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A PRELIMINARY REPORT ON THE EFFECT OF SUGARCANE MOSAIC VIRUS ON THE YIELD OF SUGARCANE VARIETIES NCo 376 and N12

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Abstract

A variant of SCMV-D is the most common strain of sugarcane mosaic virus (SCMV) occurring in sugarcane in the coastal hinterland and high altitude areas of Natal. In field trials conducted at Mount Edgecombe and Eston this strain decreased the yield of recoverable sugar from variety NCo 376 by 30 to 42 % and that from variety N12 by 15 to 30 % when all the stalks were infected. Losses in yield were mainly due to decreases in stalk mass and stalk population. There was no consistent effect of mosaic on cane quality. The relationship between decrease in yield and incidence of mosaic was approximately linear.

Introduction

Mosaic is a serious disease of sugarcane in many of the countries in which sugarcane is grown. In South Africa, mosaic occurs frequently in sugarcane grown in the coastal hinterland and the high altitude areas of Natal. Varieties NCo 376 and NCo 293, which constitute approximately 80% of the crop in these relatively cool areas, are susceptible to mosaic and can become infected with high levels of the disease, particularly when crops are planted and harvested in late spring and summer (Bailey and Fox[5]). Variety N12 which is being grown to an increasing extent in the rainfed areas of cane production in Natal, is less susceptible to mosaic than is NCo 376 or NCo 293 (Anon[4]), but levels as high as 20 % infected stools have been recorded in some commercial fields of N12.

Sugarcane varieties differ widely in their susceptibility to and tolerance of infection by SCMV. Moreover the response of a single variety to SCMV may be influenced by the strain of the virus. In comparisons of the cane yields of healthy and mosaic-infected single stools of NCo 376 and NCo 293 losses in yield were approximately 80 % (Thomson[6]; Anon[2, 3]). However, tests with spaced plants probably do not provide an accurate estimate of the effects of the disease on yield in normal field conditions. Details of the strains of SCMV in these tests were not reported.

Infection with mosaic causes stunting of the growth of NCo 376 in the field (Figure 1). The extent of the resulting loss in yield was estimated in 1980 by harvesting 'micro-plots'. These plots consisted of portions of cane row with symptoms of mosaic and adjacent, equal lengths of row with no symptoms. The results suggested reductions of 25 % in stalk population and 40 % in cane yield, but competition by healthy cane may have resulted in the yield of the infected sections of row being underestimated.

An investigation to determine the effect of mosaic on the yield of NCo 376, using conventional trial designs and multi-row plots, was started in 1979, but in the early trials there was rapid natural infection of plants in the initially healthy plots. In one trial plots of NCo 376 planted with healthy seedcane contained 47 % infected stalks 8 months after planting, whereas plots planted with infected seedcane contained 72 % infected stalks. Nevertheless this difference in the amount of infection resulted in a difference of 10 % in yield of cane when the trial was harvested after 21 months (unpublished data).

This result showed that the common strain of the virus occurring in South Africa, a variant of SCMV-D (Gillaspie, personal communication), can substantially affect the yield of NCo 376 when levels of infection are high. However, further estimates were needed to assess the economic effects of mosaic more accurately. Also, the increasing popularity of N12 made it worth investigating the effects of the disease on this variety.

The two field trials described here were established in 1985 to provide estimates of the effect of infection by SCMV-D on the yields of NCo 376 and N12. The results obtained from the plant crops are given.

Materials and Methods

To minimise the transmission of mosaic within each of the trials they were planted, respectively before and after the normal time of planting (late spring and summer). In this way the coincidence of the young, more susceptible stages of growth with the period when vectors were most active was avoided. Carbofuran (Curaterr 10 % gran) was applied in the furrow before planting at a rate of 2 kg ha^{-1} as a further precaution against infective aphids transmitting mosaic from plant to plant.

Both experiments were conducted under rainfed conditions. The strain of SCMV used in both experiments was a variant of SCMV-D. Inspection by microscope indicated that the seedcane used in both experiments was free of ratoon stunting disease (RSD).

FIGURE 1 Severe stunting of NCo 376 when planted with mosaic-infected seedcane (centre) compared with surrounding healthy varieties.

