SHORT, NON-REFEERED PAPER

EFFECT OF SUGARCANE YELLOW LEAF VIRUS INFECTION ON SUGARCANE GROWTH

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Abstract

Yellow leaf of sugarcane, particularly that caused by the sugarcane yellow leaf virus (SCYLV), has been observed in many sugar industries world-wide, including the South African industry. The objectives of this study were to investigate the effect of SCYLV infection on: shoot:root ratio of N32, juice colour production, cane yield and cane quality for varieties NCo376, N12, N31, N33 and N39. Varieties NCo376 and N39 exhibited significantly reduced cane and ERC yields when infected by SCYLV. Varieties N12, N31 and N33 exhibited no difference between healthy and infected cane. No difference in juice colour was observed between healthy and infected cane. Similarly, measurements of photosynthesis taken at two separate times showed no significant differences in readings between SCYLV infected and healthy sugarcane. Viral infection of N32, rather than reducing root production, resulted in increased production of sett roots, on average by 330%.

Keywords: sugarcane, SCYLV, yield, sett roots, shoot roots, juice colour

Introduction

Yellow leaf of sugarcane, caused by one of two pathogens: sugarcane yellow leaf phytoplasma (SCYLP) and/or sugarcane yellow leaf virus (SCYLV), has been observed in many sugar industries world-wide, including the South African industry. Recent evidence has shown that some varieties, such as N32, are 100% infected and despite this still yield well. In some cases, virally-infected N32 yields better than healthy N32. There are only a few studies on the effect of SCYLV on sugarcane yield and thus far (except for N32) none for the South African sugar industry.

The objectives of this study were to investigate the effect of SCYLV infection on the shoot:root ratio of N32, as well as juice colour production, cane yield and quality for varieties NCo376, N12, N31, N33 and, N39.

Materials and Methods

Field trial

SCYLV infected seedcane of five varieties (NCo376, N12, N31, N33 and N39) was collected from the Pongola research farm, which has previously been shown to have high levels of SCYLV infection (Rutherford *et al.* 2004). Healthy seedcane of NCo376 and

N12 was also collected from Pongola, while healthy seedcane of N31, N33 and N35 was found in the Midlands, Eshowe and South Coast respectively. In September 2008, this seedcane was planted into a nursey at Mount Edgecombe with single lines of 100 m per variety. In March 2009, leaves were cut from individual stools within each line for testing for SCYLV. The midribs of the leaves were removed, labelled and imprinted onto nitrocellulose membrane for detection of SCYLV with the tissue blot immunoassay of Shenk *et al.* (1997). Those stools found to be infected were labelled with red tape. In September 2009, infected and healthy seedcane was cut from the nursery and used to plant a variety x yield loss field trial at Mount Edgecombe. The trial was laid out as a randomised complete block design with five varieties x two treatments (healthy and infected) x six replicates. Each plot was 5 rows x 10 m with 1 m row spacing. Temik (a.i. aldicarb) at the rate of 20 kg/ha was applied at planting and for the following five months to all of the plots to control insect feeding on the sugarcane. Monthly stalk heights and counts were performed on the middle line of each plot. In December 2009, March 2010 and June 2010, the stools were tested for SCYLV infection. For this, one sugarcane leaf was cut per stool from 10 different stools within each line of each plot and tested with the tissue-blot immunoassay. After 12 months (September 2010), the sugarcane stalks in the three net rows of the plant crop were cut, stacked and weighed. Twelve random stalks were collected from each plot and sent to the millroom for sucrose analyses. An additional 12 stalks of N33 and N39 were collected and sent to the Sugar Milling Research Institute (SMRI) for juice colour analyses. After harvest, the sugarcane was ratooned and in December 2010, January 2011 and March 2011 the stools were again tested for SCYLV infection. The effects of treatments on cane and ERC (sugar) yield and cane quality was analysed by Means ANOVA, Student t-test (JMP Software, SAS Institute).

Pot trial

In September 2008, a pot trial was planted to assess the effect of viral infection on sugarcane shoot and root growth. Double-budded setts of healthy and infected N32 were planted in 75 litre pots and harvested monthly from November 2008 until April 2009 to determine shoot, sett root and shoot root biomass.

Results and Discussion

Field trial

Despite testing the seedcane before planting and applying Temik at monthly intervals (to keep aphid populations from spreading the virus), supposedly ‘healthy’ plots of NCo376, N12 and N31 were found to be infected with SCYLV, almost to the same extent as the originally-infected seedcane (Figure 1a,b). However, plots of healthy N33 and N39 remained mostly free of the virus. The extent of infection (% stools infected) increased for all treatments from the plant crop to the first ratoon crop (Figure 1a,b).

