

“Bunchy Top” of Bananas in the Tweed River District.

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In accordance with a request from the Fruitgrowers' Association, I lately visited the Tweed River district, in company with Mr. Hopkins, to investigate the disease known as “Bunchy Top” in bananas. The plantations of a number of growers were visited and inspected, and I have to thank these gentlemen for help and hospitality, and especially to mention Mr. Stewart, Secretary of the Fruitgrowers' Association, who rendered much help. Numerous banana plants were dug up and examined, specimens were examined macroscopically and microscopically on the spot, and numerous specimens were preserved for further examination in the laboratory.

A detailed examination of these latter, subsequently made by Mr. C. O. Hamblin, B.Sc., B.Sc.Agr., Assistant Biologist, by means of several series of microscopical sections, failed to reveal either fungus or bacterial disease as the cause of Bunchy Top. In many diseased plants numerous eelworms (two species) were found in the roots, but in many diseased plants the eelworms were not present in great numbers, and in some apparently healthy plants eelworms were present. There is no evidence that eelworms exude a toxin hurtful to the whole plant, and in many cases they did not appear to be present in sufficient numbers to cause a disease. A review of the whole situation, after examining all the material at my disposal, leads me to the conclusion that Bunchy Top is not due to a fungus, to bacteria, or to eelworms. There remains the alternative conclusion that it is due to some physiological condition, to some unhealthy state of the plant brought about by adverse conditions of soil or climate, or by a “running out” of the stock.

In considering this aspect we may inquire, first, briefly, what are the conditions of growth in a healthy banana plant?

1. The fleshy roots extend several feet all round the corm, absorbing, by their root hairs, the necessary mineral constituents from the soil.
2. The leaves expand and in sunlight manufacture the necessary sugar and starch, at the expense of which, combined with the necessary mineral constituents, the whole plant including the corm, grows.
3. When the food supply derived from sources 1 and 2 is adequate, new tissue is continually formed, fresh leaves unfold, the small cap covering each of the young ones remaining intact until they are sufficiently developed to suffer no damage from rain; the false stem formed from the sheathing leaf stalks increases in size, and so does the corm. This latter at length sends up an apical growth, bearing a bunch of bananas, through the centre of the false stem (formed by the sheathing stalks of the leaves), and at the summit the banana bunch emerges, gradually becoming pendulous.

We may now consider the chief symptoms of Bunchy Top in plants affected by the disease.

1. As its name implies, the most characteristic feature of the disease is the tendency for the leaves to remain close together instead of expanding normally; hence such names as Bunchy Top or Cabbage Top.
2. The laminae and stalks of the leaves are extremely brittle, and the laminae of the leaves will frequently break sharply across if squeezed in the hand.
3. The cap protecting the young leaves falls off before they have properly developed. This results in secondary symptoms. Rain enters the leaf scroll, and the water remaining stagnant at the base, decay is set up in the centre of the stem. This may reach varying degrees, from little rust-coloured areas to the offensive putrefaction of the whole of the interior of the stem.
4. At the base of the upper leaf stalks in affected plants, parallel dark green lines are visible. These were first pointed out to me by Mr. Marks, junr. They seem to be invariably present. No organism has been found connected with these lines, and no marked alteration in internal structure. A number of the cells, however, have considerable deposits of gum in them. The dark lines are probably indicative of an unhealthy condition. In diseased plants a bunch of bananas is either not developed at all, or if it is, the bananas are small and puny, and the bunch often fails to assume the pendulous position. If the bunch does completely emerge and hang down, (a) the large bracts at the apex are often greenish-red instead of red and have a tendency to curl; (b) the bananas are black at their apices (anthracnose).
5. The stems of young corms are often somewhat constricted near the apex, while the leaf laminae are somewhat broad, in contrast to the stems of young corms on healthy plants, which taper gradually to the apex, while the leaf laminae are somewhat ribbon-like.
6. The roots upon the corms of all diseased plants that were dug up were invariably found to be in an unhealthy condition. Instead of being several feet long, fleshy and turgid, their extremities were dead. Sometimes they were decayed over half their length; sometimes the decay extended as far as the corm, in which case the external coating of the corm was blackened. In some roots numerous eelworms were found, but sections through these roots at the point of junction of the healthy and unhealthy portions fail to demonstrate that the decay is entirely or in large part due to eelworms, bacteria or fungus disease.

The cause of Bunchy Top appears to be in the main due to this root decay, and the indications are that it has been brought about by adverse conditions, drought or flood, or drought followed by flood. I understand that in the Tweed River district there have been practically two droughts followed by

floods in the last two seasons. There are two reasons why bananas should here show themselves particularly sensitive to adverse climatic conditions. (a) The banana is naturally a tropical plant, and in the Tweed River district it is growing practically at its southernmost limit. (b) The bananas in the district would naturally show a tendency to "run out," since bananas are not produced from seed and, so far as I could gather, all the corms in the various plantations can be traced back to one or two original plantations. I have been informed by growers that the Bunchy Top condition is occasionally found in Fiji and in the New Hebrides. As far as their observations went it was confined to plants whose roots had been affected by an excessive amount of water.

