

## THIELAVIOPSIS PARADOXA; AN IMPORTANT DISEASE OF SUGAR CANE

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The rotting of seed cuttings of sugar cane, caused by this fungus led to the studies which are recorded in this paper. A review of the literature shows that poor germination of seed cuttings of sugar cane have been studied in other parts of the world and have been attributed to many causes, such as *Colletotrichum falcatum* in Louisiana and India, to *Marasmius plicatus* in Louisiana, to *Marasmius sacchari* in Puerto Rico, to *Ceratostomaella adiposum* in India, to *Lasiodiplodia theobromae* in Philippine Islands and *Thielaviopsis paradoxa* in many places.

The first record of this fungus was not from the tropics but from France where it was described by De Seyenes in 1886 under the name of *Sporoschisma paradoxum*. In 1892 Saccardo gave it the name of *Chalara paradoxa* (De Seyenes) Sacc.

In 1893 it was reported from Java by Went under the name of *Thielaviopsis ethacetica*, by which it is known in much of the literature. He also gave it the common name of pineapple fungus because it produced an odor in the decaying cane similar to ripe pineapples. This is the first record of the fungus in the tropics and the first record of its attacking cane that has come to the attention of the writer. In 1904 von Höhnel recognized the fungus described by Went was the same as the one described by De Seyenes and made the new combination *Thielaviopsis paradoxa* (De Seyenes) Von Höhnel. In 1928 Dade reported the results of studies on a fungus on the Gold Coast of Africa and the finding of what he believed to be the perfect stage. As a result of these studies he made the new combination of *Ceratostomaella paradoxa* (De Seyenes) Dade. In consideration of the fact that the predominant stage of the fungus is *Thielaviopsis paradoxa*, the writer will use that name.

The fungus has a very wide geographical distribution and attacks a large number of plants, including areca palm, oil palm, date palm, coconut palm, pineapple and banana.

In 1893 Massee published a paper "On *Trichosphaeria sacchari*, Mass., A fungus Causing a Disease of Sugar Cane", as a result of studies on material received from the British West Indies. The text

of this paper indicates that the author confused two or more species in his description and some of his drawings are evidently of *T. paradoxa*. A part of his description of the behavior of the fungus corresponds very well to that of *T. paradoxa*. He says,—

“Although a true parasite, in the sense of destroying perfectly healthy, living tissue, the fungus almost invariably commences as a saprophyte, the conidia germinating on the remains of dead leaf-bases scars formed by broken lateral branches, roots &c., the hyphae afterwards passing into the living, uninjured tissue of the cane; and judging from the fact that the disease is always most mature at the lower and older portions of the cane, it is evident that the fungus effects an entry by the means indicated. The cultures described also prove that the fungus can pass through the entire cycle of its development as a saprophyte.”

Three years later Went of Java published a paper entitled “Notes on Sugar Cane Diseases” in which he criticized the work of Massee. He says,—

“In most cases this disease only attacks cuttings, though it may be found in the stems of half-grown or full-grown cane too, if these are damaged; but this last mode of occurrence of the disease is rare.”

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“The paper by Massee on *Trichosphaeria sacchari* gave me the impression that what he calls the macro- and micro-conidia of this fungus are similar to or very little different from the form which I have described as *Thielaviopsis ethaceticus*. This opinion was confirmed by the material I received from the West Indies containing so-called macro- and micro-conidia of *Trichosphaeria*, which could not be distinguished from my *Thielaviopsis*.”

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“*Thielaviopsis ethaceticus* is a general saprophyte, behaving sometimes as a wound parasite, and then causing the pineapple disease of the sugar cane in Java.”

Butler (1906) of India wrote as follows,—

“One of the most serious cane diseases of Java is that caused by this fungus. It attacks chiefly planted-out sets, which are rotted by its action and consequently fail to germinate. Cut or bruised canes that are exposed to its attacks are readily infected, and hence the danger to which canes reserved for seed are exposed, while they are stored or in transit, is considerable. Through the unbroken rind of the culm infection appears rarely to occur.”

Johnson and Stevenson (1917) of Puerto Rico say that,—

“The injury caused by this fungus is restricted to the cane cuttings. An affected cutting is usually killed either before any shoots are produced or before the new shoots can establish themselves on their own roots. The loss due to this disease varies considerably, depending upon the variety of cane, moisture conditions in the soil, and possibly other factors. . . Not all seed which fail to germinate have been invaded by this fungus, but it is responsible for the death of a large proportion. Out of one lot of dead seed examined, twenty-five per

cent showed this disease and another lot but ten per cent. The loss in some instances, however, must be much higher. Of healthy seed growing under normal conditions a negligible per cent will be attacked. The disease makes great headway whenever conditions for prompt germination are lacking, and become especially severe if the seed has been left in piles or sacks for some time after cutting. For this reason all seed that is to be shipped or which it is not possible to plant at once should be treated."

Edgerton and Moreland (1920) of Louisiana published a bulletin on effect of fungi on the germination of sugar cane in which they said,—

"*Thielaviopsis paradoxa* occurs very sparingly in Louisiana and as yet does not seem to be responsible for much deterioration."