Rutherford *et al.* (2004) found that tissue-cultured virus-free N32 became 100% infected within four months of planting at Pongola, yet transmission at Mount Edgecombe was markedly slower over 12 months. The variety yield loss trial reported on in this paper was conducted at Mount Edgecombe, so it can be assumed that little virus transmission would have occurred during this trial. In addition, all the trial plots were treated monthly with Temik (a.i. aldicarb) to control any insect feeding on the sugarcane and the inadvertent transmission of the virus.

Testing for SCYLV at various crop ages showed that the viral status of the plant changed over time (Figure 1c,d). More stools tested positive for the virus when the cane was young (December/January) compared to when the cane was older (later than March). Ideally, testing for the virus should be done when the cane is 3-4 months of age and has sufficiently large leaves for midrib imprint immunoassays.

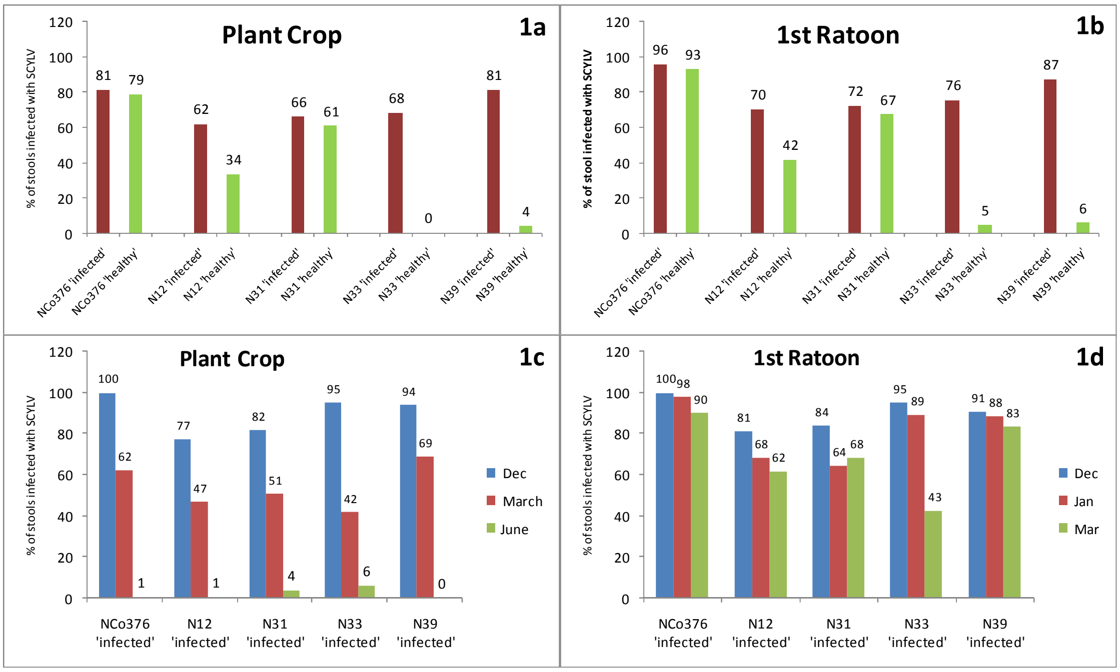

Figure 1. Percentage stools infected with SCYLV for the plant crop (a,c) and first ratoon (b,d).

Measurements of photosynthesis were taken at two separate times and on both occasions there were no significant differences in readings between SCYLV-infected and healthy sugarcane (data not shown). Similarly, no difference in juice colour was observed between healthy and infected N33 and N39 cane (data not shown).

Varieties NCo376 and N39 exhibited significantly reduced cane (Figure 2a) and ERC (Figure 2b) yields when infected by SCYLV. Varieties N12, N31 and N33 exhibited no difference between healthy and infected cane. The yield reduction in NCo376 is hard to explain, given that the virus was found in healthy and infected plots (Figure 1a,b). It is possible that the 'healthy' plots became progressively infected during the summer of the plant crop. It is possible that the infected plots, being derived from infected seedcane, lost yield due to poorer germination and poorer early growth.

Interestingly, infected N33 exhibited significantly increased ERC yield (>22%) compared to healthy N33 (Figure 2b). Similar results were observed in N32 in previous trials. Following removal of the virus through tissue culture, some of this material subsequently became re-infected. When re-infected tissue cultured material was used in yield trials in comparison with tissue cultured material that remained clean, unexpected results were obtained, i.e. SCYLV infected N32 out-yielded uninfected N32 (data not shown). Although known to be 100% infected by SCYLV, N32 continues to perform well in parts of the South African sugar industry.

