GUMMING DISEASE OF SUGARCANE IN NATAL

By G. M. THOMSON

Introduction

Gumming disease of sugarcane, caused by the bacterium *Xanthomonas vasculorum*, is the second disease of bacterial origin to be recorded in Natal. The first was red stripe disease which has been known in this country for some considerable time. However, in the light of our present knowledge of gumming disease, it is thought probable that many of the cases identified as red stripe disease may in fact have been the mild stages of gumming disease.

Towards the latter part of 1956 the Experiment Station was asked to investigate the possible cause of growth failure and general lack of vigour in a field of N:Co.310 plant cane in the Doornkop area. This particular field had been known in the past as a problem field but it was thought that matters had definitely taken a turn for the worse. The cane at the time was twelve months old but showed extreme stunting and presented an overall chlorotic appearance.

Subsequent investigations proved this to be a case of gumming disease in its acute phase. Further field inspections were carried out in the area and it was found that the disease was present on a number of the surrounding farms.

Gumming Disease in Other Countries

Gumming disease was one of the first plant diseases to be recognised as being of bacterial origin, and was the first disease of sugarcane proved to be caused by a bacterium. At times it has been considered to be among the most serious diseases of sugarcane in many countries.

It has been suggested, though not proved conclusively, that gumming disease originated in Brazil. Recently the opinion has been expressed that the disease has been present in Mauritius for many years. It has also been recorded in Australia, Fiji, Madeira, the British and French West Indies, Colombia and Puerto Rico. The disease occurred at times in some of these countries in the form of severe epidemics.

Supposed History of the Disease in Natal

The origin of gumming disease in Natal is somewhat obscure. Strict quarantine restrictions have been in force for about 30 years and it seems unlikely that the disease could have escaped notice in cane importations since those measures were instituted. A more likely explanation is that the disease was introduced at a time when there were no such restrictions in the importation of varieties from other countries. Why, then, has the disease not been noticed before? The answer to this probably lies in the cultivation, until about 11 years ago, of varieties that exhibited commercial immunity or resistance to the disease. With the release of N:Co.310 in 1945 a more susceptible and less tolerant variety was put under cultivation. A high degree of infection has apparently built up in this variety since then. With the advent in 1956 of weather conditions suited to the increased development and spread of gumming disease events took a serious turn. Hence the appearance in the Doornkop area of the disease in its acute phase.

Symptoms

There are two phases of the disease—mild and acute. Each phase shows more or less distinct symptoms though the symptoms of each may be found on a single plant.

The symptoms of the mild phase are confined to the leaves of the plants and take the form of yellow stripes with a scattering of reddish dots or specks. The stripes, which are of varying length, and up to one eighth of an inch in width, develop from the infection site towards both the tip and the base of the leaf following the veination of the leaf. In the mild phase of the disease these stripes do not develop further than the junction of the leaf blade with leaf sheath. When the leaf dies in the normal course of plant development, the disease is carried away with the leaf when the latter is shed as trash. However, prior to this, the disease may have spread to neighbouring plants. This completes the cycle of the disease in cases of mild infection, the symptoms of which are shown in Fig.1.

Sometimes the infection passes from the leaves into the stem by way of the leaf sheath, producing systemic infection or the acute phase of the disease. Systemic infection can be discovered by cutting the affected stem across or longitudinally. The symptoms consist of a slow oozing of yellow or yellow-red gummy material from the cut ends of the vascular or food-conducting elements of the stem. Sometimes, however, the bacteria are not active and this exudate is not readily produced. The oozing can be induced artificially by placing the sliced cane in an air-tight container for about half an hour after which time the gum can be seen oozing from the cut surface.

In advanced cases of systemic infection cavities are formed in the stem tissue especially in the softer parts in the vicinity of the growing point. These cavities are filled with the gummy material (see Fig. 2). The latter can also be found on the inner surface of the leaf sheaths of affected stems.

A further leaf symptom consists of chlorosis in the form of white patches of varying shape and size (see Fig. 3). This is a secondary symptom in that it is produced by the action of toxins secreted by the bacteria.

In a systemically-infected shoot the bacteria often move from the stem into the leaves. This produces much broader stripes than in the cases where the infection originates in the leaves.

