A MOSAIC CONTROL PROGRAMME FOR A SUGARCANE ESTATE IN THE NATAL MIDLANDS

By J. L. NEEN

South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe 4300

and D. ARMITAGE

Garlick Timbers, PO Hilton 3245

Abstract

Because of the rapid increase in the incidence of sugarcane mosaic virus in the Natal Midlands area, an integrated programme for the control of the disease was initiated on a farm in the area in 1982. The programme involved the monitoring of mosaic levels in individual fields, the careful roguing of volunteers and diseased plants from fields of plant cane, the use of improved quality seedcane, planting in early spring, and the introduction of varieties less susceptible to mosaic than those previously grown on the farm. Mosaic levels were reduced over a 5-year period and aspects of the programme have been translated into monetary terms in order to show the cost-effectiveness of the programme.

Introduction

Prior to 1975 the level of mosaic on a particular estate in the Natal Midlands was comparatively low and little attention was paid to its control. From 1975 the levels of mosaic began increasing markedly and consequently roguing of diseased plants was started. In 1982 an integrated control programme was introduced in an attempt to check the spread of the disease and eventually to reduce its incidence.

A number of factors were included in the programme aimed at controlling mosaic:

- the level of the disease was monitored and suitable records of mosaic levels in individual fields obtained. This necessitated the training of farm labour
- planting was scheduled early in the season in order to avoid the cane being at a young, highly susceptible stage when populations of aphids were at their greatest
- a system of roguing was introduced to remove diseased stools in both the seedcane nursery and in fields of plant cane
- the quality of seedcane was improved to minimise the possibility of using diseased seedcane
- the eradication of the old crop was improved as it had been observed that actively growing volunteer plants in fields of plant cane represented as much as 19% of the plant population
- varieties more resistant to mosaic were introduced to replace the more susceptible ones which were in use.

The control programme that was introduced and the records that were kept were designed solely for the benefit of the farm management and were not intended for publication. Because of the success of the project, however, details of the programme, the costs, results and the economic aspects may benefit other growers.

Method

Disease surveys

Inspection of the cane in all recently harvested and planted fields on the farm was undertaken annually between November and March by one inspector, employed on the farm. The data collected were used for calculating the level of mosaic in each field and subsequently the mosaic level on the farm as a whole. The sampling system used by the inspector was as recommended by the South African Sugar Association Experiment Station, ie the number of 50 m sampling sites varied in accordance with the area of the field being surveyed. For the purpose of this paper, records dating back to the 1983–84 season have been used, since the records before that date were incomplete. Occasionally, an estimated value provided by the farm manager has been used.

Roguing

Labourers were employed specifically to rogue diseased cane from commercial fields of plant cane as well as from the 10 ha nursery site. The labourers identified and hoed-out volunteer stools and diseased cane from fields of cane. Records were kept of the number of labourers employed during these operations and the costs incurred. Recently, a count of the number of rogued volunteer stools was made to provide an estimate of the stool survival rate and hence the effectiveness of the eradication of the previous crop.

It was possible for the roguing team to visit newly planted fields 3 times each season. It was not possible to differentiate between the cost of removing volunteers and that of removing diseased stools.

Early planting

Since 1984, fields have been planted in August, September, and early October of each year. Cane planted this early is less susceptible to infection (Bailey & Fox[1]) since it is more mature and reportedly less palatable to the aphids than it would be when aphid populations reach there peak during the ensuing summer. (KM Harborne, personal communication).

Improvement in quality of seedcane

Concern about the rapid increase in mosaic levels on the farm prompted the introduction of a considerable amount of seedcane of varieties N11 and N12 in 1984–85 and 1985–86. This was obtained from a registered nursery in the Tala Valley district and it was free of disease. A 10 ha irrigated nursery was also established in 1985–86 with some of the introduced varieties. This nursery was the source of seedcane of N12 and N11 on the farm for the 1986–87 and 1987–88 seasons. The nursery was inspected and rogued more frequently than the fields of plant cane in order to maintain the quality of seedcane for planting. For example, in 1986–87 diseased stools (amounting of 3% of the total number of stools) were rogued from the nursery of first ratoon cane of variety N12 on 3 separate occasions.

Eradication of the old crop

The eradication of the old crop was achieved mechanically by the method recommended by the Experiment Station, ie a shallow ploughing in winter using a mouldboard plough

equipped with a depth control wheel. This method was used in preference to chemical eradication in late summer because planting in spring is favoured above planting in autumn on the estate.

This method proved to be disappointing, particularly on the humic soils and in seasons with some winter rainfall, because large numbers of volunteers were detected after replanting had taken place. The rogue plants (particularly NCo293 and NCo376) generally showed symptoms of mosaic infection and this served as a source of contamination for the cane in the entire field. Removal of volunteers by hand-chipping with hoes was thus essential.

