

**STUDIES ON VIRUS DISEASES OF PAPAYA
(CARICA PAPAYA) IN PUERTO RICO¹**

I. Transmission of Papaya Mosaic

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INTRODUCTION

A survey of the available literature (1-14) demonstrates the presence of a serious mosaic disease of papayas (*Carica papaya*) widely spread throughout different regions of the world. In spite of this fact, surprisingly little is known as to the nature of the virus or viruses involved, means of transmission, dissemination, etc. As far as we have been able to determine, only four papers (1, 2, 6, 8) deal at any length with the problem and in only one of them (8) is there a serious claim as to the successful transmission of the disease.

In Puerto Rico, a disease of papaya known under the name of *bunchy top* was first reported in 1931 by Cook (3, 4) but it was not until 1937 that its epidemic proportions were noticed at the Isabela Substation, during the course of extensive trials conducted with the purpose of studying the possibilities of large scale commercial plantings. So severe was the attack by the following year, that the Station authorities declared the disease to be the limiting factor in the successful commercial development of this promising crop in the Island.

Almost simultaneously with the outbreak at Isabela, Jensen (6), working at the Federal Experiment Station at Mayagüez, undertook a study of the disease. He was not able to transmit it either mechanically or by grafting, but obtained evidence through field experiment that it was probably insect transmitted. As to the insects concerned, he did some preliminary experiments but without definite results.

For the past two years we have been engaged in the reinvestigation of papaya mosaic in Puerto Rico. As a result, three severe diseases, presumed to be caused by viral infection, have been identified among the papayas of the Island. The commonest of these is typical *bunchy top* disease, involving stunting;

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failure of latex flow on wounding; slow growth of short, stiff, nearly horizontal petioles; supporting small, thick, chlorotic leaves. A less common type of disease sometimes called *die-back* is distinguished by a severe chlorosis and defoliation from just below the growing point, progressing downward, and usually followed by necrosis of the tip of the stem or of the whole plant. In a small area of the Island including Guánica and Ponce, a typical *mosaic* disease seemed to replace the other types. This



FIG. 1—Left to right, leaves from diseased plants, showing deformation of leaf lamina. Extreme right, healthy leaf.

mosaic is characterized by mottling and extreme distortion of leaves, and also by the presence of green and brown rings on the fruits. It is still a question whether this mottling disease is closely related to typical *bunchy-top* and *die-back*, but the three conditions have some features in common. All three types of diseases are characterized by a marked reduction of top growth and especially by the sudden appearance of green streaks on the stem and young petioles. *Bunchy-top* and *die-back* are almost always characterized by failure of latex flow on wounding affected tissues, whether of leaf, fruit or stem; but this phenomenon is much less common in the mosaic type of disease. Our efforts to transmit either *bunchy-top* or *die-back* by mechanical means have so far proved fruitless, but we have been more successful in handling the mosaic type.

This paper deals with the transmission of papaya mosaic, resembling the so called papaya mosaic type "B", reported by Acuña and De Zayas (1) from Cuba.



FIG. 2.—Left, diseased plant showing stunting and leaf deformation. Markers show filiform deformity of lamina. Right, healthy control.

MATERIALS AND METHODS

The virus material used in the different experiments came originally from a diseased papaya plant grafted with tissue from a mosaic infected plant brought to the laboratories from the Ponce-Guánica region.

All transmission experiments were conducted on healthy papaya plants grown in 6 inch pots in the greenhouse, ranging from 1½ to 3 months of age. Plants were taken to the laboratory and inoculated, using the pin-puncture method of Seín's (9), rubbing with carborundum, and grafting. In the pin-puncture technic, pieces of leaves, from infected plants showing early symptoms of the disease, were wrapped as closely as possible to the growing point and also about the middle of the stem and punctured repeatedly 1 to 15 times with an insect

needle. When the abrasive was used, an infected leaf was macerated in a mortar with a little sterile sand and water, the extracted juices were strained through cloth and the filtered



FIG. 3—Two plants showing atrophy of growth and leaf deformation.

juice applied with a cotton swab impregnated in the liquid, over one or two of the youngest leaves previously powdered with a little carborundum. Leaves were held in position with a clean wooden label.

