Table 1. Effect of planting various proportions of healthy and mosaic-infected sweet potato vines on the yield of sweet potatoes.

% of mosaic vines per plot	Average weight of potatoes per plot (kg)	Average number of tubers/plot	% loss in weight yield	% loss in tuber number
0	20.6	141.4	—	—
25	18.6	128.7	9.8	11.7
50	16.2	110.3	21.3	22.0
75	13.9	89.5	47.3	36.7
100	8.9	60.4	57.1	57.3

means that the true loss due to the disease was probably higher than 57%, perhaps about 60%.

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Incidence, Symptomatology, and Transmission of a Yam Virus in Nigeria

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A Dioscorea spp. virus disease incidence was highest in field planting in Ibadan on *D. rotundata* Ihobia variety. Field symptoms included green vein-banding, shoestring, and distortion. The virus was transmitted mechanically, and by nymphs and winged adults of the cotton aphid *Aphis gossypii* to seedlings of *D. rotundata*. Test plants in mechanical and vector transmission studies exhibited mainly green vein-banding. The role of *A. gossypii* in field spread of this disease is discussed.

Virus diseases of *Dioscorea* spp. have been reported mainly from West Africa and the Caribbean, but may probably occur in all yam-growing areas of the world (Coursey 1967).

In Nigeria, reports by Chant (1957) and Robertson (1961) reported localized incidences of a virus disease of *D. alata, cayenensis,* and *rotundata.* Infected plants appeared stunted, with proliferation of lateral buds giving the plant a bushy form. Foliar symptoms consisted of mottling, vein-clearing, and sometimes lanceolation and distortion (Robertson 1961).

Robertson's (1961) attempts to transmit the agent by mechanical inoculation were unsuccessful and he suggested that the disease was caused by a physiological imbalance in the plant.

Some preliminary results on the incidence, symptomatology, and transmission of a *Dioscorea* spp. virus disease in Nigeria are presented.

Disease Incidence

Tubers harvested in 1974 from six varieties of *D. rotundata* (Laoko, Boki, Ihobia, Okumado, Iwo, and Umudike) were planted at IITA in April–May 1975. Virus disease incidence was highest in Ihobia, with 51.9, 8.1 and 2.8% of the plants manifesting green vein-banding, shoestring, and distortion respectively. There was considerable variation in varietal susceptibility to the virus but it appeared that all varieties were susceptible (Table 1).

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Table 1. Incidence of yam virus disease on vegetatively propagated *Discorea rotundata* plants (IITA Ibadan 1975).

Families	Total No.	GVB		Shoestring		Distortion and stunting	
		No.	%	No.	%	No.	%
Laoko	20	1	5	—	—	—	—
Boki	549	171	31.1	13	2.3	2	0.36
Ihobia	839	436	51.9	68	8.1	24	2.80
Okunmodo	13	—	—	1	7.6	—	—
Umudike	936	95	9.8	43	4.4	7	0.72
Iwo	1154	278	24.0	5	0.43	6	0.51

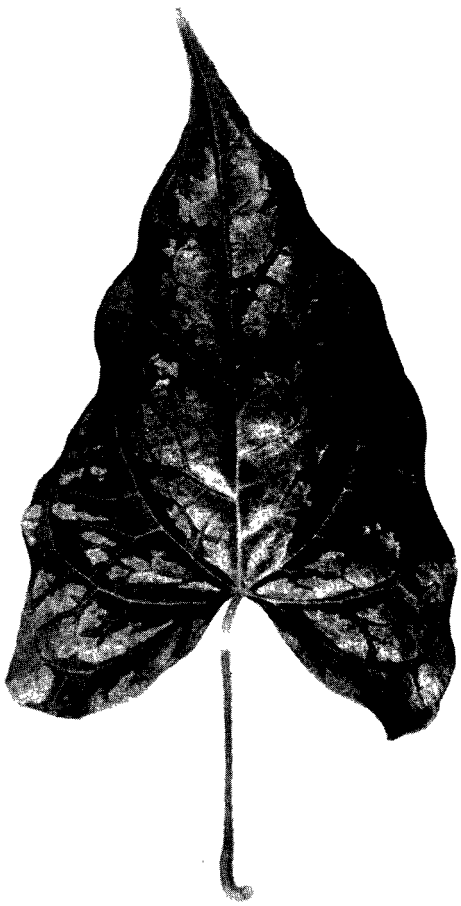

Fig. 1. Green vein-banding on Dioscorea rotundata.

Symptomatology

The most consistent symptoms of virus infection during the growing season were: (1) green vein-banding, which consisted of dark-green leaf veins against light-green interveinal areas (Fig. 1); (2) shoestring and bushiness, consisting of narrow lanceolate leaves and proliferation of lateral shoots giving the plant a bushy appearance; (3) distortion, which consisted of puckering, rugosity, and curling of leaf edges; (4) leaf mottling, consisting of irregular patches of dark-green and chlorotic areas; (5) stunting of the entire plant.

