

Whitefly-Transmitted Viruses in Puerto Rico

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Phytopathogenic viruses transmitted by whiteflies (Homoptera-Aleyrodidae) cause diseases generally characterized by arrested development of tissues and resulting in leaf curl and other malformations. Holmes (7)² grouped these viruses in the family Rugaceae and recognized the single genus, *Ruga*, for them.

Diseases incited by whitefly-transmitted viruses occur largely in the Tropics. Whiteflies, in general, are minute and short-lived but under favorable circumstances can multiply into huge populations at extremely rapid rates. Some of the species included in the genus *Bemisia* are efficient vectors of viruses affecting crops of economic importance in Africa, India and other parts of the world.

Rugaceous viruses were not known to occur in Puerto Rico prior to 1956. Neither had the whitefly vector of some of the most important rugaceous viruses, *Bemisia tabaci* Genn., been reported in Puerto Rico. This species was found by Bird (1) in 1956 closely associated with mosaic-affected plants of *Jatropha gossypifolia* (L.) Pohl. (fig. 1) and he succeeded in transmitting the causal agent of the disease via this whitefly species.

The host range of the *Jatropha* virus was found to include mostly euphorbiaceous species belonging to the genus *Jatropha*. *Croton lobatus* L. recently was found susceptible to the *Jatropha* mosaic virus. Certain solanaceous species, including *Nicotiana tabacum* L., also were inoculated via this whitefly. Tobacco plants thus inoculated developed symptoms similar to those characterizing the mild form of leaf curl affecting tobacco in the Island. The *Jatropha* virus was shown to be different from the virus studied by Costa and Bennett (5) affecting *Euphorbia prunifolia* Jacq. in Brazil.

Bird (2) reported in 1958 that *Bemisia tabaci* Genn. (= *Bemisia inconspicua* Quaintance) according to Russell (9) was the vector of the chlorosis of *Sida carpinifolia* L. (fig. 2) in Puerto Rico. The *Sida* virus was shown to be closely related to the virus studied previously on the same host by Orlando and Silberschmidt (8) in Brazil. Although unrelated to the *Jatropha* virus, the virus of *Sida* also produces what might be considered a mild form of leaf curl on tobacco.

After studying the host range of the whiteflies on *Jatropha* and *Sida*

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² Italic numbers in parentheses refer to Literature Cited, p. 467.

(both *B. tabaci*), Bird found that the whiteflies differed in their capacity to feed and breed on certain hosts; and also that they differed in their capacity to transmit several viruses. Based on these criteria, Bird (1,2,3) distinguished two races of the whitefly in Puerto Rico: *Bemisia tabaci* race *jatrophae* and *Bemisia tabaci* race *sidae*.

Bird (3) found another virus later bearing no relationship either to *Jatropha* or *Sida* viruses but transmitted by *B. tabaci* race *sidae*. This virus is called "*Rhynchosia*" virus, after the generic name of its primary host,



FIG. 1.—Leaf of *Jatropha gossypifolia* with symptoms induced by the *Jatropha* mosaic virus.

Rhynchosia minima (L.) DC. Typically, it is a legume virus. Interestingly enough, it was found to produce the severe form of leaf curl on all leading tobacco varieties grown in Puerto Rico. The symptoms (stunting, enations and severe curling) produced by this virus on tobacco are indistinguishable from those which typify the "Kroepoek" and leaf curl diseases of tobacco in Sumatra, Africa, and India (fig. 3). This virus has an extensive host range in Puerto Rico and produces mosaic diseases of *Abelmoschus esculentus* L., *Cajanus indicus* Spreng. and certain other plant species including beans, *Phaseolus lathyroides* L. and *Canavalia* species. Moreover, it causes an ephemeral mosaic on cotton when inoculation is effected during the cotyle-

don stage. The host range of the *Rhynchosia* virus, and the general symptomatology it induces on certain species, indicates a relationship to the yellow mosaic virus of *Phaseolus lunatus* L., studied by Capoor and Varma (4) in India, and to the yellow mosaic of *Phaseolus longepedunculatus* Mart., investigated by Flores and Silberschmidt (6) in Brazil.



FIG. 2.—Characteristic symptoms of the mosaic of *Sida carpinifolia* (host—*Sida carpinifolia*).

In 1961 Bird found *B. tabaci* race *sidae* capable of spreading a fourth, distinct virus causing mosaic of *Ipomoea quinquefolia* L. This particular agent produces a vivid yellow mottle on leaves of *I. quinquefolia* (fig. 4) and also affects several wild species of *Ipomoea* in Puerto Rico. It also causes a rather severe form of leaf curl on tobacco. Infected tobacco plants, however, fail to develop outgrowths and enations. This characteristic

clearly distinguishes *Ipomoea* virus from the causal agent of the *Rhynchosia* mosaic. To date, however, the writers have been unable to transmit the *Ipomoea* virus to *Ipomoea batatas* L.

It was determined more recently that the golden-yellow mosaic (fig. 5) of *Jacquemontia tamnifolia* Griseb., another convolvulaceous weed, is spread by the *sidae* race of *B. tabaci*. The host range of this new virus is rather limited as evidenced by the fact that heretofore only two plant species, besides the primary host, have been successfully inoculated via the whitefly vector.