In one case I observed at Teranora the disease appeared to be directly connected with a water soakage and to be spreading in the direction of the water flow; in another case it appeared to be most prevalent in the dampest part of the orchard. On the other hand, a grower showed me a plant which had had Bunchy Top for years while no plants in the vicinity showed the disease; while at the plantation of another grower bananas had been grown for ten years or more and had only just begun to show Bunchy Top. These are only a few observations among a number that strengthen my view that Bunchy Top is in the main due to faulty root development or root decay, and is not a contagious disease. Roots upon corms growing upon three types of soil: (a) chocolate soil, old cane land, very deep; (b) virgin scrub land, chocolate soil not very deep; (c) soil intermediate in character between that found on typical scrub land and typical forest land, all showed dying at the tips, and decay more or less extensive, travelling from the apex towards the corm, and the plants from which they arose all showed Bunchy Top. On the other hand, roots from plants growing from healthy plants in a somewhat sandy soil near the sea where the rainfall was fairly regular showed no decay; they extended for several feet, and were fleshy and turgid.

We may conclude, therefore, that either the physical or chemical condition of the soil has contributed to the decay of the roots, or the atmospheric conditions to which it has been subjected. These latter we cannot control. A comparison may therefore be made of soil in which healthy banana plants are growing and of soil in which banana plants have developed Bunchy Top, with a view to applying remedial measures.

The Soil Conditions.

Three samples of soil were submitted to Mr. F. B. Guthrie, F.I.C., Chemist, for analysis—Nos. 1 and 2 from the neighbourhood of a plant that had developed Bunchy Top and No. 3 from a plantation in which no plants had developed Bunchy Top. The points upon which an expression of opinion was asked from Mr. Guthrie, and the answers received from him, were as follows:—

Question 1.—Is the physical condition of soils 1 and 2 sufficiently different from 3 to suggest that the sandy nature of the latter is responsible for the non-development of root-rot following water-logging?

Answer.—Soil No. 3 is very much more sandy than Nos. 1 and 2, which are almost pure clay. Its capillarity is higher and its water-holding power less, so that it is less likely to become water-logged and would more readily recover from such conditions than the others. At the same time it is curious that No. 3 is more acid in reaction, a state of things usually associated with accumulation of water. This soil would probably be readily sweetened by the addition of lime, whereas the other requires draining.

Question 2.—Is there much more salt in No. 3 than in Nos. 1 and 2? (These two samples were taken from the same spot at different depths.)

Answer.—Salt is absent in all cases.

Question 3.—Would lime be of benefit to the soil? If so, should calcium oxide or calcium carbonate be added? The soil does not appear to be rich in humus and is porous to a considerable depth.

Answer.—Lime would benefit in all cases. In the case of Nos. 1 and 2, freshly slaked stone lime should be used to break up the heavy clay, $\frac{1}{2}$ ton per acre. In the case of No. 3, carbonate of lime or agricultural lime at the rate of 1 ton per acre will be more effective.

Question 4.—Are these soils, or Tweed River district soils in general, deficient in some constituent that could with advantage be supplied by an artificial fertiliser? As bananas are supposed to do better by the sea, some local growers suggest the application of salt.

Answer.—These soils are rich in nitrogen and lime, and rather poorly supplied with phosphates and potash. The soils from the Tweed River are on the whole rather above the average in plant food.

Question 5.—What general manure should be recommended for banana plantations in the Tweed River district? Soils on the Tweed River hillsides suitable for growing bananas are divided locally into "scrub land" and "forest land." The scrub land consist of deep, porous, chocolate-coloured soil, and, if very deep, appears to be capable of growing bananas for ten years or more. The forest land is of a much lighter colour, contains more clay, and the bananas do not appear to thrive on it for more than four years, neither do they on the chocolate soil if it is not deep.

Answer.—The mixture for bananas on these soils should be well supplied with potash and phosphates, in both of which the soils are rather lacking, and both of which, especially potash salts, are essential in banana growing. I should be inclined to attribute the abnormal growth observed (in the absence of any fungus or other disease) to the extreme stiffness of the soil, which hinders the free development of the root system and thus affects the growth of the plant. The remedy in this case would be to plough up well and subdrain and to apply plenty of freshly slaked lime. The application of salt might be tried as a experiment.*

* The configuration of the land and the large number of surface boulders would, in the majority of cases, render ploughing or subdraining impossible.

The replies of the Chemist indicate in what direction aid from artificial fertilisation may be expected; below are the combinations of artificial fertilisers recommended by Mr. Guthrie.

