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Mosaic Disease Control on Susceptible Cucurbits in the West Indies

Omer S. Lloyd Thomas
Virologist/Pathologist, Senior Agricultural Officer
Ministry of Agriculture, Food and Consumer Affairs
Barbados, West Indies

Aphid-borne virus diseases are the most important diseases of cucurbits in the West Indies that cause significant reduction in yield. Surveys of cucurbit farms throughout the West Indies revealed the presence of mosaic, existing in varying degrees of occurrence and severity, as the most predominant disease. The diseases were found to be caused by aphid-borne viruses, either in complexes or individually. Experiments to control the spread of these diseases with emulsion oils in Barbados revealed a six-fold reduction as compared with controls. The oil was applied with CP-3 knapsack sprayer (high volume) using cone jets to zucchini squash in a scheduled spray cycle. Droplet size emitted by the sprayer averaged 20 μm at 36 psi pressure. Rates of application averaged 7.5 ml/l of H_2O. Reaping time has been prolonged to more than seven weeks. Fruit quality was improved and crop yield increased. There were no significant differences between disease spread in inoculated and uninoculated plots ($P = .05$).

The West Indies, with a population of approximately eight million people, imports a sizeable amount of its vegetable requirements (Thomas, 1982). However, with modern agricultural technology being introduced, vegetable and food production has increased considerably.

Diseases and pests take a very heavy toll in crop loss, but improved farming systems and judicious use of pesticides make epiphytotics rare. However, some diseases still remain problematic because there is no known direct treatment for their control. As a result they sometimes occur in epiphytotic proportions, especially virus diseases.

Most of the virus diseases known to afflict vegetables in the West Indies are aphid-borne, and the group of crops most seriously affected is the cucurbits. Cucumber mosaic virus (CMV), squash mosaic virus (SMV) and watermelon mosaic virus (WMV), the most common viruses associated with diseases in cucurbits (Thomas, 1981; Turner and Stace-Smith, 1979), exist both in complexes and individually (Thomas, 1981). Their control still remains an enigma, and an instantaneous solution is not forthcoming.

In most of the islands of the West Indies squash of the zucchini, crooked necked and butternut types, watermelon, pumpkin, cantaloupe and cucumber are widely cultivated. In Montserrat,cucumber mosaic virus inflicted severe damage on squash and watermelon sometimes causing complete loss of the crops (Thomas, 1981). Similar situations are also frequent in Jamaica and Barbados.

Since cucumber mosaic, watermelon mosaic and squash mosaic viruses are all aphid-borne (Smith, 1972), and the most common aphids observed to be present in cultivations are *Aphis gossypii, Myzus persicae,* and *Macrosiphum* sp. Control measures always aim at excluding them. So, insecticide sprays have for a long time been the standard recommended control measure.

In Florida and Maine, USA, oil is used to control virus spread in peppers, tomato and squash (Zitter and Ozaki, 1978). The oil used in those cases is the JMS stylet oil which was developed in Florida. This oil has never been tested in the West Indies to measure its performance under our tropical conditions. Therefore, a series of experiments were set up in Barbados to evaluate for the first time the efficacy of JMS stylet oil in reducing the occurrence of aphid-borne cucurbit virus diseases in the West Indies.

This paper reports on the results of the experiments.

MATERIALS AND METHODS

Surveys: During the growing seasons of 1979-1984, farms of cucurbits (cucumber, squash, watermelon, cantaloupe and pumpkin) in six West Indian islands (Barbados, Grenada, Antigua, Montserrat, St. Lucia and Jamaica) were surveyed for the presence of virus diseases. Over 60% of the cucurbit farms in the islands were examined on a random basis. Samples of plants carrying symptoms of virus diseases were prepared for diagnostic assays.

Diagnosis: Crude extracts were prepared from the diseased plants selected by mascerating the leaves in mortar with pestle. The homogenate was squeezed through a bi-layer of cheesecloth. This was partially purified by differential high and low speed centrifugation using the methods described by Franki (1972).

Serology: The partially clarified material extracted from the diseased plants were tested against antisera to the viruses which cause diseases in cucurbits as reported by Smith (1972). The following antisera provided by Dr. Gooding from North Carolina University were used: cucumber mosaic virus, squash mosaic virus, watermelon virus and *beta* virus 1. The Agar Gel double diffusion technique was used to test each antiserum against the clarified extract from each of squash, watermelon, cantaloupe, pumpkin and cucumber.