Experiment 1

The experiment was planted in a deep, humic clay loam soil (Inanda form) in the Eston area in late March 1985. Mosaic is common in fields of commercial cane in this area. Plots of NCo 376 and N12 with 'O', '25' and '100 %' mosaic were established by planting the appropriate proportion of setts from healthy and mosaic-infected seedcane. The healthy seedcane was obtained from mosaic-free plots at the Experiment Station. The infected seedcane consisted of stalks exhibiting symptoms of mosaic collected from commercial fields in the Eston area, but because of the difficulty of diagnosing mosaic in mature cane in dry conditions, a few stalks might not have been infected.

Each plot consisted of four rows, 10 m long, spaced 1,2 m apart. Data from all four rows of a plot were used (statistical analysis showed that variability would have been greater if data from the two inner rows of each plot only had been used). Treatments were replicated four times in randomised blocks, and the trial was surrounded by guard areas of NCo 376.

The incidence of mosaic was determined periodically up to 12 months after planting, by counting the number of shoots and stalks with and without symptoms of mosaic. Estimates of stalk height were made before harvesting the trial in September 1986, 17,2 months after planting.

Experiment 2

This experiment was planted at Mount Edgecombe in September 1985 on a sandy clay loam soil (Swartland form). Plots of NCo 376 and N12 with either 'O' or '100 %' mosaic were established using setts obtained from stalks showing either no symptoms of mosaic or clear leaf symptoms, all collected from commercial fields of cane in the Dumisa area.

Individual plots consisted of five rows, each 4 m long spaced 1,2 m apart. Each plot was bordered on either side by one row and at the end by 0,5 m lengths of row of N11 which is highly resistant to mosaic. There were six replications of each treatment in randomised blocks. Data from all five rows in a plot were used; again this was statistically more acceptable than using data from the three inner rows only.

The incidence of mosaic was determined, by the same method as in Experiment 1, until April 1986, 7 months after planting. Mean stalk heights were determined just before harvest in August 1986, 10,8 months after planting.

Results

Experiment 1

At 10 weeks after planting the shoot populations of plots planted with infected seedcane were much greater than those of plots planted with healthy seedcane (Table 1). This was presumably due to differences in the physiological condition of the seedcane from the two sources; it was unlikely to have been related to mosaic.

The weather was comparatively cool and dry during the first 6 months after planting. Furthermore foraging buck and rabbits caused considerable damage to plants during this period. However, both varieties eventually tillered well, and satisfactory shoot populations were obtained. Growing conditions were good after October 1985, but the effective crop age at harvest was probably about 13 rather than 17,2 months, because of the early grazing damage.

Initial differences in levels of mosaic changed little throughout the plant crop and it was evident that little vector-borne transmission of mosaic occurred in the trial (Table 1).

The yields of cane of both varieties were substantially decreased by mosaic. In NCo 376 yield fell by 11 and 27 % in plots with '25 %' and '100 %' infection, respectively (Table 1). Mosaic had a less marked effect on the cane yield of N12. Here the decreases in yield with '25 %' and '100 %' levels of infection were only 4 and 11 %, respectively (Table 1).

Mosaic had little effect on the stalk population of either variety and the decreases in yield resulted largely from decreases in mean stalk mass (Table 2).

Table 2

Effect of mosaic on the yield and components of yield of NCo 376 and N12 at Eston (Experiment 1), % differences between plots of '0' and '100 %' infection

Variety	Stalks with symptoms	Stalk population	Stalk mass	Tc ha^{-1}	Ers % cane	T ers ha^{-1}
NCo 376	+65	−2	−25	−27	−2	−28
N12	+54	−2	−13	−11	−7	−16

Mosaic had little detectable effect on the cane quality of NCo 376, but there was an apparent increase in fibre % cane and a fall in the estimated recoverable sugar (ers) = sucrose − 0,485 non-sucrose − 0,056 fibre content of the cane with increasing levels of mosaic infection in N12 (Table 1).