4½ cwt	Superphosphate	}	per acre.
1½ "	Sulphate of potash		
3 "	Dried blood (or) 2 cwt. Sulphate of ammonia.		

Different quantities of these proportions might be tried.

6½ cwt.	Superphosphate	}	per acre.
2½ "	Sulphate of potash		
4½ "	Dried blood		

8½ cwt.	Superphosphate	}	per acre.
3 "	Sulphate of potash		
6 "	Dried blood		

These formulæ are affected by the failure of supplies of sulphate of potash, and it will be necessary, Mr. Guthrie adds, to apply the potash separately. Make up the mixture as to the other items, but apply the potash in the form of wood-ashes two or three weeks previously. Roughly, 13 or 14 cwt. of wood-ashes will be required for each 1 cwt. of sulphate of potash.

It is interesting to note that in reply to numerous inquiries among growers as to whether anyone had succeeded in arresting Bunchy Top, the only one who thought he had had some indications of success was Mr. Marks, junr. He had applied lime directly to the corms and around them with the view of neutralising an acid produced, as he thought, by worms. The production of the acid by worms may be doubted, but of the amelioration of the soil by the application of lime there can be no doubt.

The Treatment of the Plants.

We turn now to a consideration of what may be done to combat the disease by treatment of the plants themselves. Suckers should be taken for fresh plantations only from plants which are perfectly healthy and which have shown no signs of Bunchy Top. Whatever may be the cause of this disease, the tendency to form Bunchy Top may become hereditary. Our cauliflowers, which we prize to-day, are nothing less than botanical monstrosities, only in this case it has suited us to propagate the abnormal plants. A good banana sucker should have a firm corm, a tapering stem (without any sign of constriction), and ribbon-like leaves. In Jamaica the life of a banana plantation is reckoned at five years; in the Tweed River district they have lasted much longer, but there appears to be a tendency to grow too many stems on one clump. I may quote here from Fawcett's book on the banana. "There is no part of banana cultivation that needs as much individual attention, supervision and judgment, as the pruning. The retaining of wormy suckers may mean the loss of hundreds of pounds to the large cultivator. If the planter is fortunate in growing a fairly even field of plants, then all is plain sailing, as one size of follower* may be left throughout the field, but, otherwise, then each sucker must be treated on its own merits. I have observed more mistakes in pruning, entailing more or less loss to the owner, than I care to recollect; some from ignorance, but more often from

* A "follower" is a sucker left at the root of the parent plant to produce the succeeding crop.

greed. It is hardly possible to grow more than 450 stems per acre and get your followers *right*. Some persons try to get as many as 600 to 700. These speculators usually wind up by marketing not more than 200, and most of these in the bad months."

It is curious that Bunchy Top has been observed in sugar cane. In reply to inquiries, Mr. Ward, of the Botanic Gardens, informs me that something similar to Bunchy Top has been observed in cannas, and he thinks it would be possible to produce Bunchy Top by treating the parts of the plant below ground in an unsuitable manner. That Bunchy Top should occur in plants so widely separated botanically as the sugar cane and the banana, indicates that the disease is of physiological origin, for a fungus disease usually confines its attacks to plants that are closely related.

Different manners of treating stems from which a bunch of bananas had been removed were noted. Sometimes they were left, sometimes they were cut in half, sometimes they were cut near the base. I am of opinion that as soon as the foliage leaves have withered the old stems should be removed completely from the plant and left to rot at some distance from it, in order that water may not collect above the corm, and that the mucilaginous slime incidental to decay may not fall directly upon the parent stock.

In order that the banana industry in the Tweed River district be put on a better footing I would recommend :—

1. That fresh stock from a more tropical district be imported under suitable supervision to replace the present stock, which may be running out. The variety grown is almost exclusively that known as the Cavendish.
2. That a man versed in tropical agriculture travel the district to advise growers.
3. That a small banana plantation in the district be acquired by the Government for experimental purposes.
4. That the Tweed River Fruitgrowers' Association experiment on some plantation, not too old, which has shown indications of developing Bunchy Top, by applying such manurial dressings as have already been indicated, plots, say, of one-tenth acre being tried, leaving check plots at intervals.

TO COMBAT WIRE WEED.

REPLYING to a Muswellbrook correspondent who had discovered wire weed (sometimes known as hog weed) to be making serious inroads on his stand of young lucerne, the Agrostologist replied: Wire weed (*Polygonum aviculare*) is a bad weed in cultivated areas, but a good stand of lucerne has been proved to be able to hold its own against it in most localities. The crop should be disc-harrowed when firmly established (about six months after sowing), most of the wire weed being removed in this way. If the crop is mown before the weed sets its seed, it will be generally found that the lucerne has the upper hand next autumn.