FIG. 3.—Leaves of *Rhynchosia minima* (left) and *Nicotiana tabacum* (right) affected by the mosaic virus of *Rhynchosia minima*.

Five distinct rugaceous viruses have been identified thus far in Puerto Rico. Three were previously undescribed. One apparently is related to the agent that causes leaf curl of tobacco in India.

The Puerto Rican counterpart of the Indian leaf curl virus is a virulent entity and should receive more attention. It has an extensive host range. It has a well distributed and abundant primary host which almost always is affected by mosaic and colonized by viruliferous whiteflies. Unquestionably, *R. minima* is the ideal host; it thrives well even when affected by the virus. It supports large colonies of the whitefly without sustaining severe damage.

Occasionally, the *Rhynchosia* virus spreads via its vector causing light to severe damage in tobacco fields. It also invades pigeon pea plantings, particularly in the dry areas of the southern coast of the Island.

A seemingly new yellow mosaic destroyed a large bean planting of the



FIG. 4.—Mosaic-affected leaves of *Ipomoea quinquefolia* (causal agent—mosaic virus of *Ipomoea quinquefolia*).

variety Harvester a few months ago in the municipality of Isabela. As a result of host range and vector studies, it was clearly demonstrated that the causal agent was none other than the *Rhynchosia* mosaic virus being spread by *B. tabaci* race *sidae*.

It is probable that additional whitefly-transmitted viruses will be discovered in Puerto Rico. It also seems likely that some of those already

known will acquire greater importance as additional acreage is devoted to susceptible crops.

SUMMARY

The viruses transmitted by the Puerto Rican whitefly (*Bemisia tabaci* Genn.), their vectors, and their main hosts are discussed in the present



FIG. 5.—Leaf of *Jacquemontia tamnifolia* affected by the *Jacquemontia* mosaic virus.

paper. The possible relationships between some of these viruses and certain foreign rugaceous viruses also are discussed. It seems that the *Rhynchosia* mosaic (Puerto Rico), the yellow mosaic of *Phaseolus lunatus* L. (India) and the yellow mosaic of *Phaseolus longepedunculatus* Mart. (Brazil) are related diseases. The Puerto Rican mosaic of *Sida carpinifolia* also seems related to the Brazilian chlorosis of Malvaceae. Five seemingly different rugaceous viruses have been studied in Puerto Rico.

RESUMEN

En este artículo se enumeran los virus transmitidos en Puerto Rico por la mosca blanca *Bemisia tabaci* Genn. Además se mencionan sus vectores y

sus principales hospedadoras. También se discute la relación que pudiera existir entre algunos de estos virus y ciertos virus rugáceos que ocurren en otros países. Tal parece que el mosaico de *Rhynchosia minima* está relacionado con el mosaico amarillo de *Phaseolus lunatus* (India) y con el mosaico amarillo de *Phaseolus longepedunculatus* (Brasil). El mosaico de *Sida carpinifolia* estudiado en Puerto Rico es muy similar al que ocurre en Brasil en la misma especie. Hasta la fecha se han estudiado en Puerto Rico cinco virus rugáceos. Estos son aparentemente distintos.

LITERATURE CITED

1. Bird, J., A whitefly transmitted mosaic of *Jatropha gossypifolia*, Agr. Exp. Sta., Univ. P.R., Tech. Paper 22, 1957.
2. Bird, J., Infectious chlorosis of *Sida carpinifolia* in Puerto Rico, Agr. Exp. Sta., Univ. P.R., Tech. Paper 26, 1958.
3. Bird, J., A whitefly transmitted mosaic of *Rhynchosia minima* DC. and its relation to tobacco leaf curl and other virus diseases of plants in Puerto Rico, *Proc. Carib. Region Amer. Soc. Hort. Sci.* 5: 1962.
4. Capoor, S. P. and Varma, P. M., Yellow mosaic of *Phaseolus lunatus* L., *Curr. Sci.* 17: 152-3, 1948.
5. Costa, A. S. and Bennett, C. W., Whitefly-transmitted mosaic of *Euphorbia prunifolia*, *Phytopathology* 40: 266-83, 1950.
6. Flores, E. and Silberschmidt, K., Studies on a new virus disease of *Phaseolus longepedunculatus*, *Anais da Academia Brasileira de Ciências* 38: 327-34, 1966.
7. Holmes, F. O., *The Filterable Viruses*, The Williams & Wilkins Co., Baltimore, Maryland, 1948.
8. Orlando, H. and Silberschmidt, K., Estudos sobre a disseminação natural do vírus da "clorose infecciosa" das malvaceas (*Abutilon virus* I Baur) e sua relação com o inseto-vetor "*Bemisia tabaci* (Genn.)" (Homoptera-Aleyrodidae), *Arquivos do Instituto Biológico* 17: 1-36, 1946.
9. Russell, L. M., Synonyms of *Bemisia tabaci* (Gennadius) (Homoptera-Aleyrodidae), *Bull. Brooklyn Ent. Soc.* 52: 122-3, 1957.