

SOME FACTORS INFLUENCING THE SPREAD OF SUGARCANE MOSAIC IN NATAL

By A. McMARTIN and N. C. KING.

Since the discovery of mosaic on the variety Co.281 a few years ago an attempt has been made to determine the extent of the outbreak, the varieties affected, the effect on the cane, and any factors which may be contributory in determining the spread of the disease. To assist us in this work the services of several government inspectors of the Division of Botany and Plant Pathology were made available for a period during the two years 1946 and 1947, and a permanent inspector is now engaged in continuing the work. As a result of this and our own investigations it has been possible to obtain a picture of the position as it appears today.

Distribution of the Disease.

The disease is distributed generally in scattered areas throughout the South Coast, but none has been found between the Umkomaas River and Durban.

It has been found in greatest intensity on the inland side of Umzinto, where some individual heavily infected fields were discovered. Nowhere else has such a high incidence been encountered.

It occurs at Port Shepstone, and at one or two points between there and Umzinto.

In 1946 none was found in the newly developing cane growing area at Eston and the surrounding district, but in 1947 a small outbreak was located there.

On the North Coast, the disease has been found mainly between Avoca and Stanger, the heaviest outbreak occurring on the north side of the Umdhloti river, near the sea. The areas north of Stanger are comparatively free, very small outbreaks having been found only at Empangeni, Eshowe and Nkwalini, involving not more than five farms with a very small number of infected stools on each. North of Empangeni no mosaic has been found.

An interesting feature of the distribution of mosaic is the manner in which it is absent, with the exception of about two points, from fields near the sea. This may be due either to the absence of conditions for its spread, or to the cultivation mainly of Co.301, which appears more resistant.

The disease appears to occur more frequently in broken country inland, particularly where areas of indigenous bush have been left, and where large amounts of *Setaria sulcata* may be found, mainly infected with mosaic. The distribution of mosaic is shown on the accompanying map which shows

the areas in which it has been found, but does not attempt to indicate the number of diseased stools in any area.

Severity of the Disease.

As has been stated, the largest numbers of diseased stools have been found in the Umzinto district, where the incidence in portions of some fields was as high as 90 per cent. At the other extreme were some fields in other districts where only one stool was found; although other diseased stools were possibly present, but undetected, it indicates nevertheless an incidence of infinitesimal proportions. Generally speaking, however, the outbreaks in most districts were of only moderate proportions. In some infected areas during 1947 an increase in the number of infected fields was apparent and a spread occurred into some farms in which during the previous year no disease was reported. The incidence in young plant cane however, was generally less in 1947 than in 1946, showing much greater care in the selection of planting material.

Mosaic in some other countries is known to exist in different strains, exhibiting different degrees of aggressiveness, but no evidence has yet been forthcoming that in Natal more than one strain exists. Plants which have been collected showing symptoms deviating from the normal have been replanted at the Experiment Station and have produced markings typical of those usually found.