Means of Spread of the Disease

There are two types of spread of systemic diseases such as gummosis, viz. primary and secondary. Primary spread is brought about by the planting of sytemically-infected setts.

The production of leaf stripes in the mild phase of the disease, and the stripes produced from a systemically-infected stem provide means of dissemination of the disease. The bacteria ooze from these stripes and are transported to healthy leaves by wind-driven rain or mist. This is what is meant by secondary spread of the disease.

The leaf is apparently the main part of the plant through which infection of a healthy shoot takes place. Some sort of injury is necessary for the bacteria to gain entry into the tissues of the leaf. The injury, however, need be no more severe than that caused by the leaves rubbing against one another. It will be realised then that gumming is a highly infectious disease, and that given correct climatic conditions such as high atmospheric humidity in the form of mist or rain, the spread of the disease can be a very rapid process.

The Identification of Gumming Disease in the Laboratory

As mentioned above there are now two known diseases of sugarcane in Natal with bacteria as the causal organisms, viz. gumming disease and red stripe disease. The organisms responsible for these are *Xanthomonas vasculorum* and *Xanthomonas rubrilineans* respectively. These two organisms are different species of the same genus and are closely related. It has been suggested that the symptoms of red stripe disease and gumming disease can be confusing at times. This confusion can arise when considering the normal symptoms of red stripe disease and the symptoms of a mild gumming disease infection.

This close similarity between the two disease organisms has led to a certain amount of difficulty in the laboratory work which has formed a most important part of the studies in connection with the outbreak of gumming disease. All the specimens sent in for confirmation have had to be tested for the possible presence of *Xanthomonas vasculorum*. These tests have to be carried out under controlled conditions of temperature, pH etc., and involve the isolation of the organism from the diseased plant tissues. Once an organism has been isolated on an artificial medium it has to be sub-cultured on to fresh batches of medium a number of times until a pure culture is obtained. Then begins a series of biochemical tests in which the reactions of the organism to various chemical constituents of the media are investigated. These tests involve the culturing of the organism on media containing such substances as starch, fat, various sugars and alcohols.

It is only by comparing their reactions in these biochemical media that the organisms responsible for red stripe disease and gumming disease can be separated. In the many tests carried out so far it has been found that very often the two diseases occur together on the same plant.

The Incidence of Gumming Disease in Natal

Subsequent to the outbreak of gumming disease in the Doornkop area it was decided to carry out a spot survey of the sugar industry with the view to determining the incidence of the disease in the remainder of the sugar belt. The Chief of the Division of Plant Control and Quarantine very kindly offered the assistance of four additional plant disease inspectors for this purpose. These inspectors, in the three months at their disposal, visited a total of 687 farms. Of these approximately 14 per cent were found to be infected and about 74 per cent to be free of the disease. The balance are still suspect at this stage, by which is meant that either specimens were not sent for confirmation, or that laboratory tests have not yet been completed. Thus it is probable that the number of infected farms will be slightly greater than those already confirmed. At this stage it must be made clear that the inspectors had a very large area to cover, so that the figures reflect only the presence or absence of the disease. They give no indication of the severity of infection. However, it can be said that in no area was the cane as badly affected by the disease as that in the Doornkop area.

Varietal Susceptibility to Gumming Disease as suggested by the Survey

During the course of the survey carried out by the team of plant disease inspectors a total of 1,162 fields was inspected for the presence of gumming disease. Of these approximately 54 per cent were under N:Co.310. Of the diseased fields about 94 per cent were under this variety. The following table shows the number of fields inspected during the course of the survey. The fields are divided up according to the varieties concerned.

TABLE 1

Number of Fields of Each Variety Inspected and Found to be Infected or Free of Gumming Disease

	Co. 281	Co. 301	Co. 331	N:Co. 292	N:Co. 293	N:Co. 310	N:Co. 339	N:Co. 376	Total
No. of fields diseased	1*	—	—	—	1	99	2	2	105
No. of fields suspect...	—	—	—	—	—	83	—	—	83
No. of fields free ...	—	65	162	41	69	443	93	101	974
Total No. of fields inspected	1*	65	162	41	70	625	95	103	1162

* This case of gumming disease in Co.281 does not represent a whole field. The case was that of a number of volunteer stools of Co.281 in a field of N:Co.310.

