A CRITICAL COMPARISON OF METHODS OF TESTING FOR RESISTANCE TO MOSAIC

By N. C. KING and J. DICK

During the latter part of 1953, seedlings of the N.50 series were subjected to a routine mosaic test in the field. This was carried out by planting alternate lines of mosaic-infected canes and new varieties, the whole area being then planted with maize to ensure the presence of a supply of aphid vectors. At the completion of the trial, it was noticed that only a very few varieties were infected with mosaic, and it was considered possible that the method of testing might have been at fault. Consequently, these varieties were artificially inoculated in the glasshouse, and the marked differences between the results of the two trials indicated the necessity for further investigation of the validity of different methods of testing.

This series of varieties has now been subjected to replicated trials with four methods of testing: the original field method as described above; field tests from which mosaic-infected cane was omitted, but in which the maize planted with the cane was infected by inoculation; glasshouse tests in which the cane was artificially inoculated by the abrasive method; and glasshouse tests in which aphids derived from mosaic-infected maize were caged on the plants. Of these four methods, the second and third were included in trials repeated during both the 1954-55 and the 1955-56 seasons, and certain other varieties, whose reactions to mosaic were known, were included as controls.

In the field trials, care was taken to ensure that aphids were present in all lines, and, where these did not appear naturally, they were introduced from maize in other fields.

The results of all these trials are summarised in Table I, in which, with the exception of the first column, the figures represent the ratios between mosaic-infected and total shoots expressed as percentages. In the first column, representing the results of field tests during the 1953-54 season, percentages have been calculated for infected stools and the figures are, therefore, somewhat higher than they would have been for individual shoots.

TABLE I

Summary of Results

Percentage of Mosaic Infection

Variety	Field 53/54	Field 54/55	Field 55/56	Artificial 54/55	Artificial 55/56	Caged Aphids 55/56
50/59	0	0	0	25	5	16
83	1	1	0	95	87	10
85	10	1	6	81	77	45
87	0	0	0	44	0	0
90	10	4	0	55	47	53
91	1	1	3	60	87	42
93	–	0	1	—	29	40
95	0	0	1	70	33	0
121	0	–	–	93	—	—
123	0	0	0	30	78	13
156	0	0	1	70	96	0
167	0	0	0	5	0	0
177	40	8	22	77	100	87
191	14	–	–	43	—	—
211	0	0	0	33	14	15
215	0	0	0	0	0	0
N.10	–	0	0	6	50	18
N.19	–	4	3	75	80	16
N.Q.1	–	0	0	42	81	62
N.Q.2	–	0	0	0	33	16
Co.281... ...	–	9	23	—	48	83
N:Co.310 ...	–	0	0	—	20	48
N:Co.339 ...	–	–	9	—	51	100
N:Co.349 ...	–	10	12	—	87	100
N:Co.376 ...	–	0	1	—	87	61
N:Co.382 ...	–	0	0	—	24	10

Note—A blank space indicates that the variety was not included in the particular trial.

From these figures it was apparent that the incidence of mosaic in field tests was considerably lower than that resulting from either of the other methods. In the field, although a source of infection and a population of vectors were provided, there was no means of ensuring that infective aphids actually fed on each individual plant. In the artificial method, each shoot was treated with the inoculum while, in cage tests, fairly large populations of infective aphids were isolated with relatively small numbers of shoots of the variety concerned, and no alternative food-plant was available.

In addition, comparison of the results of the two methods carried out in the glasshouse indicated that, of twenty-four varieties tested concurrently, eight were significantly more readily infected by artificial inoculation, while three were more readily infected by caged aphids.

The hypothesis is thus suggested that a variety might be inherently, or genetically, capable of developing mosaic, but might not, under natural conditions, become infected on account of some factor making it either less attractive to the aphid vector or difficult for its mouthparts to penetrate. A preliminary attempt at discovering whether *Aphis maidis* showed any varietal preference gave negative results although, under glasshouse conditions, incipient colonies of the aphid have been seen on N:Co.339, the only variety grown in Natal on which this has been observed. Further investigations on this aspect of the problem are considered desirable.

This investigation was undertaken primarily to obtain information on the most suitable method for studying the mosaic reactions of new varieties. From the results, it would appear that artificial inoculation, although it is probably the most reliable means of revealing the inherent ability of a variety to develop mosaic, may produce misleading results, from the practical point of view, by forcing infection on a variety which would not develop the disease under natural conditions.

The cage method, although somewhat nearer to what occurs in nature, is still artificial since aphids caged with a particular variety, with no alternative food-plant, must perforce feed on the variety provided, if they are to feed at all. Here, also, infection may be forced on a variety which would normally remain free. In an experiment on streak disease of maize, carried out in 1954, it was found that many varieties which were considered to be resistant, were just as readily infected as varieties known to be susceptible, when caged with infective leafhoppers.

It will be noticed that, of the twenty-six varieties studied, only one, a variety selected for breeding and not for commercial cultivation, appeared completely immune. If the results of artificial inoculation or of caging were to be used as criteria, very few of the remainder would be regarded as sufficiently resistant for cultivation and most of the released varieties included as controls would be condemned.

The two field methods are not adequately compared in this set of trials, but previous experience and theoretical considerations suggest that they should yield comparable results since, in both, a source of infection and a population of vectors are provided. The older method, in which lines of mosaic-infected cane alternate with lines of the varieties undergoing testing, requires more land and, largely for this reason, has been given up in favour of the method in which the mosaic-infected lines are omitted and the maize, which is planted in the cane-rows, is artificially inoculated.

