is becoming less popular in the northern irrigated region but currently constitutes 16% of the crush. While smut incidence was lower in the more recent releases bred and selected specifically for the northern irrigated region, increasing smut levels have been observed in N41. This variety was released for propagation in the south in 2002 before being gazetted for the northern irrigated region in 2006. It currently constitutes 12% of the total crush for the region but is likely to lose favour due to smut.

Mean mosaic incidence was estimated to be 0.1% stools infected between 2011 and 2015 compared with 1% in 1984-85 (Table 1). More mosaic was recorded in the Midlands ($P=0.0002$) and mosaic incidence was significantly higher in the varieties commonly grown in the Midlands region ($P=0.0346$). Mosaic incidence was higher in varieties N12 ($P=0.0022$) and N36 ($P<0.0001$) than the regional mean of 0.66%. Variety N12 (intermediate mosaic rating) was released in 1979 but remains the most popular variety in the Midlands region, comprising more than 50% of the crush. Mosaic levels gradually increased in this variety over time, exacerbated by a diminishing supply of mosaic-free N12 seedcane. Most of the variety releases from 1997 onwards were specifically bred and selected for the Midlands and other high lying areas and were rated resistant to mosaic. Mosaic incidence remains low in these varieties. Variety N36 (intermediate mosaic rating) was initially gazetted for the northern irrigated region in 2000 before being released for propagation in the south in 2005. Newly planted fields in the Midlands soon became infected with mosaic, with low levels being observed in over 80% of the 108 fields of N36 inspected between 2006 and 2010 (data not shown).

Conclusions

The incidence of RSD, smut and mosaic has decreased in the industry since the introduction of the RSD diagnostic service and LPD&VCCs. Improved varietal resistance has played a major role in lowering smut and mosaic levels, while routine monitoring and improved seedcane health have contributed to a decline in all three diseases. The Biosecurity-Extension-Researcher partnership provides a foundation for the implementation of integrated disease management strategies and facilitates knowledge exchange between SASRI researchers and sugarcane growers.

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