

DISEASES OF THE BANANA*

BUNCHY TOP

BUNCHY Top differs considerably from the usual conception of a plant disease. It is not caused by a fungus or bacterial parasite, but an infectious agent or virus which is very much smaller than either of these. Although this virus cannot be seen by even a high powered microscope, it is known to live and multiply in the sap of the diseased plant. In most virus diseases the affected plant has no definite lesion such as a spot or rot, but is usually stunted and abnormal in foliage or fruit development.

In the case of bunchy top the leaves formed after infection are short and narrow with the margin distinctly up-curved. They fail to bend over normally and retain a stiff erect habit which, combined with the fact that the leaf stalk is greatly reduced in length, gives the characteristic rosetted appearance to which the disease owes its name. The foliage on such plants is crisp and brittle when crushed. A bunch is rarely produced unless infection has taken place late in the life of the plant.

Effective control of bunchy top necessitates recognising the disease in its early stages. A plant should be regarded with suspicion if the youngest leaves exhibit a light-green colour along the edge and have blades which dip back sharply from the midrib and curve in again conspicuously from the margin. A definite and unquestionable diagnosis can then be made by examining the base of the youngest leaf from the underside and with the light behind it. If the plant is infected there will be seen narrow dark-green lines, broken in a dot and dash manner or sometimes continuous, lying between and parallel to the clear veins which run out at right angles to the midrib. There is also often one or more wide dark-green streaks running down the outside of the leaf stalk near its junction with the pseudostem.

Bunchy top is spread in the plantation by the banana aphid when it sucks the virus-infected sap of a diseased plant and then leaves it and feeds on a healthy one. Aphids may travel considerable distances in the air, and this accounts for isolated outbreaks of bunchy top in plantations otherwise free from the disease.

In a single stool the virus from a diseased parent plant may travel in the sap stream down to the corm and thence out through the connecting tissue to the young suckers, which will in turn develop the disease, usually remaining in a stunted and rosetted condition. The possibility of sucker infection has an important bearing on the control measures discussed below.

* By J. H. Simmonds, M.Sc., Plant Pathologist in the *Queensland Agricultural Journal*, Vol. XLIII, Part 3, 1 March, 1935.

CONTROL

There is no known method of destroying the virus in the plant without destroying the plant itself, and hence anything in the nature of a cure is impossible; nor is it commercially practical to destroy all aphids in a plantation and so limit the spread of the disease by this means. It, therefore, becomes necessary to concentrate on eliminating the source of supply of the virus by exclusion and destruction of diseased plants.

Firstly, care must be taken that all suckers used for planting are free from bunchy top infection. The agents of the Banana Industry Protection Board are in a position to advise growers where suitable planting material may be obtained. They should also be consulted regarding the current planting policy, as a planting permit may have to be refused if the spread of bunchy top or other disease or pest is involved.

Secondly, diseased plants must be destroyed as soon as they show the first symptoms of infection. Thorough inspections should be made for the purpose of locating bunchy top plants. The frequency of these inspections will depend on the amount of bunchy top present, and must ensure that in every case the diseased plant is found as soon as the infection becomes recognisable. Eradication must follow immediately, and to be effective the following procedure should be followed:

To prevent aphids leaving the diseased plant for a healthy one first pour not less than half a pint of pure kerosene into the central leaf of the affected plant and other plants connected with it in the same stool. Wait for a few hours to allow the kerosene to trickle down round the leaf bases and so kill all aphids present. Then dig out the stool including the infected plant and any others connected with it, and chop into small pieces to facilitate drying.

HEART ROT

A second virus disease of bananas is now known to occur in this State. Although this disease is widely distributed throughout Southern Queensland it fortunately has not exhibited the capacity for rapid spread that has made bunchy top so serious. The characteristics of the disease vary at different times of the year. The most general symptom is a chlorotic condition of the younger leaves formed by light-green to yellow streaks or bands which extend out from the midrib. These streaks may be narrow and interrupted so that a mosaic effect is produced. During the colder months a soft black rot may involve the funnel leaf and develop down into the heart of the plant. If this rot reaches the corm the whole plant may die. Often, however, with a change in environmental conditions the extension of the rot will cease, but the new leaves coming away may be narrow with irregular and blackened edges resulting from the previous rotting of their margin. As in the case of bunchy top the virus may pass from a diseased plant to the suckers with the production of a stunted and heavily mosaic-marked plant.