Changes in variety and replant decisions

The planting of varieties susceptible to mosaic such as NCo293 and NCo376 was discontinued during the 1982–83 season. Varieties N11 and N12 which are less susceptible to mosaic were introduced, at first on a limited scale, but later on a much larger area of the farm once their yield potential was realised. Table 1 indicates the proportion of the different varieties on the estate during the period under discussion.

The records indicated that mosaic levels in early stage ratoon crops were generally higher than the levels detected in late stage ratoon crops (Figure 1). Therefore the decision regarding which fields to plough out and to plant to less susceptible varieties was often based on disease levels rather than on the stage of the ratoon. For example, the survey data indicated a plant crop of NCo376 in a 25 ha field to have a mosaic infection level of 100%, and it was consequently ploughed out after the first crop, in preference to ratoon crops at later stages of development which had lower levels of infection.

A second consideration was the area of land under cane on the farm compared with the area allocated to other enterprises such as timber and cattle. The threat of mosaic

Table 1

Estimated area of land (ha) under different varieties between 1983–84 and 1987–88

Season	NCo293	NCo376	N11	N12	N13	Other
1983–84	115	276	26	90	3	4
1984–85	100	245	34	124	7	4
1985–86	67	216	64	148	7	4
1986–87	59	179	67	166	7	12
1987–88	44	130	84	200	7	20

Table 2

Area and % land ploughed and replanted to sugarcane since 1982–83

Season	Area under sugarcane (ha)	Area ploughed-out		Area replanted to sugarcane	
		ha	%	ha	%
1982–83	511	34,5	6,8	37,5	7,3
1983–84	514	45,3	8,8	45,3	8,8
1984–85	514	85,7	16,6	53,7	10,4
1985–86	506	29,7	5,9	21,7	4,3
1986–87	490	79,7	16,3	63,7	13,0
1987–88	485	56,5	11,6	51,5	10,6