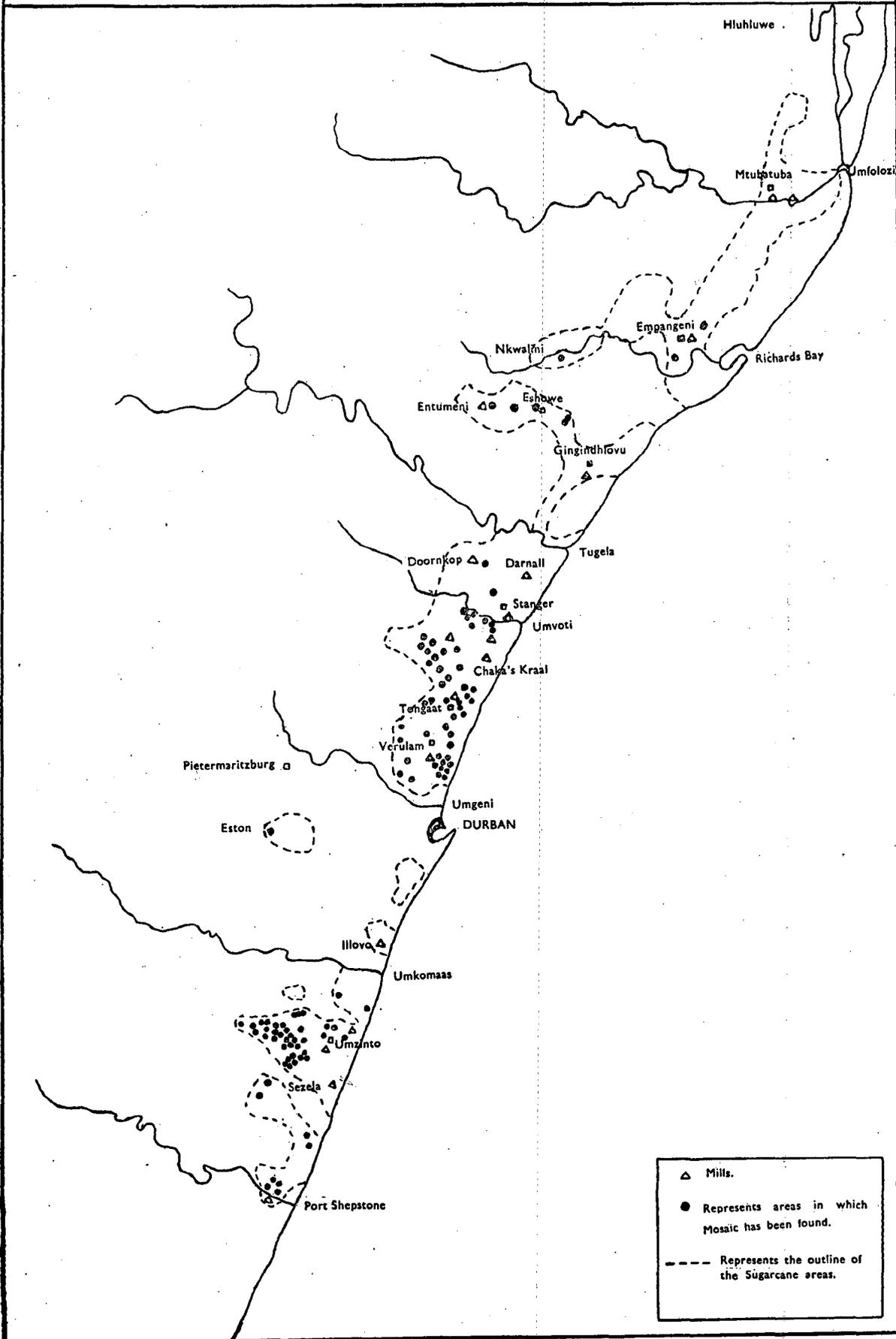
An apparent intensification of the mosaic pattern on some leaves may be produced when the plant is subjected to cold, and in frosty areas severe looking symptoms may be produced, which disappear with the return of normal weather conditions; it has also been shown experimentally that an application of sulphate of ammonia could alter certain yellow-looking mosaic types to normal.

The effect of mosaic on the vigour of the affected plants appears to be negligible, at least on the varieties Co.281 and Co.301, the varieties on which the behaviour of the disease has been most subjected to observation. It would appear therefore that these two varieties although susceptible, are tolerant towards the strain of mosaic at present in Natal.

Varietal Susceptibility.

Mosaic has been found mostly on Co.281, less on Co.301, and a little on Co. 331. Some cases have also been found on N:Co.310.

DISTRIBUTION OF SUGARCANE MOSAIC IN NATAL 1946-47.



Climatic Factors and the spread of Mosaic.

Mosaic is spread in two ways, (1) primary infection, by means of infected cuttings and (2) secondary spread from infected to healthy plants by means of the maize aphid, *Aphis maidis*.