The cause of heart rot was first investigated by Magee in New South Wales. He showed that the disease was due to an infectious virus which was carried from infected to healthy plants by the banana aphid. Heart

rot therefore resembles bunchy top in this respect. As would be expected, the control measures advocated in the case of the latter have so far effectively checked the spread of the former disease. Briefly, the recommendations are as follows:

1. Plant only disease free suckers.
2. Kerosene and dig out an affected stool immediately heart rot symptoms are noticed.

LEAF SPOT AND SPECKLE

Although leaf spot and speckle are probably distinct diseases they will be considered together here since they are usually both present in the plantation, and the final effect on the plant is very similar in each case.

Leaf spot is caused by the fungus *Cercospora musae*. It is a disease which is widely distributed outside Queensland occurring as it does in India, the Eastern Tropics, and Fiji. The spots are easily recognised and are most prominent on the upper surface. They consist of narrow, oblong, or elliptical, brown to black, areas about half-an-inch long by an eighth in width. With age the centre dries out leaving a characteristic grey spot bordered with a black line and surrounded by a yellow halo. Usually the grey spots are still easily distinguishable after the leaf has dried out. Minute greyish tufts of fungus spores can sometimes be seen on the surface of the spots following prolonged rainy weather.

Speckle is found on the under surface of the leaf as scattered or aggregated dark brown to black blotches of varying size and intensity. These dark patches are formed in the first place by a close speckling of the surface with greyish dots which later darken and coalesce. The cause of speckle is not as yet definitely known, although it is evidently of fungus origin. Its distribution is as wide as leaf spot.

Leaf spot is usually most abundant towards the outer end of the leaf, whilst speckle is, if anything, more prevalent towards the base. A shaded situation may definitely favour the development of the latter, but not the former. With both diseases the lower leaves are attacked first, and if the spots are numerous the individual lesions will coalesce and form large peninsulas of dead tissue extending from the margin in towards the midrib. Eventually the whole leaf will dry out. This results in a gradual defoliation of the plant from the base up and under average plantation conditions on growing plants an equilibrium is reached at which there are usually three leaves unaffected and four to five with leaf spot and speckle present in increasing intensity from above downwards. This is apparently sufficient leaf area to support the growth of the plant, and it is doubtful whether the initial size of the bunch when thrown is greatly affected by these leaf diseases. However, once the bunch is out no further leaves are formed, and the gradual invasion and consequent death of those present deprives the bunch of its normal shelter, with the result that the fruit often fails to develop properly and may become badly scalded.

Leaf spot and speckle are usually present at all times of the year, the relative importance of each varying somewhat with environmental conditions. Both diseases are favoured by wet weather, but in the case of

leaf spot three or more days of continuous rain during the moderately warm weather of February, March, or April appears necessary for an epidemic outbreak. The leaf defoliation is most serious during the winter months when growth is at its slowest. In the spring the situation changes and the plants tend to outgrow the disease. Conditions such as poor drainage, unsuitable soil and aspect, cold and heavy weevil borer infestation will add to the seriousness of leaf disease by retarding the growth of the plant, and even on their own account in the absence of disease may be responsible for abnormal leaf fall.

CONTROL

From the above discussion it will be seen that the maintenance of a continuous vigorous growth will help towards reducing loss from these diseases. In this connection it must be remembered that the banana is essentially a tropical plant and greatly affected by cool temperatures. The broad flexible leaves and other growth characters indicate that adequate shelter from strong winds and abundant and evenly distributed moisture are necessary. The roots are adapted to a loose well-drained soil adequately supplied with humus, and will suffer if exposed to extreme variations of wet and dry conditions. The provision of adequate windbreaks and the safeguarding of the better surface soil from erosion during the heavy summer rains by means of terracing, cover-cropping and other modifications of the usual cultural practice will greatly assist in maintaining the productivity of a banana plantation in spite of the presence of disease.

Direct control of the leaf diseases by fungicides is made difficult by the nature of the banana plant itself and the inaccessibility of most plantations. Dusting has been proved to be ineffective, probably owing to the difficulty of obtaining a permanent cover on the shiny leaf. Bordeaux mixture applied in February and March with a suitable spreader will check speckle and to a lesser extent leaf spot, but it is doubtful whether the final results obtained justify the trouble of spraying such a crop as the banana.