Table 1

Effect of mosaic on stalk populations, cane quality, and cane and estimated recoverable sugar (ers) yields of NCo 376 and N12 at Eston (Experiment 1)

Variety	Levels of infection (%)	Shoots $ha^{-1} \times 10^{-3}$ at 10 weeks	% stalks with symptoms at 12 months	Harvested stalks $ha^{-1} \times 10^{-3}$	Fibre % cane	Ers % cane	Yield (t ha^{-1})	
							Cane	Ers
NCo 376	'0'	34	2	143	12,1	11,4	96,8	11,0
	'25'	58	13	134	11,8	11,1	86,4	9,6
	'100'	86	67	140	12,0	11,2	70,9	7,9
N12	'0'	54	1	144	12,4	12,3	80,8	9,9
	'25'	64	14	142	12,5	11,7	77,7	9,0
	'100'	108	55	147	13,1	11,5	71,9	8,3
LSD (P = 0,05)						0,9	9,8	1,1
(P= 0,01)						1,3	13,5	1,6
CV (%)						5,0	8,0	8,1

The loss in the yield of recoverable sugar from NCo 376 because of mosaic was closely related to the effect of the disease on cane yield. The yield of recoverable sugar of NCo 376 was decreased by 13 and 28% respectively, by the '25%' and '100%' levels of infection, and that of N12 by 9 and 16% respectively (Tables 1 and 2).

Experiment 2

Mosaic had little effect on the number of buds which sprouted (Table 3). With good conditions for growth the plant crops of both varieties grew well and the yields of cane, 92 and 85 t ha^{-1} for NCo 376 and N12 respectively, were high considering the short period of growth of 10,8 months.

Mosaic had broadly similar effects on the crop in the two experiments despite the differences in growing conditions and the different rates of germination in Experiment 1.

The main effect of mosaic was a decrease in the yield of cane. In the experiment at Eston, the yield of both varieties was decreased, mainly through a decrease in stalk mass. Decreased stalk mass also contributed to the decrease in yield of NCo 376 at Mount Edgecombe (Table 2); here the infected and healthy seedcane germinated at similar rates and mosaic caused substantial reductions in the stalk populations of both varieties (Tables 3 and 4). It is possible that the small effect of mosaic on stalk population at Eston was the result of the better germination and establishment of the

Table 3

Effect of mosaic on germination, stalk population, cane quality, and cane and ers yields of NCo 376 and N12 at Mount Edgecombe (Experiment 2)

Variety	Levels of infection (%)	% buds germinated	stalks with symptoms at 7 months	Harvested stalks $ha^{-1} \times 10^{-3}$	Fibre % cane	Ers % cane	Yield (t ha^{-1})	
							Cane	Ers
NCo 376	'0'	45	0	158	12,4	12,9	91,5	11,8
	'100'	39	85	138	13,1	13,4	65,6	8,8
N12	'0'	45	0	175	12,7	13,0	84,7	11,0
	'100'	41	73	157	13,8	13,4	73,3	9,8
LSD (P = 0,05)				12	0,8	0,5	8,3	1,3
(P = 0,01)				17	1,1	0,7	11,7	1,8
Means of both varieties	'0'	45	0	166	12,6	12,9	88,1	11,4
	'100'	40	79	148	13,5	13,4	79,0	9,2
LSD (P = 0,05)				8	0,5	0,3	5,9	0,9
(P = 0,01)				12	0,8	0,5	8,2	1,3
CV (%)				6,0	4,6	2,9	8,4	10,0

Mosaic did not spread from infected to healthy plots and the large initial differences in levels of mosaic were maintained throughout the growth period (Table 3). The ers % cane and fibre % cane were slightly higher in infected than in healthy plots. Recoverable sugar yield fell relatively more in NCo 376 than in N12 as a result of infection; mosaic resulted in both a smaller stalk population and a smaller stalk mass in NCo 376, but most of the decrease in yield of N12 was due to a decrease in population (Table 4).

Table 4

Effect of mosaic on the yield and components of yield of NCo 376 and N12 at Mount Edgecombe (Experiment 2), % differences between plots of '0' and '100%' infection

Variety	Stalks with symptoms	Stalk population	Stalk mass	Tc ha^{-1}	Ers % cane	T ers ha^{-1}
NCo 376	85	−13	−18	−29	+4	−25
N12	73	−10	− 4	−14	+3	−11

Discussion

Planting the experiments either before or after the main planting period of late spring and summer was effective in preventing the transmission of mosaic in the trial plots, so that differences between treatments were successfully maintained throughout the growth period.

crop that occurred with infected seedcane at this site. Results from the ratoon crop should clarify this. Mosaic tended to increase the recoverable sugar content of the cane at Mount Edgecombe, but to decrease it at Eston (Tables 1 and 3).