It has been obvious during the years under consideration that primary spread accounted for many of the highly infected fields, but it has also been apparent that secondary spread has also been playing a not unimportant part. It was obvious in some young fields that the amount of infection was much higher than could be accounted for by replanting from an infected field where the amount of infection in the seed cane was known.

This suggested that perhaps a greater frequency of the insect vector in the cane fields than previously was occurring, a condition which may have arisen owing to the drought, sugarcane remaining greener than most of the natural grass flora during these years, and perhaps being more attractive than the normal food plants. An additional important factor, also attributable to the drought, was the increase in maize growing in the cane areas, during the years of short supply of that crop.

Maize Growing and Mosaic.

From a survey of the distribution and incidence of mosaic, it was very suggestive that where maize was interplanted with cane, and a focus of infection

existed, either as some already infected cane, or infected *Setaria sulcata*, a rapid increase in the number of infected cane plants was experienced.

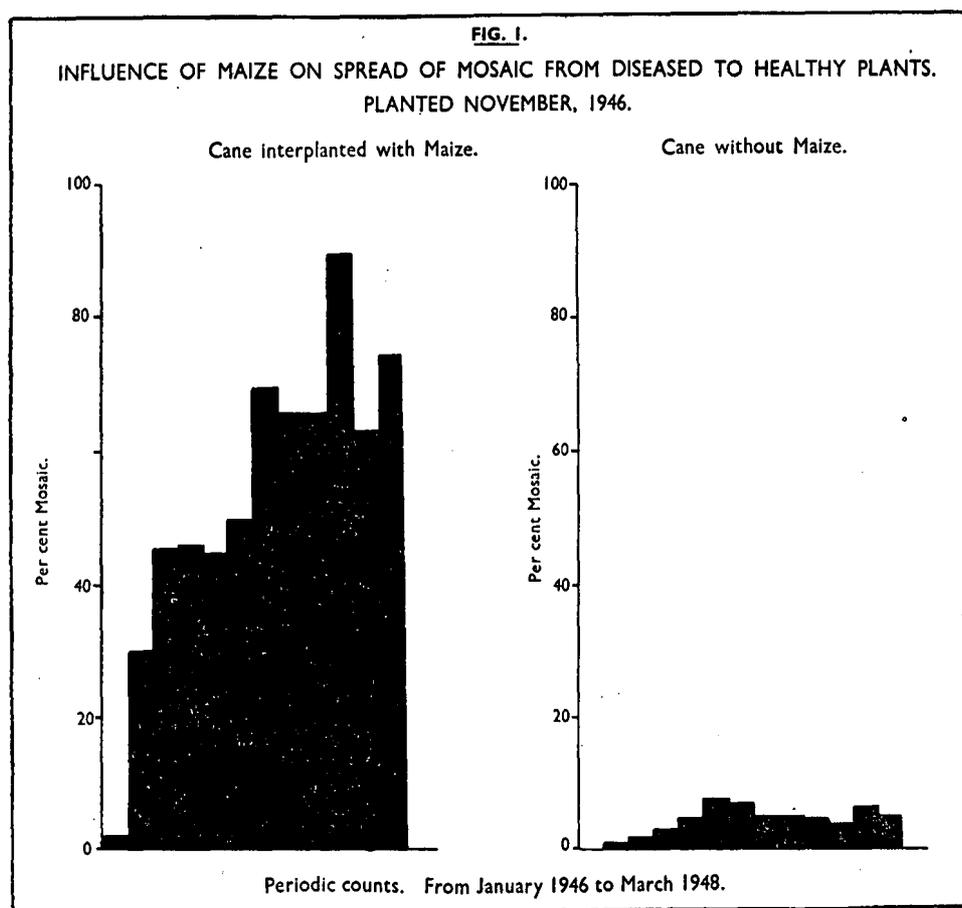
Where foci of infection existed, but maize was not growing, the mosaic increase was slight; where maize was grown, but no diseased grass existed, no disease was found in the cane. Thus it was suspected that a large and increasing outbreak could be built up by firstly, planting diseased setts and secondly interplanting with maize. The reason of course, is that the insect vector breeds on maize, but not on cane.