In grafting, slips made with a razor blade from stems of infected plants showing oil streaks, were inserted into slits in the stem of the healthy stock, or slices from the cortical layers of healthy stem were taken and the infected slips firmly attached to it. In both cases, the grafts were covered with a piece of moist cotton and lightly tied with strings. The cotton was kept moist during the first few days by spraying with water from an atomizer.

All inoculated plants were kept in the laboratory from 4 to 5 days, then replanted into 10 inch. pots and taken to a wire screen shelter for further observations. Temperature inside

the shelter during the course of the experiment ranged from 74 to 90°F.

Controls were treated in the same manner, using materials from healthy plants for the different operations.

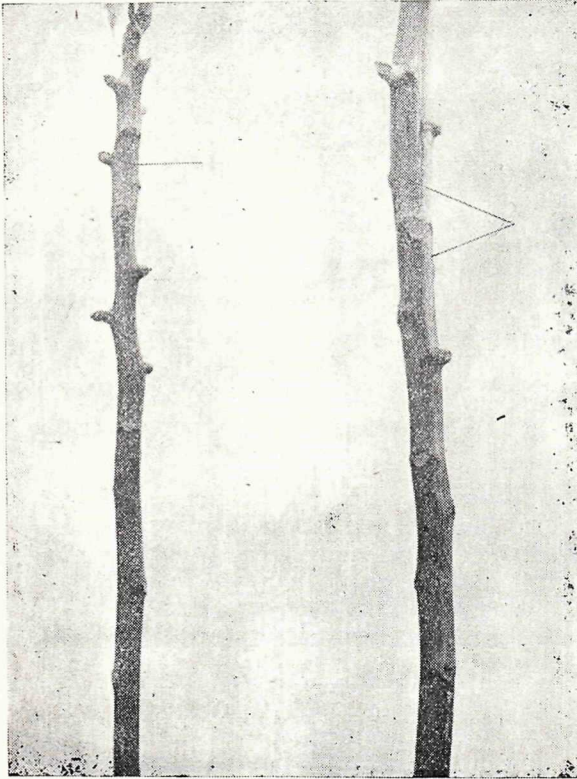


FIG. 4—Oily spots on stem of diseased plants.

TRANSMISSION

By pin punctures: Papaya mosaic was readily transmissible from diseased to healthy papayas by the use of a needle as described above. Eleven out of twenty-nine trees were infected by using this technic.

It was observed that, in general, the chances for a successful transmission were better if the leaves used as a source of inoculum were taken from the infected plant during the first two or three days after inception of the disease. Extracts made from leaves just beginning to show symptoms yielded a very infectious liquid.

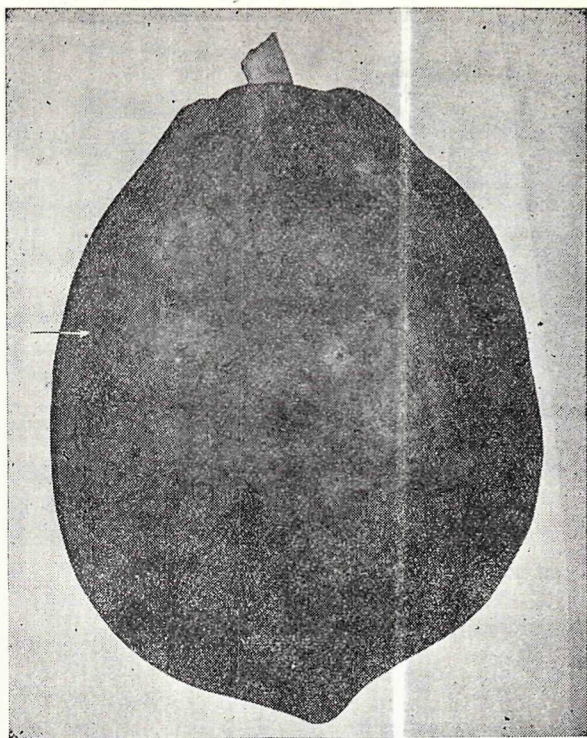


FIG. 5—Fruit taken from a diseased tree. Notice sharp rings on the surface of the fruit.

By the use of carborundum: Transmission by means of an abrasive (carborundum) was also readily accomplished. We have found this method to be a much easier and more effective way of transmitting the disease than pin puncture. Positive results were obtained in twenty three out of twenty eight inoculations.

By grafting: Pieces of stem tissues from infected plants grafted on healthy plants, in the manner described under Methods, transmitted the disease.