Lee (1922) of Hawaii writing of *T. paradoxa* in Philippine Islands says,—

"One of the most serious diseases of sugar cane is the so-called pine-apple disease. The affection is found most commonly in the cuttings, and frequently results in the failure of 50 to 75 per cent of the seeds to germinate. Not infrequently a complete failure results. Plants that do grow from diseased cuttings are generally diseased. In the early stages of infection, diseased cuttings, when split open, are seen to be characterized by a reddening of the tissues, usually in blotches. In advanced cases the red discolored areas turn black with reddish margins and a pineapple odor is given off. Such cases may also have a black mold produced in advanced portions of the infection. Frequently a reddening of the stalk is produced on the cane seed."

Lee (1922) of Hawaii writing of *T. paradoxa* in Philippine Islands says,—

"Many fields have been observed which had to be entirely replanted or which were entirely abandoned due to lack of germination of the seed caused by this disease. Such loss is in most cases entirely unnecessary."

Cottrell-Dormer (1925) of Australia wrote,—

"It has been responsible for rather serious damage over an area of one or two acres of heavy black soil. This disease is a very well known one in other countries, and has already been recorded for Queensland. It is a disease of the set and is caused by a fungus which infects tissues of the plant and prevents it from germinating."

The disease in Puerto Rico attracted the attention of the writer first during the winter of 1927-28 when he received many complaints concerning poor germination. An investigation showed that *Thielaviopsis paradoxa* was the cause of this poor germination and that it was most severe in cold, wet clay soils. No severe outbreaks have been reported since that time. The disease and the fungus causing it have been the subjects of study ever since that date.

Inquiry concernings poor germination in previous years showed that in the opinion of the growers the poor germination was due to poor seed cuttings. The writer is inclined to believe that poor germination in most cases has been due to this fungus combined with unfavorable soil and weather conditions. It is the common practice of the Puerto Rico growers to use seed cuttings with three buds and tests have shown that three bud cuttings are more satisfactory than two or one bud cuttings. This appears to be due to the rapid destruction of short cuttings by this fungi before the young plants can become well established. The dipping of cuttings in Bordeaux mixture which has been practiced to some extent here and in other places has no doubt been advantageous when the cuttings were dipped before they became infected. When the cut surfaces of short seed pieces which are used for experimental purposes are dipped in melted paraffine or tar, the germination was almost or entirely perfect.

The fungus grows readily as a saprophyte, as stated by previous workers. It penetrates wounds of healthy cane and destroys the cell walls of the parenchyma tissue. The first symptoms of the disease is a reddening of the tissues, followed by blackening and a complete breaking down of the parenchyma. In most cases, pure cultures can be obtained from the inner-blackened tissues of these cuttings, showing that the fungus alone is capable of destroying the tissues. Other organisms, especially bacteria, can be obtained near the cut surfaces. The fibro-vascular bundles withstand destruction for a very long time. When the rind is cut through and the cane broken, these bundles can be pulled out in mass like the hairs of a brush.

Field planting at intervals of six or eight weeks have been made over a period of about two years, using both infected and uninfected seed cuttings. Each seed piece had three buds which is in accordance with the planting practice in Porto Rico and were of about the same age. Fifty cuttings of each variety were used in each test. After six or eight weeks the cuttings were lifted, examined and of the number of buds germinating on each piece recorded. These studies show:

(1) *Thielaviopsis paradoxa* is the dominant factor in poor germination in Porto Rico. It lives as a saprophyte on the old canes and is an active wound parasite.

(2) It is most severe during the cooler months of the year. In fact it is rather difficult to get cultures from the lowlands during the summer months and cultures in the laboratory die out. The organism is abundant and vigorous in the higher elevations where the temperature is lower during the summer months.

(3) The destruction of seed cuttings is greatest in the wet, poorly drained soils.

(4) Short seed pieces are usually destroyed more rapidly than long seed pieces of corresponding ages.

(5) The loss of short seed pieces in experimental work and in the propagation of a new variety is sometimes very high. This can be prevented by dipping the freshly cut ends in Bordeaux mixture, paraffine or tar.

(6) The losses from year to year are not equally severe. Sometimes the losses are very high and sometimes very low, depending on local condition, but always higher than the grower believes them to be.

(7) Other fungi and bacteria are more or less common on the decaying cane, but I have no doubt that *Thielaviopsis paradoxa* is the dominant factor in Porto Rico.

(8) *Masamius sacchari* is sometimes quite common; the mycelium forming a net work on the seed pieces and killing some of the buds, but I am unable to say just how important it is.

(9) The fact that *T. paradoxa*, which thrives best during the periods of low temperatures in Porto Rico, is not more destructive in the extreme northern and southern ranges of sugar production, would make temperature studies on the organism in different parts of the world very desirable.

(10) It is very evident that any organism that rots the seed pieces or kills the young buds will reduce the percentage of germination. Also, it is evident that the cut ends of seed pieces are ideal for the penetration of semi-parasitic and rot organisms.

(11) My studies in Porto Rico indicate that *Thielaviopsis paradoxa* is the most important organism in reducing germination. That it is most severe in poorly drained soils and during the cool months of the year. *Marasmius sacchari* attacks and kills buds and young shoots and is probably second in importance.

(12) Comparative studies on causes of poor germination in different parts of the world might give us some interesting results.

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