Experimental evidence on the relationship between mosaic and maize growing.

An experiment to investigate this relationship was planted at the Experiment Station in November, 1946.

Two plots, some distance apart, were planted with Co.281, consisting of alternate lines of healthy and mosaic infected setts. Each line consisted of 25 4-budded setts. One plot had maize interplanted with the cane, the other had not.

At a very early stage, when the young shoots were about one foot high, mosaic appeared in the mosaic free lines in the plot with maize and rapidly increased: the first appearance of the disease in the other plot was later, and the increase much smaller.



The increase of the disease in the initially healthy cane is shown in the diagram (Fig. 1.) At present, the plot which had the maize has now 75.3 per cent. of infected canes among those planted from healthy setts, while the plot without maize has only 4.8 per cent. of infection.

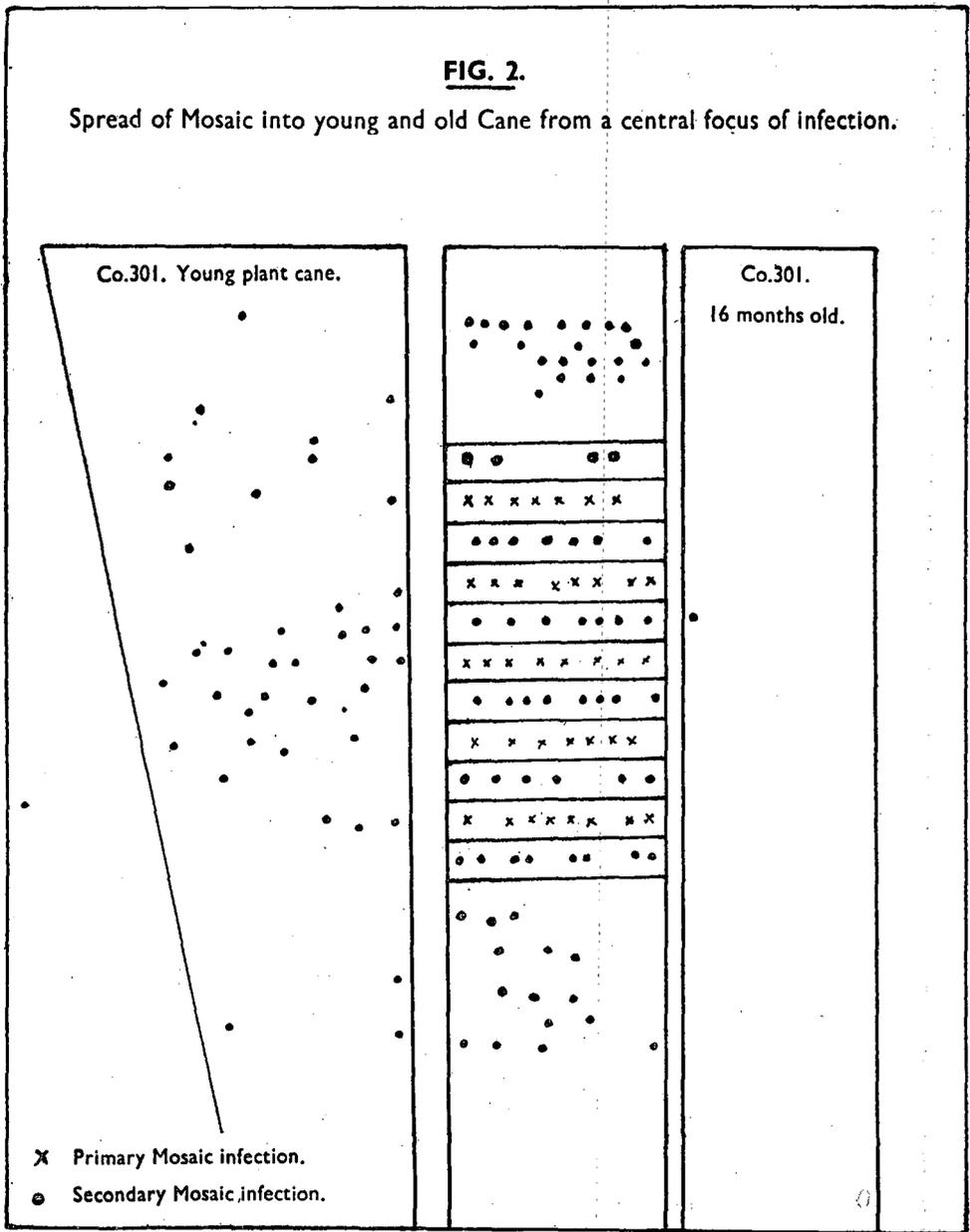
An interesting feature of this experiment was the manner in which the disease spread into the cane surrounding the plots, particularly again in the case of the one with the maize.