Perhaps the most practical method of reducing the loss due to leaf defoliation is to protect the developing bunch from exposure by covering it with bagging. Two methods are available. The bunch may be entirely enclosed in a hessian bag of suitable size. This procedure results in the greatest final benefit, but the slowness of the operation and the difficulty of determining the correct cutting maturity are decided disadvantages. In the second method half a corn sack is used. This is rapidly thrown over the exposed side of the bunch and secured behind with a nail. All bunches likely to be exposed should be covered as soon as the fruit commences to fill out, the correct time being largely a matter of experience. In order to provide for the heavy defoliation in winter and spring bagging should commence in April and continue throughout the winter so long as bunches are left without leaf protection.

YELLOW LEAF SPOT

This leaf spot is serious only in the northern parts of the State, where it may cause leaf defoliation in a manner similar to *Cercospora* leaf spot. The disease commences on the lower leaves as indefinite light yellow areas.

These take up an elliptic or more characteristically a definite diamond shape, turn deep yellow, and then gradually darken in the centre where they dry out to dark brown, leaving a narrow but distinct yellow margin. These spots, except in the very earliest stages, are considerably larger than those caused by *Cercospora musae*, and may be as much as 3 to 4 inches long by 1 to 1½ inches broad. Young plantations may suffer badly from yellow leaf spot, whereas they are usually free from severe attacks of the other leaf diseases.

Yellow leaf spot is apparently caused by the fungus *Cordana musae*, whose fructifications form a greyish down covering the under surface of the spots. This organism is widely distributed throughout tropical countries, but is not usually considered of as much importance as in Queensland, where severe defoliation has been known to result from its presence.

In plantations where yellow leaf spot is serious the protection of the fruit from scalding by the method described in the case of leaf spot and speckle should give some relief.

PANAMA DISEASE

Panama disease affects only the tall-growing varieties, such as the Sugar, Lady's Finger, and Gros Michel. It is widely distributed throughout the world and has received its name from the region where it was first known to cause serious loss. The presence of the disease is indicated by the development of a deep yellow colour round the margin of the lower leaves, which later turn brown and dry out. The leaf stalk collapses, leaving the dead leaves in a gradually increasing number draped round the pseudostem.

A definite diagnosis of Panama is made by splitting up the base of the plant lengthwise, when the corm will be found discoloured by numerous brown to black lines running in all directions through the white tissue. The brown vessels can usually be followed up through the sheathing leaf bases and out into the vertical partitions of the leaf stalk. The reddish-brown lines in the latter situation are often a means of quickly identifying the disease.

Panama disease is caused by a fungus (*Fusarium cubense*) which is capable of living for some time in the soil and when a suitable opportunity offers may infect the banana plant by means of the roots or wounds in the corm. It then travels up the water conducting vessels causing the black lines already referred to. The fungus may grow out through the tissue connecting a diseased parent with the surrounding suckers, and the planting of such infected material is one of the chief means by which the disease is spread.

CONTROL

The only satisfactory way of dealing with Panama disease is by a combination of exclusion and eradication.

1. Only land which has not previously grown bananas or on which the disease has never occurred should be planted with susceptible varieties.

2. Obtain planting material only from a district in which Panama does not exist.

3. A plant may become infected by wind-borne spores, or by infectious material accidentally introduced on boots and farm implements. Immediately a plant shows signs of infection the whole stool should be dug out, chopped into pieces and burnt on the spot. Any instrument used in cutting a diseased plant should be washed in formalin solution or passed through a flame before using it on a healthy plant. It is unwise to replant in the same spot.

4. Unfavourable soil conditions, especially poor drainage, greatly increases the severity of Panama attack and, conversely, the provision of optimum conditions of growth for the fruit will help to diminish the loss from this disease.

DRY ROT

Dry rot is not a disease of serious consequence, as only an isolated plant or a small group of plants is usually attacked. In an affected plant the leaves commence to die back from the margin and eventually the whole of the foliage becomes brown and dry. The pseudostem may be easily pushed over owing to the absence of sound roots. The normal corm tissue is largely replaced by a more or less dry, punky substance of a dirty white to brown colour. This consists of a mass of closely interwoven fungal threads which have invaded the corm and largely replaced the plant tissues.

Dry rot is caused by certain of the mushroom and bracket fungi, including a *Poria*, all of which live for the most part on dead and rotting stumps such as are present in abundance in the average banana plantation. From here it is possible for them to pass to a living banana plant should one be growing in close proximity and by invasion of the corm produce the dry rot described above.