Disease Control Program

Oil Spray: The oil spray used in these trials was JMS stylet oil. This is a mineral emulsion oil which has been developed in Florida.

Equipment: The oil was applied with an ordinary knapsack sprayer (high volume) CP-3 hand pumped type using 36 psi and

a flow rate of 500 ml/min. This equipment gave droplet sizes averaging about 20 μm with the cone jets.

Experimental Design: A 4 × 4 latin square design was set up at the Graeme Hall Research Station in Christ church, Barbados. The treatments within the latin square were:

1. Oil treatment of inoculated plot
2. Oil treatment of uninoculated plor
3. No oil treatment of inoculated plot
4. No oil treatment of uninoculated plot

The plants used in the experiment were zucchini squash, the size of each plot within the latin square was 25 m^2 (5 m × 5 m) with a population of eighty-one zucchini squash plants.

Inoculation: The plots were inoculated by planting in the middle of plots (a) and (c), one squash plant known to be carrying symptoms of mosaic virus. Inoculation took place five days after crop emergence.

Application of Mineral Oil: The oil was applied initially at five days after seedling emergence (at that time over 85% of the seeds would have germinated) and then two times weekly throughout the period of rapid growth. Subsequently the application of oil was reduced to once per week and continued through harvest. Between March 18 and May 14, 11 applications were made. The oil was applied at the rate of 17.6 l/ha (2 gal/acre) or 0.75% emulsion in tank mixes. A suitable fungicide was appliced on a weekly basis to control mildew diseases. There was continuous harvest for five weeks. Disease readings were made each week on the plants from all replicates beginning about four weeks after emergence. At the end of the five-week harvest, srand counts were taken along with counts of diseased plants per plot.

RESULTS

The viruses identified in the cucurbits from each of the islands surveyed are shown in Table 1. There was evidence of complex infections of squash and pumpkin by CMV and SMV in samples obtained from Jamaica, Barbados and Montserrat. None of the antigens prepared from the cucurbits reacted serologically to *beta* virus 1. Profuse growth of french weeds (*Commelina elegans*) carrying CMV was found within and withour some curcurbit plots in Monrserrat, Jamaica and Antigua.

Mosaic symptoms were presenr in the unsprayed uninoculared plots within four weeks after crop emergence. After seven weeks, 10% of the planrs showed symptoms. In the unsprayed inoculated plors 25% of the plants showed symptoms, while in rhe inoculated plors rhat were sprayed 3.7% of planrs carried symproms and 5% of the sprayed uninoculated plots carried symproms (Table 2).

Overall plant appearance and disease control were betrer in plots treared with oil ($P = 0.05$). The oil spray gave a better control in plors that were uninoculared, bur the differences between inoculared and uninoculated were not significant ($P > 0.05$) (Table 2).

The interaction between oil trearment and inoculation did not significantly affect disease spread ($P = 0.05$). Unsprayed plots, inoculared or not, displayed very severe symptoms with widespread stunting and partially killed plants; fruirs were mortled and twisted and in some cases highly irregular in shape.

TABLE 1. Occurrence of virus diseases on cucurbits in the West Indies 1979-1984

West Indian Island Surveyed	Cucurbits Cultivated					Viruses Identified
	Squash	Pumpkin	Cucumber	Cantaloupe	Water Melon	
Antigua	-	A, C	A, D	-	A, D	
Barbados	A,B,C	A	A	D	A, D	
Grenada	A	A	A, D	-	A, D	
Montserrat	A, C	A,B,C,D	A	D	A, D	
Jamaica	A, C	A,B,D	A, C	A, D	A, D	
St. Lucia	B, D	A	A, D	A	A	

A = CMV; B = SMV; C = SMV/CMV Complex; D = Water Melon Mosaic
E = Beta virus 1; - = Crop not grown at time of survey

DISCUSSION

Complex infections of cucurbits by two or more types of viruses seem ro inflict a more severe type of symptom. Complex infecrion of cucurbirs by viruses was first reported from the West Indies in 1979 from Jamaica (Turner and Stace-Smith, 1979). Montserrat's report of complex infection highlighted severe symptom development resulting in total crop loss (Thomas, 1980).