SYMPTOMS

Plants inoculated either by pin puncture or carborundum developed symptoms in 8 to 15 days after inoculation. Grafted plants took from two to three weeks before showing any evidence of the disease.

Inoculated and grafted plants exhibited at first a slight chlorosis of top leaves, followed by mottling, wrinkling and puckering. A light yellowing of the veins was also noticeable at this stage. As the disease progressed there was a marked deformation (figs. 1-2-3) and reduction of the leaf lamina, which in the majority of cases acquired a filiform structure. Leaves fully formed before onset of the disease remained normal.

A few days after the appearance of the initial symptoms, more or less elongated streaks, dark green in color (fig. 4), began to form about the middle of the stem, progressing upward and finally covering the whole length of the shoot. In only a few plants were we able to notice the occurrence of the streaks simultaneously with the appearance of primary symptoms. Concomitant with all these manifestations there was a gradual inhibition of the apical growth ultimately leaving the plant badly stunted (figs. 2 and 3), with a few small short petioles and distorted leaves on top. Two other distinguishing features of this disease were the flow of latex on wounding any part of the plant and the presence of green and dark-brown rings on the fruits (fig. 5).

The symptoms described above are generally present in field-affected plants, but the distortion of the leaves and atrophy of growth are not as severe as under laboratory conditions. Whether this is due to the influence of the environment on the expression of the disease, the age of the plant when inoculated, or other factors, we cannot say at present.

DISCUSSION

Proper consideration of the published works on the so-called "Papaya Mosaic" diseases show that, although all of them present certain symptoms in common with the mosaic described in this paper, they, nevertheless, vary in certain other respects.

The diseases described from Trinidad (2), Hawaii (8), Cuba (Mosaic type "A") (1) and Puerto Rico (6), share with our mosaic the presence of oily spots on the stem and petioles; and the marked stunting of growth with reduction in the size of the leaves, internodes and petioles. They differ, however, in not showing the characteristic mottling and extreme distortion of the leaf lamina, which is a prominent feature of our disease. The Trinidad mosaic is further differentiated by the

fact that, according to Baker, it is characterized by "a rapid die-back starting from the crown a few weeks after infection." On the other hand, the Trinidad, Hawaii, Puerto Rico and Cuba diseases present some symptoms in common, but the first is again differentiated from the last three by the rapid die-back of the crown.

There is, however, another disease reported from Cuba as mosaic of papaya (type "B") (1), which insofar as can be judged from its description, seems to be related, if not identical, with the mosaic under consideration. It is pertinent to state that in our opinion, the mosaic (type "B") from Cuba closely fits into the description we have just given of our own mosaic. Added weight for this assumption is supplied by a photograph of a distorted leaf, included in the paper just mentioned, which is indistinguishable from our own material. Unfortunately, the Cuban investigators were unable to transmit the disease mechanically, so that definite comparisons of both diseases under controlled laboratory conditions are still wanting.

SUMMARY

A mosaic disease of papaya is reported; characterized by stunting, with accompanying reduction in size of internodes, leaves and petioles, oily spots on stem and petioles, marked mottling and distortion of leaves, uninterrupted latex flow, and dark-green to brown rings on fruits.

The disease is transmitted by pin puncture, rubbing with carborundum and stem grafting.

The similarities and differences in symptomatology between this disease and others of similar nature reported from other parts of the world, are presented.

The disease is, however, believed to be closely related to, if not identical with, the mosaic type "B" from Cuba.

RESUMEN

Se ha hecho relación de una enfermedad denominada "mosaico" de la papaya, la cual se caracteriza por un detenimiento en el desarrollo de la planta, acompañado de reducción en el tamaño de los internodios, hojas y pecíolos; manchas oleaginosas en los tallos y pecíolos; marcado moteado y torcimiento de las hojas; interrupción del flujo del látex y círculos verdinegros o color castaño en las frutas.

La enfermedad se transmite mediante punturas con agujas, frotaciones con carborundo e injertos en los tallos.

Se han dado a conocer las similitudes y diferencias en la sintomatología entre esta enfermedad y otras de naturaleza parecida, sobre las cuales se han recibido informes de otros sitios del mundo.

La enfermedad está, por lo tanto, de acuerdo con el criterio del autor, íntimamente relacionada con el "mosaico" tipo "B" procedente de Cuba.

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