The figures set out above indicate that, with the information at present at our disposal, N:Co.310 is definitely our most susceptible variety. It will also be seen that only very small percentages of the fields under other varieties were found to be infected with gumming disease. It is, however, too early to draw definite conclusions in the matter of the comparative susceptibility of the varieties now being cultivated.

Inoculation studies with this disease, using the more important varieties, are proceeding under glasshouse conditions at the Experiment Station. It has been found that artificial inoculation is a relatively simple matter and some idea of the susceptibility of the various varieties can be obtained. However the position cannot be assessed without following up these tests with further experiments under field conditions.

The Control of Gumming Disease

The survey of the industry has shown gumming disease to be fairly widely scattered over the industry especially north of Durban as far as Umfolozi. The South Coast has been found remarkably free of the disease as has the Pongola area. However, the lack of easily-recognisable symptoms does not allow one to assume the absence of the disease in such areas. It is thought that there is little cause for undue alarm at this stage. However, at the same time, an attitude of complacency would be short-sighted indeed.

The presence of gumming disease over such a large part of the industry tends to rule out eradication as a means of controlling the disease. The best method of control is by means of the cultivation of resistant varieties. Any measure of effective control by roguing and eradication would be difficult as long as varieties with a resistance below a certain level are planted.

At this point it might be as well to explain the difference between resistance and tolerance to a disease in plants. Resistance is based on the number of individuals which contract the disease, while tolerance is based on the extent to which a disease affects the individuals attacked. Despite a high percentage of infection good yields can be obtained by planting varieties susceptible to, but tolerant of gumming disease. However, by doing this, no progress is made in the way of controlling the disease. The disease is maintained by the constant reinfection of the crops although these suffer little by being infected. This harbouring of the disease in susceptible and tolerant varieties can cause a higher percentage of disease in any adjacent fields of more resistant canes. Experience in other countries has shown that, if a resistant variety is grown in close proximity to a field badly infected with gumming disease, the heavy bombardment of inoculum from that field tends somehow to break down the resistance of the other variety.[2]

Thus the most effective means of controlling a disease such as gumming, is by the cultivation of resistant varieties only.

This disease has appeared suddenly in our industry, and although we already have what might appear to be some resistant varieties, a great deal of work still remains to be done. All new varieties will have to be tested for their resistance to gumming disease.

Meanwhile temporary steps can be taken by the farmer. These depend on the severity of the disease in each case. In those fields in which a few isolated stools are found, the situation can be dealt with by the method of roguing out of the infected plants at the same time taking the necessary precautions to prevent the spread of the disease in the process.

In cases where whole fields are involved more drastic measures may be necessary. It may even be advisable to remove the crop altogether and to plough the field very thoroughly. If the crop is at a millable stage of growth then it should be burnt before cutting, and all plant remains must be removed after harvesting. The latter operation should be carried out with the maximum of thoroughness so that no volunteer stools arise to act as a source of infection to any future crop.

If the cane is not millable then an attempt must be made to assess the possible loss in yield if the crop is carried through to its normal stage of growth before harvesting. If the decision is to remove the crop without any further delay, then the cane must be cut down, allowed to dry out and then burned. After this the field must be thoroughly ploughed.

Any subsequent planting in such fields should be with varieties resistant to the disease.

Summary

With the appearance of gumming disease in this country attempts have been made to solve the mystery of its origin. It is thought that the disease