This plot is diagrammatically represented in Fig. 2, the dots representing the new infections which have spread from those planted with the disease, marked with an X. To the left of the plot is a field of Co.301 planted at the same time as the experiment, while on the right is some Co.301 planted the previous

season. As is seen many new cases arose in the young cane, but only one in the old; this has also been found in Louisiana, that spread is much more rapid in young than in older canes.

This experiment clearly demonstrates, then, that the interplanting of maize with cane can lead to a rapidly increasing outbreak of mosaic, at least when some foci of infection of the disease exist.

Another injurious effect of this practice is that of the maize on the vigour of the cane, apart from the spread of mosaic; this is illustrated by the accompanying photograph (Fig. 3). taken at the edge of the plot which had maize interplanted, and showing some adjacent lines of Co.281 which had no maize.



Use of Interplanting to Test Varietal Resistance.

Following the results obtained in this trial, a similar experiment was planted using different varieties; these consisted of lines 12 feet long planted with healthy setts, alternated with mosaic infected Co.281, and interplanted with maize.

The results in the following table show the development of mosaic in some varieties in different degrees of severity, and its absence in the other, immune varieties. At a year old the lines were cut down, and the mosaic incidence in the young ratoons recorded.

Variety.	PER CENT. MOSAIC SHOOTS.				Increase or decrease.
	One month after planting.	At a year old.	Ratoon at 2 months.		
Co.290 ...	0	0	0	0	0
N.M.168...	0	0	2	+ 2	
N.M.179...	0	0	2	+ 2	
Uba... ..	0	0	0	0	
P.O.J.2725	0	3	1	- 2	
Co.301 ...	0	6	4	- 2	
N:Co.151...	0	7	5	- 2	
N:Co.292...	0	10	5	- 5	
N:Co.310...	0	16	11	- 5	
Co.281 ...	0	17	70	+53	
Co.331 ...	0	21	9	-12	
N:Co.349...	0	39	6	-33	
N:Co.291...	0	43	89	+46	
N:Co.154...	0	54	35	-19	
N:Co.79 ...	0	85	98	+13	

This technique for testing resistance towards mosaic is simple and appears to give satisfactory results.

It will be seen from the table how Co.281 is much more susceptible than Co.301 and Co.331 and moreover has shown a large increase in diseased shoots on ratooning, where Co.301 and Co.331 have decreased. N:Co. 310 likewise has shown some decrease on ratooning.

Recovery of Diseased Plants.

The phenomenon of natural recovery of diseased plants has been noted previously with some canes infected with streak disease, and also now with some cases of mosaic disease. Thus when mosaic was first found on Co.301 a line of infected setts was planted, several of which however gave rise to healthy shoots. This line has now 58 per cent. of healthy canes. A line of Co.281 planted with diseased setts gave rise to entirely diseased shoots, but has now 4 per cent. of healthy canes after 18 months.

The naturally occurring germination recovery of Co.301 was demonstrated in a pot experiment carried out to test the effect of a hot water treatment on mosaic infected setts, this treatment having been found beneficial for another virus disease, chlorotic streak, in other countries.