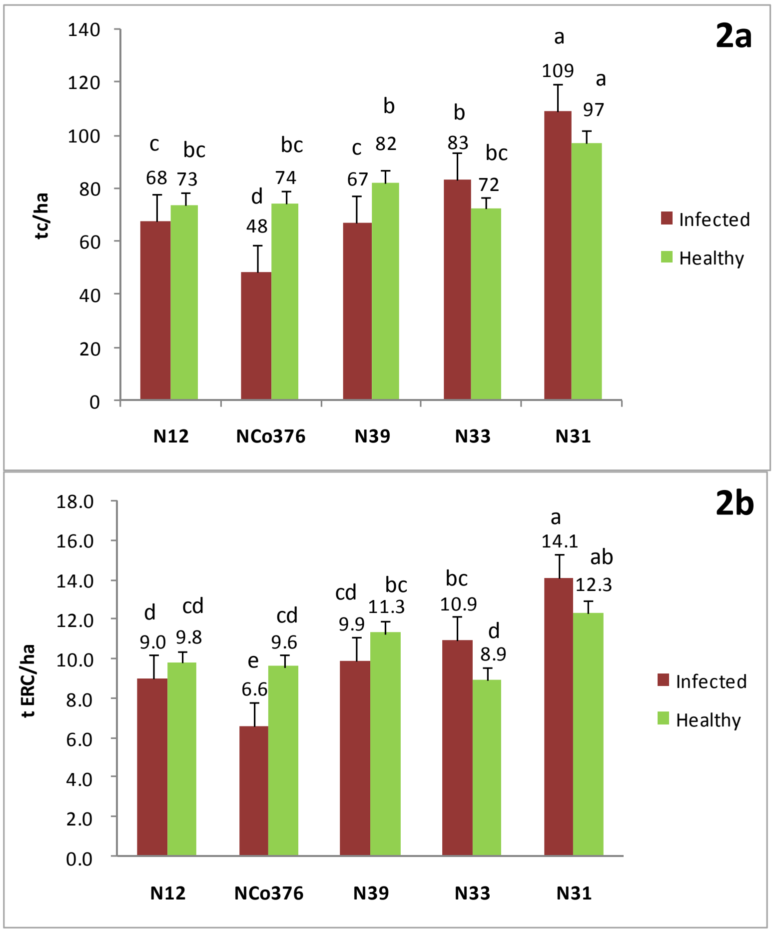

Figure 2. Graphs showing the cane (tc/ha) (a) and ERC (t ERC/ha) (b) yields for the five varieties (infected and healthy) in the plant crop.

Studies found that YLS resulted in losses as high as 30% in susceptible variety SP71-6163 in Brazil (Comstock *et al.*, 1994) and 10% in variety LCP82-89 in Louisiana (Grisham *et al.*, 2001). Not much prior information was available on yield losses for South African varieties before this study. However, Rutherford *et al.* (2004) reported on a decline (~10%) in yield in variety N30, relative to controls, from when it was a pre-release variety to when it was commercially released.

Pot trial

Infection with SCYLV had no effect on stalk or shoot root weight for the duration of the pot trial. Interestingly, SCYLV infection resulted in a trend of increased sett root weight for the duration of the trial, significantly greater for the first two months of growth.

Very few studies have been published investigating the effect of SCYLV infection on belowground (root) biomass. Vasconcelos *et al.* (2007) recently showed that SCYLV infected sugarcane exhibited 43% reduction in root mass. Data from this trial showed that viral infection in N32, rather than reducing root production, resulted in increased production of sett roots, on average by 330%. This could account for the increased yield seen in this variety when infected.

The phenomenon of yield increase in infected plants is not without precedent. Barley Yellow Dwarf Virus (also a luteovirid) in various ryegrass cultivars is mostly symptom-less (as is SCYLV in sugarcane) and infection significantly increased aboveground biomass for some cultivars (Catherall and Parry, 1987). However, unlike N32, these same cultivars exhibited reductions in root biomass. This could be disadvantageous under conditions of water stress.

The SCYLV yield loss field trial is continuing and data is being collected from the first ratoon crop. This trial will continue for at least one more season. Another pot trial will be established to look at the effect of SCYLV infection on the shoot and root biomass of N33 (to confirm the data obtained from the field trial).

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