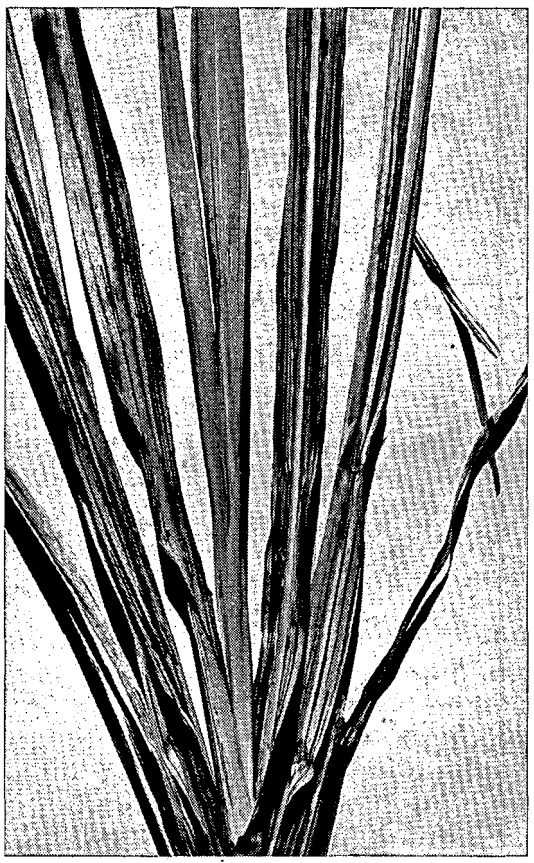

Fig. 1

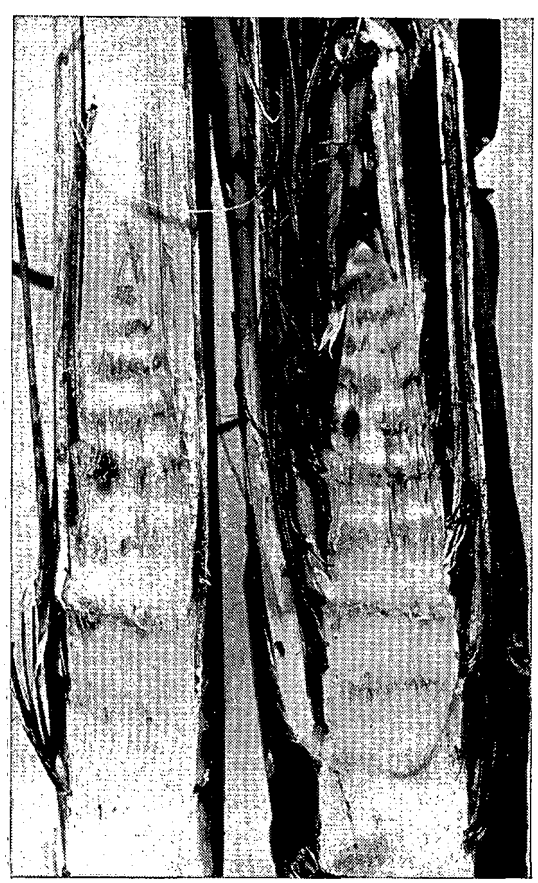

Fig. 2

Fig. 3

Fig. I. Leaves of N:Co.310 showing the leaf stripe stage of gumming disease. Note the large number of stripes some of which were found to have extended through the leaf sheath and into the stem.

Fig. 2. Showing the internal symptoms of stems systemically infected with gumming disease. Note the pockets formed by the action of the bacteria on the softer parts in the vicinity of the growing point. Gummy material can be seen exuding from one of these pockets.

Fig. 3. The chlorotic leaf symptom of gumming disease. This is the result of the action on the chlorophyll of the leaves by toxins produced by the bacteria.

has been present for some considerable time and that particular weather conditions have led it to assume its more easily recognisable acute phase.

A survey carried out by a team of plant disease inspectors has shown the disease to be more or less widely scattered over the sugar belt, being of more serious form in some parts of the industry than in others. At this stage there would appear to be little cause for undue alarm about this disease although at the same time there is little cause for complacency. The survey indicated that N:Co.310 is the most susceptible variety at this stage, and that there are in cultivation a number of what appear to be commercially resistant varieties.

The most effective method of controlling a disease such as gumming is by the cultivation of resistant varieties, and this will have to be borne in mind in future breeding policy.

Although the disease has been present in Natal for some considerable time, the unusual weather conditions that prevailed in 1956 were apparently ideally suited to the further development of the disease so that it appeared in the Doornkop area in its acute phase. Assuming that weather conditions play an important role in outbreaks of gumming disease, it seems likely that this disease will revert to its mild form with the advent of more normal climatic conditions in the future.

REFERENCES

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[2] Shepherd, E. F. S. (1937), The gumming disease of the sugarcane. Dept. Agr., Mauritius, Sci. Ser., Bul. 25.

