Table 3. Vector transmission of yam virus to *D. rotundata* Boki variety (IITA Ibadan 1975).

Virus source	No. of tested plants	Inoculation period (min)	No. of infected plants	Symptom expression
D. rotundata (GVB)	37	240	17	GVB
D. rotundata (GVB)	27	1	7	GVB
Check	20	240	0	—
Check	18	1	0	—

shoestring after a long incubation period cannot be readily explained.

The relationships between the virus, varietal reaction, symptom expression, and incubation period with particular reference to the characteristic shoestring symptoms are being further investigated.

Transmission attempts with a green-banding virus of *Dioscorea* spp. in Puerto Rico (Ruppel et al. 1966) resulted in an extremely low (20%) transmission to *D. composita* and *D. floribunda*. Transmission percentages in this study to *D. rotundata*, however, were as high as 80%. It is not known whether the Puerto Rico virus is similar to that in Nigeria. Investigations to determine the properties of the Nigerian disease agent are in progress.

Rearing of *A. gossypii* on caged *C. benghalensis* was relatively easy. Attempts have not been made, however, to rear them on caged *D. rotundata*. The ease with which *A. gossypii* transmits the virus, and the level of field infestation of yam by this aphid indicate that it may play a role in the field spread of the disease. Transmission of the virus by nymphs after 1 min inoculation feeding, after which they appeared to lose infectivity in subsequent serial transfer, suggests a nonpersistent relationship between the virus and the aphid.

Investigations are in progress to identify other yam-infesting insects that may also be vectors of the virus.

Chant, S. R. *Annual Report, Federal Department of Agricultural Research, Nigeria, 1954/55.* 1957.

Coursey, D. G. *Yams.* Longmans Green & Co. Ltd., London, 1967, 230 p.

Robertson, D. G. *Annual Report, Federal Department of Agricultural Research, Nigeria, 1959/60.* 1961.

Annual Report Federal Department of Agricultural Research, Nigeria, 1962/63. 1964.

Ruppel, E. G., Delpin, H., and Martin, F. W. *Preliminary studies of a virus disease of sapogenin-producing Dioscorea species in Puerto Rico.* J. Agric. Univ. Puerto Rico, 50, 1966, 151–157.

Lipid Metabolism in Mosaic-Infected Cassava

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Two varieties of cassava, M4 and H.165 (accession numbers M.67-01 and M.72-10), were selected for studies on the lipid metabolism in cassava mosaic-infected plants. There was a decrease in total lipids, phospholipids, and triglycerides in the leaves and petioles of both infected varieties.

Diseases exert a profound influence on the metabolism of the host plant. Diener (1960) reported a high concentration of asparagine and glutamine in virus-infected cherry and peach leaves. Accumulation of asparagine was also reported in maize plants infected by maize rough dwarf virus (Harpaz and Applebaum 1961). Previous studies have shown that in mosaic-infected cassava, carbohydrate and nitrogen metabolism are altered due to the virus infection (Beck and Chant 1958; Ala-

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gianagalingam and Ramakrishnan 1970, 1974). Ramakrishnan et al. (1969) found that the respiratory rate in mosaic-infected cassava leaves is higher than that in healthy leaves. Alagianagalingam and Ramakrishnan (1969) found higher quantities of phosphorus, calcium, and sodium in mosaic-infected cassava leaves. There was less magnesium and iron than in healthy leaves.

Materials and Methods

Two varieties of cassava, M_4 and H.165, were selected for the study. In each variety, a completely healthy and a diseased plant were selected for lipid estimation. Leaves of uniform maturity from plants grown in the same field were used for analysis. Total lipids, phospholipids, and triglycerides of leaves and petioles in both varieties were determined.

The tissues were extracted twice at 60 °C with ethanol-ether (3:1 v/v) for 2 h followed by chloroform-methanol extraction (1:1 v/v, also twice). The extract was centrifuged each time at 1500 g for 30 min. The combined supernatant was made up to a known volume with ethanol and samples used for the estimation of the lipids.

Total lipids were estimated by the gravimetric method (Brand 1963). Phospholipids were determined by the Ackermann and Toro (1963) methods. Triglycerides were estimated using florisil column to separate the phospholipids, hydrolyzing the eluted triglycerides, and estimating the glycerol liberated (Van Handel 1957).

Results and Discussion

Diseased plants recorded reduction in total lipids in both the leaves and petioles (for M4, 7.5 and 12.2%; H.165, 4 and 8.5%). The percentage reduction in phospholipids in leaves and petioles was: M4, 18 and 54.6%; H.165, 18 and 72%. There was a reduction in triglyceride of 11 and 19% in the leaves of M4 and H.165 respectively, and of 39 and 28% in petioles.

The reduction in lipid metabolism in cassava mosaic-infected cassava plants observed in this study may be due to the decreased synthesis or increased breakdown of lipids. Carbohydrate metabolism is closely interrelated to lipid metabolism; it is possible that the reduction in carbohydrate metabolism in cassava mosaic-infected plants may also be responsible for the reduction in lipid metabolism.

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Ackermann, P. G., and Toro. In Frankil, S. and Reitman, S., eds., Gradwohl's clinical laboratory methods and diagnosis. Mosby. St. Louis, MO, 1963, 258.

Alagianagalingam, M. N., and Ramakrishnan, K. *Studies on a virus disease of tapioca (Manihot esculenta Crantz.) I. Water relations and mineral metabolism.* Madras Agri. J. 56(6), 1969, 406–411.

Studies on a virus disease of tapioca (Manihot esculenta Crantz). II. Carbohydrate metabolism. Madras Agri. J. 57(2), 1970, 55–62.

Effect of cassava mosaic virus on the nitrogen metabolism of cassava (Manihot esculenta Crantz). Madras Agri. J. 61, 1974, 18–26.

Beck, B. D. A., and Chant, S. R. *A preliminary investigation on the effects of mosaic virus on Manihot utilissima Pohl. in Nigeria.* Trop. Agric. Trin. 35, 1958, 59–64.

Brand, S. In Frankil, S., and Reitman, S., eds., Gradwohl's clinical laboratory methods and diagnosis. Mosby. St. Louis, MO, 1963, 251.

Diener, T. G. *Free amino acids and amides in healthy and virus infected cherry and peach leaves.* Phytopathology, 50, 1960, 141–145.

Harpaz, I., and Applebaum. *Accumulation of asparagine in maize plants infected by maize rough dwarf virus and its significance in plant virology.* Nature, 192, 1961, 708–711.

Ramakrishnan, K., Nambiar, K. K. N., and Alagianagalingam, M. N. *Physiology of virus infected plants.* Proc. Indian Acad. Sci. 69B, 1969, 104–114.

Van Handel, E., and Zilversmit, D. B. *Micromethod for direct determination of serum triglycerides.* J. Lab. Clin. Med. 50, 1957, 152–157.