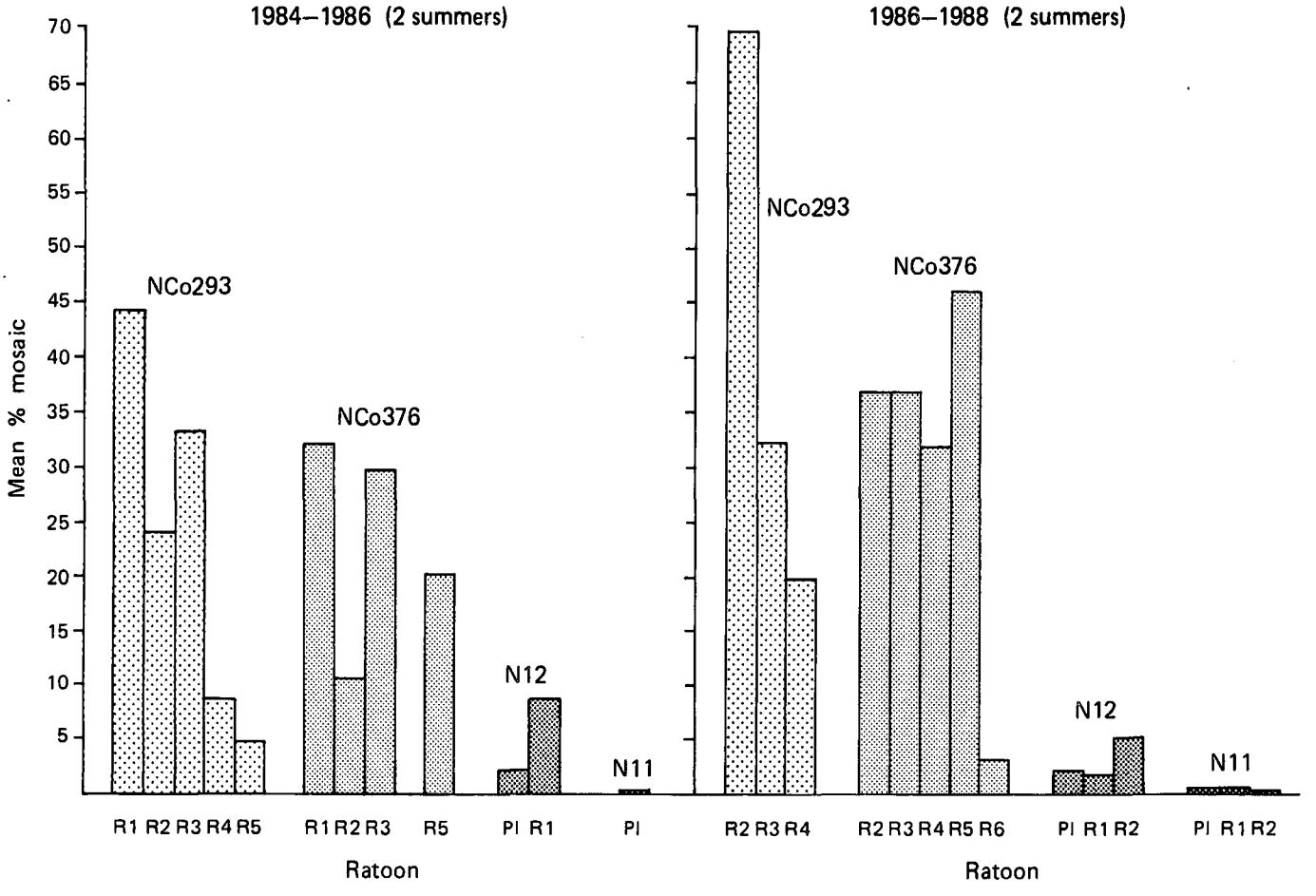

FIGURE 1 Mean % mosaic in ratoon crops of NCo293 and NCo376 and in plant and ratoon crops of N11 and N12 for the periods 1984–1986 and 1986–1988.

coupled with the estate's relatively high proportion of B pool cane motivated the early eradication of cane where it was highly infected with mosaic rather than the eradication of older ratoons with less infection. Some of these fields were planted to timber and pasture crops rather than to cane. The areas ploughed out and replanted to sugarcane are shown in Table 2.

Results and discussion

Levels of mosaic

The harvest cycle of cane on the estate is 24 months. Changes in the mosaic level of cane in an individual field are therefore represented by the levels recorded in alternate and not consecutive seasons.

The levels of mosaic recorded on the estate in the period 1982–83 to 1987–88 are presented in Table 3. The 1982–83 mosaic level was estimated, as the records for the year were kept for a few fields only and not for whole area harvested.

Table 3

Levels of mosaic infection on the estate from 1982–83 to 1987–88

Season	Mosaic (%)	Season	Mosaic (%)
1982–83	±25,0*	1983–84	14,6
1984–85	18,6	1985–86	12,1
1986–87	12,8	1987–88	11,6

* Estimated

It is apparent that there has been a consistent decline in the level of mosaic on the estate over the period under discussion.

The influence of varieties on the level of mosaic is illustrated in Table 4, where NCo293 and NCo376 are seen to be the varieties with the highest disease levels. Thus, the decision that was taken to eliminate these two varieties gradually and to replace them with newer varieties which are less susceptible to mosaic was fully justified.

Table 4

Mosaic levels (%) in different varieties on the estate

Season	NCo293	NCo376	N11	N12	N13	N16	N17	N18
1983–84	20,4	21,9	—	5,1	3,4	—	—	—
1984–85	20,3	32,6	0,00	5,2	—	—	—	—
1985–86	38,1	13,1	0,40	6,7	5,4	—	—	—
1986–87	42,3	37,0	0,04	4,7	6,7	—	—	—
1987–88	15,0*	24,2	0,01	7,9	1,0	3,2	1,6	0,7
Mean	27,2	25,8	0,10	5,9	4,1	3,2	1,6	0,7

* This represents only 4,5 ha of the 44 ha of NCo293 remaining on the estate

The contribution of the roguing and hand-chipping operations in reducing the level of mosaic on the estate is difficult to quantify, but it is likely that without them the level of mosaic would have continued to escalate. It was found during the second roguing operation that some fields of NCo376 had levels of volunteer plants as high as 19% and 5% in the case of NCo293. Most of the volunteers showed symptoms of mosaic infection and if they had survived these would have served as a serious source of secondary infection.

Similarly, the beneficial effects of the use of seedcane from a nursery and the early ploughing out of fields of infected cane is difficult to quantify. However, the use of healthy seedcane must have contributed to the lower levels of mosaic.

Costs

The effect of reducing the mosaic level on the loss of revenue from 1 000 tc is presented in Table 5. For this exercise the value of cane has been taken as R33 t^{-1} and the crop loss as 30% for each percentage unit of mosaic infection, eg 10% mosaic infection causes a crop loss of 3% (Bailey and Fox[1]).[2]

Table 5

Cane yields and estimated crop and resultant revenue losses due to the effects of mosaic infection

Season	Area harvested (ha)	Cane produced		Mosaic level (%)	Estimated losses due to mosaic*		
		Total (t)	(tc) ha^{-1}		Yield (%)	Revenue to farm (R)	Revenue 1000 t^{-1} (R)
1982–83	260,0	24 390	93,8	±25,0	7,5	60 360	2 470
1983–84	241,5	20 234	83,7	14,6	4,4	29 250	1 450
1984–85	334,5	29 176	87,2	18,6	5,6	53 720	1 840
1985–86	209,0	20 622	98,7	12,1	3,6	24 700	1 200
1986–87	261,4	25 572	97,7	12,8	3,8	32 400	1 270
1987–88	233,4	23 250	99,6	11,6	3,5	26 700	1 150

* % yield loss = 30% × mosaic level %; for 25% mosaic level yield loss is 30% × 25 = 7,5%

It is evident that the effect of lowering the mosaic level on the estate has reduced the overall loss of revenue t^{-1}. The estimated loss for the 1982-83 season was about R2 400 per 1 000 tc, whereas the more accurate estimate for the 1987–88 season was about R1 100 per 1 000 tc.