Infected plants may manifest all of the above symptom combinations or any one of them exclusively. Different symptoms appeared at different times during the growth cycle of infected plants.

Mechanical Transmission

Source of Inoculum

Crude sap for mechanical inoculation was prepared from infected plants manifesting exclusively one of the following symptoms: leaf mottling (MOT), green vein-banding (GVB), shoestring (SS), or green vein-banding together with distortion (GVB/Dist). Inoculum from plants exhibiting each symptom type was prepared by macerating 5 g of infected leaves in 1 ml buffer solution containing 0.05 *M*, pH 7.0 phosphate buffer and 0.01 *M* cysteine hydrochloride (Ruppel et al. 1966). Activated charcoal was added to the inoculum during maceration.

Test Plants

Seeds obtained from female Boki plants were germinated in petri dishes. Seedlings were later transplanted in peat pots and grown under fluorescent light to the 3-leaf stage before transplanting in sterilized soil in pots.

Inoculation

Test seedlings were inoculated at the 3-leaf stage by rubbing carborundum-dusted leaves

Table 2. Mechanical transmission of yam virus to *D. rotundata* Boki variety (IITA Ibadan 1975).

Virus source	No. of tested plants	No. of infected plants	Symptom expression
D. rotundata (GVB)	31	26	GVB
	31	2	GVB/SS
D. rotundata MOT)	20	20	GVB
D. rotundata (SS)	23	15	GVB
D. rotundata (GVB/DIST)	20	18	GVB
Check	47	0	—

with cheese-cloth pads dipped in the crude sap preparation. Untreated checks were rubbed with the buffer solution alone. All plants were grown in an insect-proof greenhouse with a mean temperature of 27.8–34.5 °C, a mean relative humidity of 67–89%, and mean solar radiation of 57.4–89.2 cal/g cm^2/day.

Insect Transmission

The cotton aphid, *Aphis gossypii* (Glov.) (identified, courtesy of the Commonwealth Institute of Entomology, London, England) was frequently observed infesting *D. rotundata* plants at IITA, and more often, a common weed (*Commelina benghalensis*) growing among yam plants. A preliminary test to identify biological factors responsible for the rapid spread of the disease was conducted by protecting 25 disease-free *D. rotundata* seedlings in the field with a 40-mesh screened cage. An equal number of seedlings from the same source were planted unprotected in an adjacent plot. Characteristic green vein-banding and leaf mottling symptoms were observed on the unprotected seedlings which were infested with *A. gossypii* 10 days after planting, whereas 60 days after caging, all the seedlings protected from insect infestation remained symptom-free.

Nymphs and adults of *A. gossypii* were reared on *C. benghalensis* in cages. They were given a 4-h access feeding on infected *D. rotundata* plants and then transferred to disease-free seedlings for a 4-h inoculation feed. An equal number of virus-free aphids were transferred to another set of seedlings from the same source and allowed to feed for the same period. At the end of the feeding period they were removed by a fine camel-hair brush.

To determine the minimum time required for inoculation by aphids after access feeding, a serial transfer study was conducted. Inoculation feeding periods were varied from 1 min to 4 h (with 30 min intervals) with the same aphid, on a series of test plants.

Results and Discussion

Mechanical transmission studies indicate that irrespective of the inoculum source, 97% of the infected test plants manifested only the green vein-banding symptoms (Table 2). However, two of the infected plants exhibited shoestring and bushy-form symptoms 77 days after inoculation. The interval between inoculation and green vein-banding symptom expression ranged from 7 to 13 days. All of the untreated plants were symptom-free after 90 days. Attempts to mechanically transmit the virus to an unidentified wild species, and also to *D. preussii* and *D. data*, were unsuccessful.

Vector transmission studies indicate that *A. gossypii* is a very efficient vector of the virus (Table 3). All infected plants developed the characteristic green vein-banding symptom between 7 to 15 days. In the serial transmission tests, only plants exposed to 1-min inoculation feeding developed typical symptoms. The remaining plants in the inoculation series were symptom-free. Both nymphs and adults of *A. gossypii* were capable of transmitting the virus.

In the mechanical inoculation tests, all infected test plants manifested the characteristic green vein-banding between 7 and 13 days. On a few plants, however, leaf mottling preceded the green vein-banding, and on two plants lateral shoot proliferation and shoestring were observed after 77 days.

Under field conditions, leaf mottling is normally followed by green vein-banding, suggesting that the former is an early manifestation of the disease but transient in nature. The occurrence of lateral shoot proliferation and

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.

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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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