The Chairman, Dr. A. McMartin, stated that this subject had had considerable publicity and we were now pleased to have first-hand information from Mr. Thomson. He had often wondered why the disease had never before appeared in Natal although it had been known in Mauritius for many years and we had received many cuttings from Mauritius before the days of quarantine. He said that the pathological department of the Experiment Station had done a lot of work on the subject and he also wished to thank the Department of Plant Control and Quarantine who had proved of enormous assistance by providing inspectors.

Mr. Udal wanted to know if all the farms on the South Coast had been inspected.

Mr. Thomson replied that while the whole of the South Coast area from Port Shepstone to Illovo had been examined it had not yet been possible to inspect every farm.

Dr. Dick remarked that Mr. Thomson had mentioned the cultivation of resistant varieties as an important control measure against the disease. He asked whether, in infected areas, it would be advisable to replace N:Co.310 with less susceptible varieties.

Mr. Thomson replied that the disease now appeared to be going into its dormant stage so he did not think it necessary to apply such drastic remedies. He would not recommend the elimination of N:Co.310 because of its susceptibility to gumming disease, especially as the most recent survey had shown that it now looked much more healthy and appeared to have thrown off the disease. The next season would prove whether this disease would become a real menace or if it had really gone back into the dormant stage.

Dr. Douwes Dekker enquired if this disease had been found in other plants in other parts of the world.

Mr. Thomson replied that it had been found in various grasses and bamboos and a disease of palm trees was also due to the same organism. He said that although this disease was likely to remain in the country for a long time it was not one of our most serious diseases.

Mr. Leclezio stated he had been informed by a pathologist that streptomycin and other antibiotics could cure the disease. He asked if anything had been done in this country along these lines.

Mr. Thomson replied that no such work had been done as yet. He had experienced trouble in the laboratory due to contaminants and he was seriously thinking of using antibiotics to control these.

Dr. Dick referred to a statement that the lethal temperature for the causal organism was in the neighbourhood of 50°C. He asked whether the hot water treatment recommended for the control of ratoon stunting disease would be effective also against gumming disease infections in cuttings.

Mr. Thomson replied that in the laboratory a temperature of 50° would almost instantaneously destroy the organism which causes the disease. He thought therefore that the normal hot water treatment would prove efficaceous in controlling both diseases.

Dr. Dodds said that as far as the susceptibility of different varieties was concerned he remembered that when Co.301 was introduced into Rhodesia it was found that this variety which was very susceptible to smut, infected others which were very resistant, and when the susceptible variety 301 was eliminated the disease died down again. He wondered if this would apply in the case of gumosis.

Mr. Thomson replied that while this might happen, he did not think it would prove to be a permanent feature.

Dr. McMartin said that in the particular case quoted by Dr. Dodds it should be remembered that

any misses which appeared in the fields were supplied with Co.301 irrespective of the variety grown in that field. This, of course, was a very severe trial for susceptibility for the other varieties. He felt that it was not quite fair to compare what took place under those conditions with what might occur under field conditions in Natal.

Mr. King asked if it were necessary to bath the labourers in "Jeyes" fluid.

Mr. Thomson said that considering the present state of the disease, he was not infavour of the idea. In areas near the coast where the disease had not shown severe symptoms it would of course not be necessary, but it might possibly become so in areas where the disease was severe.

Mr. Wyatt said that the picture given in the paper of the severity of the disease was rather alarming, but fields which were so bad before that they were condemned in October, now showed a marked difference and now appeared that they were going to give very good yields, after a period of only six months. The Doornkop area was surveyed when the diesease was at its worst, the rest of the industry was surveyed subsequently. If the whole industry had been surveyed in October the picture might have been very different. Similarly if the Doornkop fields had been surveyed today the disease might never have been noticed.

Dr. McMartin recollected that when he was in Mauritius resistance to gumming disease was one of the most important factors in seedling selection. He wondered if that applied today.

Mr. Leclezio replied that while this was still an important feature of their policy in seedling selection the disease which existed in endemic form, was not very serious in the field.

Mr. Barnes said that this disease was at one time present in Barbados but in recent years it had apparently disappeared. At one time it was insisted that seed cane introduced from that country be free from gumosis, but latterly the need for this precaution had disappeared.