In order to prevent the spread of dry rot to adjacent stools it is advisable to locate, if possible, the stump or roots from which infection has proceeded and remove and burn this material together with the infection corm.

CIGAR END

Cigar end is a trouble affecting relatively young fruit in the plantation. A firm dark decay commences at the apex of the fruit surrounding the dead floral parts. This rot extends back slowly for half-an-inch or so, causing the tissue to shrink and become more or less rounded in contrast to the angular nature of the immature fruit. There is a sharp line of demarcation between healthy and diseased tissue. Usually no further extension takes place, but the fruit ripens prematurely. The disease is caused by a fungus (*Stachylidium theobromae*). The spores of this organism are produced in abundance on the surface of the blackened area, where they form an ashy grey or pinkish-grey coat. In typical cases this gives to the shrunken end a striking resemblance to a burnt cigar tip, hence the name. The old shrivelled floral organs often persist for considerably longer than normally on affected fruit.

Although occasionally a large proportion of the fruit in a bunch is affected, it is more common for only a few fingers to show the disease; hence special control measures are not usually required. However, it is a wise precaution to open up the young bunch, where necessary, to the light and air and to remove the bracts which tend to remain attached to the developing hand, especially during wet weather. After a spell of dry weather when choke throat is in evidence, splitting the top of the pseudostem may be necessary to relieve the pressure on the out-coming bunch and so avoid injury to the tips of the fingers.

BLACK FINGER

While the bunch is still young and the fruit immature and angular one or more fingers may develop a jet black decay commencing at the tip and extending back towards the base until, unlike cigar end, the whole of the fruit becomes tapered by the gradual shrinkage of the affected region, which remains firm and eventually dries up to form a mummy. In the later stages numerous minute raised pustules constituting the fruiting bodies of the casual organism appear over the surface.

The cause of black finger has only recently been investigated. A fungus (*Phoma* sp.) has been isolated from affected fruit, and its pathogenicity proved by artificially inoculating healthy fruit on the plant and in the laboratory.

So far this disease has not appeared with sufficient frequency to call for special control measures, but the ventilating of the young bunch as for cigar end should help to prevent its occurrence.

GUMMING

Fruit which have developed gumming can be readily distinguished as the bunch begins to fill out, by a tapered or pinched appearance of the flower end. One or more fruit so affected may be scattered through the bunch. On splitting the fruit lengthwise a reddish-brown gummy condition of the tissues below the flower tip and extending along the centre will be apparent. Dark gummy specks of less intensity may form a more or less interrupted band along the outer margin of the pulp. Affected fruit does not ripen as soon as the normal, the tip in particular remaining green.

A disease occurring in the West Indies which closely resembles this one has been shown to be due to infection by a bacterium through the floral organs of the young fruit. As bacteria have in the past been isolated from Queensland specimens, it is possible that the same trouble exists in both countries.

So far it has not been necessary to take special precautions for the control of this disease, though the remarks already made regarding the opening up of the young bunch and the removal of bracts can be applied here also. All fruit having the characteristic pinched tip should of course, be rejected when packing.

BLACK PIT

Black pit has made its appearance on frequent occasions since it was first recorded in 1930. Commencing as small reddish spots, shallow black pits of $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter are formed in the skin of green fruit. The spotting is most abundant on the upper hands of the bunch and on mature fruit.

The lesions are restricted to the skin and do not usually act as centres for any further decay. However, when the pits are numerous the disfigurement is sufficiently serious to render the fruit unfit for market, and at times whole bunches have had to be discarded.

The cause of black pit is not definitely known, but it has been observed that bunches bagged in the manner advised in connection with leaf spot develop few or no spots. Accordingly this means of reducing loss is recommended in plantations subject to the disease.

SQUIRTER

Squitter is a disease rarely seen in Queensland, since it usually makes its appearance in cased bananas after arrival on the Southern markets.

A fruit typically affected with this disease has the pulp decomposed to a dark semi-fluid state so that a squeeze of the hand will expel it in a stream from the stalk end. At an earlier stage there will be found a dark area of rotting tissue lying along the centre of the fruit with or without an obvious connection with the finger stalk through which infection almost invariably occurs. External symptoms may take the form of a blackened stalk, but are often lacking altogether.