FIG. 3.



Photograph showing the effect of interplanting sugarcane with maize.
To the right of stick, no maize interplanted. To the left of stick, maize interplanted.

Three-budded setts with mosaic were given the following soaking treatment:—

50°C for 30 and 60 minutes.

53°C for 30 and 60 minutes.

56°C for 20 and 40 minutes.

59°C for 20 and 40 minutes.

The varieties Co.281 and Co.301 were used, and five setts of each treatment were planted in tins.

The following table shows the results:—

	Co.281.		Co.301.	
	No. of shoots out of 15.		No. of shoots out of 15.	
	Germin-ated.	Mosaic free.	Germin-ated.	Mosaic free.
Control	15	0	10	3
50°C for 30 min. ...	15	0	14	4
50°C for 1 hour ...	12	0	11	1
53°C for 30 min. ...	14	0	15	9
53°C for 1 hour ...	10	0	7	3
56°C for 20 min. ...	7	0	3	0
56°C for 40 min. ...	1	0	2	1
59°C for 20 min. ...	0	0	0	0
59°C for 40 min. ...	0	0	0	0
Total	74	0	62	21

Thus no treatment affected the mosaic on Co.281, but on Co.301 some recovery occurred in the untreated setts, bearing out the field observation previously referred to.

Field observations have also demonstrated recovery of diseased shoots of N:Co.310.

Compost Treatment and Recovery from Mosaic.

To test the effect of manuring the ground with compost on the recovery of diseased setts, and also on the spread of the disease into healthy plants, some compost kindly supplied by Mr. Dymond was applied at the rate of 20 tons per acre to alternating pairs of lines of Co.281 (one diseased and one healthy line in each pair), in the maize free plot referred to previously.

Thus in the plot there was healthy cane planted with and without compost, and diseased cane with and without compost.

The recovery from mosaic in the compost and the non-compost lines was nil, and at present the lines planted with healthy cane show an incidence of 6.2 per cent. of mosaic in the composted lines and 3.3 per cent. in the untreated lines.

The germination of the cane without compost was 44 per cent. and that with compost was 61 per cent. while the response to the latter in growth and vigour was much marked and easily discernible by eye, but has not yet been accompanied by any decrease in the incidence of mosaic disease.

Summary.

Sugarcane mosaic disease at present is distributed throughout the South Coast and in the North Coast as far as Stanger, but from there northwards has been found only as a few isolated cases. Generally near the sea it is absent, and is of greater frequency in inland areas, particularly near areas of indigenous bush, where large quantities of the grass host *Setaria sulcata* abound.

No evidence of different strains of the disease has been found, and the disease as yet appears to do no harm to the widely grown varieties Co.281 and Co.301. The recent droughts are suspected to have influenced the spread of the disease, and a relationship between maize growing and rapid increase of mosaic was suspected, and has been demonstrated experimentally. This technique, i.e. interplanting maize with cane, is being tried as a means of variety testing.

Field observations show that a certain amount of natural recovery may take place, and with Co.301 has also been shown experimentally that germination recovery may occur. The hot-water treatment or manuring with compost, has had no effect on germination recovery.

Experiment Station,
South African Sugar Association,
Mount Edgecombe,
March, 1948.

The PRESIDENT said that the paper just read he commended for serious consideration because it summarised our present information gained from years of experimentation and field observation.

Dr. DODDS reminded the meeting that the status of Mosaic disease had changed within the past ten years. When the Experiment Station was started, mosaic was rightly regarded with a great deal of alarm. Since then varieties of cane and strains of the disease have changed, and present varieties are of hybrid constitution and far more tolerant, so little injury is now caused. We are fortunate in having a strain of the disease which hitherto was not very virulent. In Louisiana at least that is not so, and varieties such as Co.281 and Co.290 suffer severely. Hawaii seemed to have similar conditions to ours as regards strains of mosaic, and little injury is caused by the disease in that territory.