This latter method has here given results which are reasonably consistent and, for the released varieties included as controls, approximate closely to agricultural experience. It is therefore concluded that this method should continue to be used but, since it may allow some degree of susceptibility to pass unnoticed, that too much reliance should not be placed on the results of a single trial.

Summary

Before deciding on the release of new varieties of sugarcane, a factor which must be investigated is their susceptibility or resistance to infection by mosaic disease. This paper discusses results obtained by various methods of testing for this factor, either in the glasshouse or in the field. The conclusion is suggested that artificial methods may produce misleading results by forcing infection on varieties which might not, under natural conditions, become infected.

Experiment Station
South African Sugar Association
Mount Edgecombe
June 1956

Dr. Dick, who read the paper, explained that one aspect of the selection of new varieties of cane consisted of tests for resistance to certain diseases, including mosaic. The present paper was the result of attempts at deciding on the most suitable method of carrying out such tests.

Dr. Van der Pol (in the Chair) said that this was a most important subject, for the selection of new resistant varieties was of invaluable benefit to the sugar industry.

Dr. Dodds said that South Africa as yet has not suffered very severely from mosaic disease, but it has been a constant threat ever since Uba went out of cultivation. The disease had proved very serious in other countries, for instance Louisiana, where in the year 1923 the crop was reduced to a quarter of its

normal size mainly through the inroads of this disease. Dr. Dodds, referring to Table I, pointed to the big difference between column 2 and column 3. This could be expected because seasons varied, but comparing columns 4 and 5, a very high degree of correlation was observed. This might point to the fact that our newer seedlings were much less susceptible than were the previous, earlier ones. He asked whether any alternative vector to *aphis maidis* had been found in this country.

Dr. Dick stated that, in other parts of the world, at least two other species of aphids had been shown to be able to transmit mosaic. He had not been able to discover whether these insects occurred in Natal, where *Aphis maidis* was still the only known vector.

Mr. Main enquired about N:Co.349, which he said in earlier trials was discarded because of its susceptibility to mosaic. He asked which method was used for testing. He considered 349 a remarkable variety and he wondered if it should not be re-tested for mosaic resistance because the method used may have been faulty.

Dr. McMartin said not only was N:Co.349 very susceptible but it was also very intolerant. Co.281 was susceptible, but tolerant, that is to say its yield was not appreciably affected by mosaic. He regretted that more planters were not present at the meeting so that they could realise the enormous amount of work which lay behind the selection of varieties. The selection of Uba to control mosaic was easy to make because Uba was immune—in other words, it could not contract mosaic disease. The release of Co.281 was the subject of argument, however, because Co. 281 was not immune, but eventually it was released and proved one of the major varieties in the industry, and it was many years before any signs of mosaic were found in it. The same position applied to Co.301, and subsequent varieties. All the Co. and N:Co. canes which have been released are susceptible in varying degrees, but sufficiently tolerant that no appreciable effect on yield is noticed. The work done by Dr. Dick and Mr. King was necessary because although we knew that the varieties we wished to release were not immune, they were commercially resistant to the disease, and the best method of testing for this had to be found.

Dr. Dodds said that anyone who was not a plant pathologist found it difficult to identify mosaic disease because it varied in different varieties. In Portuguese East Africa he had seen varieties such as Co.290 and Co.281 severely affected by brown spot disease and therefore mosaic disease, if present, was not apparent but he had not noticed any N:Co.310 in that country which was affected noticeably by mosaic. However, it was difficult to notice and identify mosaic disease in various varieties and he wished that there was a more positive way of identifying it other than just visual observation. He had seen N:Co.339, for example, in Portuguese East Africa with very slight leaf markings that could possibly have been mosaic, but had done the cane no harm.

Dr. Dick said that mosaic existed in various strains. For instance, in N:Co.339 one strain was very difficult to see while another produced much more striking symptoms.

Mr. Thomson stated that, in more than one variety, different strains of mosaic disease existed. Some were very difficult to discern, while others were more obvious. He pointed out that the same strain of mosaic could cause different markings in different varieties. Another point of difficulty was that the markings on the leaves of cane could be caused by a mixture of more than one strain. A certain imported variety which had been used in America for sorting out different strains of mosaic had been tried here but it had not given satisfactory results.

Dr. Cleasby remarked on the fact that the variety 50/167 showed no infection except in one test. He asked why this should be so. He wondered if it might be that in the one case where it showed susceptibility this was due to a different strain of the disease.

Dr. Dick explained that, in testing seedlings, the inoculum was prepared by extracting the juice from the leaves of infected cane plants. In an attempt at ensuring that a mixture of strains would be present, leaves were collected from as many varieties as possible. In field tests, maize planted with the cane was also inoculated with a mixture of juice from many sources.

Mr. Rault stated that his Company had refrained from propagating a certain cane although it gave enormous yields because of its tolerance to mosaic and its possibilities as a carrier.

Dr. McMartin said that the mere fact that a variety was released showed that the Experiment Station had a considerable amount of confidence in it. He did not know if one had, say, a large area of N:Co.339 whether this would affect other varieties which were less tolerant. One could be misled on this point because on casual inspection it might appear that the less tolerant variety had been infected by N:Co. 339, but this might have been due only to a general all-round increase in aphid population. He pointed out that in field plot experiments, where N:Co.349 suffered very badly, N:Co.310, for instance, was able to shake off the disease in ratoons although it was planted near to the susceptible variety N:Co.339.