The disease is caused by a fungus (*Nigrospora sphaerica*), which for the most part exists in a non-parasitic manner on leaf bases, the bunch spathe or other dead banana material in the plantation, and on discarded bunch stalks and rotting fruit in the dumps near the packing shed. The shiny black fungus spores produced in these situations are liberated into the air and contaminate the fruit either in the plantation or during packing operations. The fungus then gains entrance through the broken fruit stalk and travelling down the vascular fibres sets up the typical rot in the pulp of the fruit.

Squitter does not develop when the fruit is in the unsprung or in the fully ripe condition, but in the intermediate stages. About ten days are necessary for the complete rot to take place. The disease is seasonal in its occurrence and is met with only in the cooler months from May until late spring. Chilling may have some indirect bearing on squitter development, and the delayed ripening period in the winter months may also be a factor in its seasonal distribution.

CONTROL

1. Plantation and packing-shed hygiene will help to reduce the number of spores present. The bunch spathe and loose trash should be removed from the vicinity of the bunch. Rejected fruit and bunch stalks should be buried or burnt and the packing shed sprayed out occasionally with a 5 per cent. solution of formalin.

2. During the winter months squirter-labile fruit should be marketed without delay and ripened as quickly as possible by up-to-date methods so that the period during which the rot can take place is reduced to a minimum.

3. Packing in part hands instead of singles will often reduce the number of fruit infected.

4. Bagging bunches during the winter months, as has been advocated for leaf spot control, may help with squirter also, as it will lessen the amount of chilling likely to take place.

FRUIT STALK ROT OR BLACK END

This is purely a transport and market trouble. As the fruit ripens a soft, black, and usually wet rot commences at the broken end of the fruit stalk, or, in the case of bunch fruit, in wounds caused by bending the fruit at its point of attachment to the main stem. This results in a black shrivelled condition of the fruit stalk, from whence the rot may extend to the adjacent skin of the fruit and produce a soft watery condition of the pulp beneath.

Various wound parasites, more especially *Glaeosporium musarum*, *Nigrospora sphaerica*, *Fusarium* spp., and *Stachylidium theobromae* are associated with this type of decay. The development of *G. musarum* is favoured by high temperatures and most of the black end in summer is due to this organism. *N. sphaerica* is active during the winter and supplements the work of *Glaeosporium* at this time. The species of *Fusarium* and *S. theobromae* are of comparatively minor importance and are apparently unrestricted as regards their time of appearance. All these fungi occur abundantly on banana refuse in and around the packing shed and on dead leaf stalks, bunch tracts, and other parts of the plant in the field. Consequently contamination with the spores of these organisms is easily accounted for. Bruises caused by rough handling and the surfaces exposed by breaking the bunch into fingers then serve as points of entry of the fungus which develops further during transport.

CONTROL

1. Practise packing shed and plantation hygiene as recommended for squirter control. The plants should be kept reasonably free from dead leaves by periodic trashing.

2. Cut, pack, and rail fruit with the minimum of delay.

3. During periods when black end is prevalent the consignments should be ripened immediately they arrive at the market by up-to-date methods, keeping the humidity as low as practicable during the process, and the temperature at the correct point.

4. Pack in part hands rather than singles, avoiding undue tearing when splitting up the hands.

5. In the case of fruit sold and ripened in the bunch practically all loss may be eliminated by careful handling of the fruit so as to avoid bruising fruit stalk.

ANTHRACNOSE

Like black end, anthracnose is mainly a marketing trouble. Dark slightly sunken areas appear on the skin of the ripening fruit and enlarge rapidly. At first the skin only is affected, but later a soft water-soaked condition extends into the pulp and greatly hastens what is commonly known as the over-ripe condition. Under moist conditions the surface of the spots becomes covered with a pinkish mass of the spores of *Glaeosporium musarum*, the fungus causing the disease.

Anthracnose is of most importance during a period of two or three months in midsummer. The skin of the fruit marketed at this time appears to be of a softer nature and more susceptible to attack, and the high temperatures prevailing favour the growth of the parasite. At this time black depressed areas may be formed on green fruit in the plantation, but this is of rare occurrence.

No definite means of control are known. The recommendations made in connection with black end are applicable here also. Careful handling at all stages to avoid bruising is important. As there is a tendency for fruit to ripen quickly during the summer months when anthracnose is prevalent the correct picking maturity must be studied in order to avoid the waste associated with fruit arriving in a mixed ripe condition. Fruit should not be allowed to stand in the hot sun either before or after packing.