Vegerable growers in the West Indies have long been plagued by large numbers of aphid-transmitted virus diseases for which only limited control measures have been available. Virus disease control in these crops is aimed at the widespread use of insecticide and growing resistant varieries. This control measure has not proven very successful in these islands. In Barbados one field of squash recorded an occurrence of 45% mosaic within 6 weeks of crop emergence, in spite of well-timed applicarions of Ambush and Diazinon insecticides.

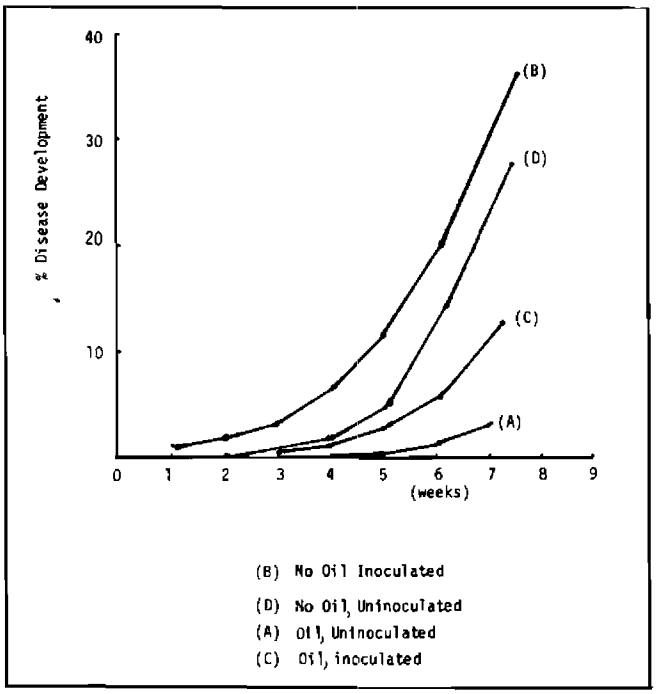
All the cucurbirs culrivated in Jamaica, Antigua and Grenada were afflicted by CMV (Table 1). The squash which was used to test the efficacy of the mineral oil suffers natural epiphyroric levels in all the islands in which it was cultivated. Being the only cucurbit afflicted by all viruses (Table 1), it was used for rhe disease conrrol test. From Table 2 it is evident that whether or not a field was artifically inoculated, the disease will spread if viruliferous aphids are in flight. This means that disease spread is not necessarily contingent to the presence of in-field inoculum. From this experimenr there was a 2.5-fold increase in disease spread in inoculated versus

TABLE 2. Disease development (within treatments) per plot

Plot	No. of Replicates	Total No. of Plants	Mean No. of Disease Plants per Replicate	Disease				
				Total No. of Plants	Cumulative %	% Severe	% Moderate	% Mild
(A) Oil	4	324	3	13	3.7	0.0	1.1	2.6
(B) No Oil	4	324	20	81	25.0	11.2	6.8	7.0
(C) Oil	4	324	4	16	5.0	1.0	0.5	3.5
(D) No Oil	4	324	8	33	10.0	3.0	6.0	1.0

A = Inoculated and Sprayed with Oil
B = Inoculated and Unsprayed
C = Uninoculated and Sprayed with Oil
D = Uninoculated and Unsprayed

FIG. 1. Test results of JMS stylet oil on plots of squash



uninoculated in untreated plots (Table 2). Table 2 also suggests that irrespective of the presence of viruliferous aphids and/or in-field inoculum, the oil application affords a 6.8-fold reduction in disease spread at the upper limit, and a two-fold reduction at the lower limit ($P = 0.05$).

The pattern of spread of the disease is different between sprayed and unsprayed plots (Fig. 1). There is a more gradual spread in those treated. The leveling off of curves (a) and (c) between six and seven weeks indicates no further disease spread at that time, while within the same period, curves (b) and (d) had moderate increases. This observation indicates the similarity in the pattern of disease spread whether or not a field was inoculated, and also a similarity in the pattern of the suppression of spread by the oil treatment whether or not some plants within a field were previously infected (Fig. 1).

The levels of disease control obtained with JMS stylet oil in this study compare favourably with those of other investigators using this oil to control non-persistent aphid-borne virus diseases in crops (Bradley, 1963; Zitter and Ozaki, 1978; Simons and Zitter, 1981).

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