The original policy here was to aim at the ideal of eliminating the disease entirely. That was found to be impracticable however, and apparently mosaic will always be with us, but not, we hope, in such an acute form as previously.

Mr. RICQUEBOURG said that he was one of the planters guilty of interplanting maize with cane.

He did that because of the shortage of food for his labour. No ill effects were found however on his farm by government inspectors. Mosaic seemed to disappear as cane grew older.

Mr. POLLOCK remarked that whereas eighteen months ago he could find but little mosaic, during that period it had become prevalent in Co.301.

Mr. DYMOND asked Dr. McMartin if he could explain why a certain field showed such an irregular stand. It had been dotted with clumps of bush prior to planting and now where the bush had existed previously, the cane was deep green and much higher and bigger than on the surrounding areas. Might the poorer cane be infected with mosaic?

Dr. McMARTIN in reply stated that the field had been inspected and no mosaic was found and he suggested that the richer areas might have been the sites of old ant heaps. Another possible factor might be the fact that there was a certain amount of water-logging and the better cane was that growing on higher ground.

Mr. STEWARD asked Dr. Dodds if there was now no reason for alarm about mosaic and if it were safe to do nothing about the disease.

Dr. DODDS replied that it was still necessary to use the best setts for planting from every point of view, including freedom from disease.

Mr. COLEPEPER thought it advisable that it should be remembered that the strain of the disease might become virulent as had happened in Louisiana and Hawaii. He would ask Dr. McMartin if he could shed any light on this aspect of the disease in this country.

Dr. McMARTIN said that like any other virus disease, mosaic was liable to become virulent without warning. At the moment, as Dr. Dodds had said, mosaic did not appear to have reduced yields. The new varieties now being grown were tolerant, but long continued growth of a tolerant variety meant keeping the virus going, and there was the possibility of a virulent strain developing. The greatest spread in a crop was in its young stages and therefore it was necessary to plant only healthy cane. Although at the moment the disease might not have any harmful effect, its ill effect might become apparent in future crops.

Mr. DU TOIT asked Dr. McMartin if any significance could be attached to the figures he quoted about increase in infection in various varieties at a year old and at two months' ratoons. Furthermore, if there were any significant difference in the per-

centage of infection in compost treated as against no-compost plots.

Dr. McMARTIN, in reply, explained that although there was more infection in the compost treated plots, the incidence of the disease in these plots was so scattered, that all one could say was that compost had made no difference to the spread of the disease. As there was only a single plot of each variety in the maize interplanting test he had no means of estimating statistical significance of the difference between varieties. Regarding the variety trial, there would probably have been a statistical difference between varieties had the experiment been done on a larger scale with sufficient replication.

Dr. DODDS drew attention to the fact that Co.290 had proved very resistant. In past years it had shown a slight amount of infection and was one of the varieties recently severely affected in Louisiana. It was rather discouraging to see that some of our promising N.Co seedlings exhibited a high degree of infection.

Mr. RICQUEBOURG mentioned that germination of Co.301 had been poor in the past planting season which should have been a good one for germination. He wondered if mosaic might be a contributory cause.

Dr. McMARTIN said that the trouble was more likely to be fungus attack which had destroyed the young shoots of the germinating setts.

Mr. FIELDING asked for more information on the influence of compost on germination.

Dr. McMARTIN replying, said that compost had obviously produced much better young cane. He could not, from the test, calculate significance, but in any case compost had not resulted in any improved resistance to mosaic.

Mr. RAULT enquired whether any information was available as to the effect of mosaic on sucrose content or purity of cane.

Mr. DU TOIT said that one such test had been done on cane from the South Coast. In this test there was no apparent difference between healthy and mosaic infected canes as far as sucrose percentage or juice purity was concerned.

Dr. McMARTIN stated that one would not anticipate any reduction in sucrose content or juice purity due to mosaic. Any ill effect of the disease would more likely result in a diminution in yield of cane per acre rather than of sugar per ton of cane.