Table 6

Costs of implementing the mosaic control programme from 1982–83 to 1987–88

Season	Labour cost for roguing volunteers & diseased cane (R)	Purchase of seedcane (R)	Nursery costs (r)	Total costs (R)	Cost 1000 t^{-1} (R)
1982–83	Not available				
1983–84	1 530	-	-	1 530	76
1984–85	865	2 600	-	3 465	119
1985–86	2 530	1 075	-	3 605	175
1986–87	5 545	-	5 100	10 645	416
1987–88	4 200	-	5 100	9 300	400
			Total	28 545	

The cost of the mosaic control programme on the farm has increased steadily each season from approximately R76 per 1 000 tc during the 1983–84 season to about R400 per 1 000 tc for the 1987–88 season (Table 6). The largest factor contributing to the marked rise in cost from 1986–87 to 1987–88 was the establishment to the 10 ha nursery, the cost of which should be written off over a 10-year period.

Conclusion

The integrated mosaic control programme that was introduced in 1982 substantially reduced the level of mosaic on the estate. Without such a programme the current level of mosaic infection in the fields could have been far more serious and the cost in terms of lost revenue substantial.

If the mean level of mosaic on the farm had not increased but remained at about 20%, as it was between 1982–84, then the current loss in revenue, based on the mean yield for the farm for the past 6 seasons, could be estimated at about R47 000 a^{-1}. If it is assumed that the mosaic control programme reduced the level of mosaic on the farm to a mean value of 12,2%, as it was estimated to be over the last 3 seasons, then the mean annual loss of revenue would decrease to about R29 000. This represents a saving of R18 000 a^{-1} and a total saving of R90 000 over a five year period. The cost of the operation was R28 500 for the same period.

The role that the new mosaic-resistant varieties have played in the programme must be emphasised, especially as there is no direct cost for acquiring new varieties. Individual field records have shown, for example, fields of NCo293 and NCo376 with mosaic levels of infection ranging from 50 to 100%; whereas fields of N12 and N11 planted in close proximity have had levels of 5 and less than 1%, respectively.

Despite the relative resistance to mosaic of the newer 'N' varieties these may still become infected. For example, a mosaic level of 29% was recorded in a field of second ratoon N12 during the 1987–88 season. Growing alongside this was a plant crop of N12 which had a level of 1,9% mosaic infection. Apart from the difference in time of establishment, the main difference between the two crops of N12 was that the cane with the low mosaic level originated from a well-managed nursery and the other did not.

The benefits of early planting, other than achieving a well-established crop before the aphid populations increase, is again difficult to quantify. Ever since 1984 all planting on the estate has been completed before the end of October.

The experience on the estate also illustrates that even shallow mouldboard ploughing in winter is not totally effective in eradicating the old crop, and thus a follow-up operation using labour with vine hoes or mattocks is essential either before or after planting.

Increasing annually the area replanted to less susceptible varieties is an important aspect of a mosaic control programme. However, this practice is expensive because each additional ha planted represents a cost of about R1 700 to the farm, and for this reason it was rejected in this instance.

The interdependence of all aspects of this particular control programme clearly illustrates the need for an integrated approach to disease control, and highlights the need to combat mosaic with every method available.

The recording of disease levels in individual fields revealed some anomalies which are not easy to explain. For example, the levels of mosaic in NCo376, a highly susceptible variety, have remained at a very low level in some of the very late stage ratoons. Variety N12, a moderately resistant variety was infected to a level of 9% mosaic in a first ratoon under nursery conditions; and on occasions fields of NCo376 with 100% mosaic infection still yielded reasonably well, when observation plots and yield trials with similar levels of disease suffered severe yield depression. It is clear that other factors such as climate, stage of growth when infected and season of planting and harvesting are all likely to affect the extent of crop loss. Nevertheless, the control programme described is clearly effective and it is likely that the levels of mosaic will continue to decline.

Acknowledgements

We thank Mr QV Mann for valuable assistance and guidance and the owner of the estate, Mr P Garlick for permission to use the data.

REFERENCES

1. 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.
2. Bailey, RA and Fox PH (1987). A preliminary report on the effect of sugarcane mosaic virus on the yield of sugarcane varieties NCo376 and N12. *Proc S Afr Sug Technol Ass* 61: 1–4.