An interesting feature of the results was the difference between the sites in the percentage of stalks exhibiting symptoms of mosaic in plots that had been planted with infected seedcane. Higher percentages of stalks showed symptoms of mosaic at Mount Edgecombe than at Eston, and higher levels were apparent in NCo 376 than in N12 at both sites (Tables 1 and 3). All the stalks of seedcane used to establish the '100%' plots were supposed to have been infected, but this might not have been achieved at Eston because of the difficulty of recognising mosaic in the conditions in which the seedcane was collected. Moreover, some buds on an infected stalk may not contain the virus, and any such buds would give rise to healthy shoots (Abbott[1]). This may explain the levels of 85 and 73% of stalks with symptoms that were recorded in NCo 376 and N12 in Experiment 2. The figures obtained in the two experiments may also have been affected by the usual difficulty of recognising the occasionally subtle and inconspicuous symptoms of mosaic in a dense crop, as well as by the possibility of latent infection.

The results of Experiment 1 indicate that the effect of increasing levels of mosaic on the yields of the varieties was approximately linear (Figure 2). Accordingly the results may be extrapolated to provide an index for comparing the effects of mosaic on different varieties and in different situations.

The data from these experiments suggest that if all the stalks had been infected, the variant strain of SCMV-D would have reduced the recoverable sugar yield of NCo 376 by 30 and 42 %, and of N12 by 15 and 30 %, at Mount Edgecombe and Eston respectively.

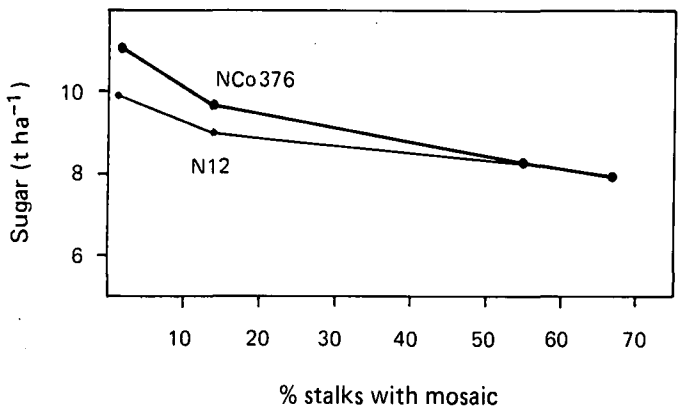

FIGURE 2 Recoverable sugar yield of NCo 376 and N12 in relation to mosaic at Eston (Experiment 1).

These estimates of the effect of mosaic on NCo 376 are similar to that of 40 % that was obtained previously with this strain of SCMV, by harvesting microplots with and without symptoms (unpublished data).

The present results show that N12 is both more resistant to and tolerant of infection with mosaic than NCo 376. Considering the magnitude of the decrease in yield of NCo 376 in relation to results in published reports of the effect of mosaic on other varieties (Anon[4]), it is evident that NCo 376 is intolerant of infection by the common strain of SCMV occurring in South Africa. In addition, NCo 376 is known to be the most susceptible of the sugarcane varieties released in South Africa to this strain of the virus (Anon[4]; Bailey and Fox[5]).

These estimates of the effects of mosaic on the growth and yield of NCo 376 and N12 are preliminary. Further data are being obtained from the ratoon crops of both experiments, and also from other trials.

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REFERENCES

1. Abbott, EV (1961). In: *Sugarcane diseases of the world Vol 1. Ed* Martin, HP, Abbott, EV and Hughes, CG. Elsevier, Amsterdam. 406-430.
2. Anon (1965). Varieties and disease. *Ann Rep S Afr Sug Assoc Exp Stn* 1964-65: 29-32.
3. Anon (1970). Mosaic disease tolerance. *Ann Rep S Afr Sug Assoc Exp Stn* 1969-70: 37.
4. Anon (1985). Reactions of new varieties to mosaic. *Ann Rep S Afr Sug Assoc Exp Stn* 1984-85: 57.
5. Bailey, RA and Fox, PH (1980). The susceptibility of varieties to mosaic and the effect of planting date on mosaic incidence in South Africa. *Proc S Afr Sug Technol Ass* 54: 161-167.
6. Thomson, GM (1963). The mosaic tolerance of five sugarcane varieties in Natal. *Proc S Afr Sug Technol Ass* 37: 123-126.