YAM MOSAIC VIRUS

Yam mosaic virus R/1:*/*:E/E:S/Ve/Ap, potyvirus group

Described by Thouvenel & Fauquet (1977, 1979).

A virus with flexuous filamentous particles about 785 nm long, consisting of one species of single-stranded RNA and one species of coat protein. It is sap-transmissible with difficulty to a small range of hosts and transmitted by aphids in the non-persistent manner. It causes economically important losses in yams in tropical areas (Africa and America).

MAIN DISEASES: Causes interveinal mosaic and sometimes vein-banding in yams (*Dioscorea* spp.).

GEOGRAPHICAL DISTRIBUTION: Reported from several African countries: Ivory Coast, Nigeria (Mohamed & Terry, 1979), Togo (Reckhaus, 1980); probably also present in the Caribbean area.

HOST RANGE AND SYMPTOMATOLOGY: Known to infect several species of Dioscoreaceae, particularly *Dioscorea alata*, *D. cayenensis*, *D. esculenta* and *D. rotundata*.

Diagnostic species

Dioscorea cayenensis. Systemic symptoms are apt to differ considerably in different leaves of the same plant: mosaic, vein-banding, green spotting or flecking, curling and mottling (Figs 1–5).

D. esculenta. Mosaic and vein-banding (Fig. 6).

D. preussii. Mosaic and vein-banding.

D. composita and *D. floribunda*. Not infected.

Nicotiana benthamiana. Mottling on inoculated and systemically infected leaves.

N. megalosiphon. Systemic chlorotic spotting on the whole plant.

Propagation species

N. benthamiana and *D. cayenensis* are suitable hosts for maintaining the virus and are good sources of virus for purification.

Assay species

No local lesion assay host is known. *D. cayenensis* is suitable for assaying transmission by aphids.

STRAINS: None recorded.

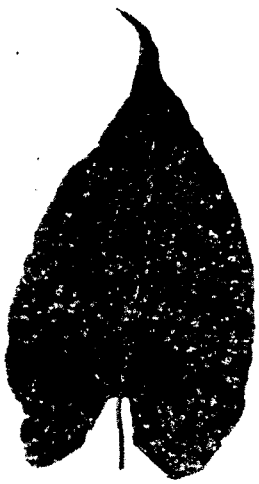
TRANSMISSION BY VECTORS: Transmitted in a non-persistent manner by the aphids *Aphis gossypii*, *A. craccivora*, *Rhopalosiphum maidis* and *Toxoptera citricidus*. Aphids acquire virus after a 5 min access period and infect plants after an inoculation access period of less than 15 min (Thouvenel & Fauquet, 1979).

TRANSMISSION THROUGH SEED: No transmission has been detected through seed of *Dioscorea cayenensis* (Thouvenel & Fauquet, 1979).

SEROLOGY: The virus is moderately immunogenic; antiserum with a titre of 1/2048 in microprecipitin tests was obtained. Flocculent precipitates are formed in microprecipitin tests. The virus is detected easily in crude sap of yams by enzyme-linked immunosorbent assay (ELISA) (Thouvenel & Fauquet, 1980).

RELATIONSHIPS: The virus belongs to the potyvirus group. It is serologically related to, but distinguishable from, pepper veinal mottle virus, guinea grass mosaic virus and passionfruit ringspot virus. In Guadeloupe (Caribbean), a virus serologically related to yam mosaic virus and with similar particle shape was reported in *Dioscorea trifida* (Migliori & Cadilhac, 1976).

STABILITY IN SAP: Crude sap from diseased *D. cayenensis* leaves was not infective, so the properties of the virus were studied with leaf extracts in phosphate buffer containing cysteine hydrochloride, bentonite and activated charcoal. In such yam extracts, the thermal inactivation point is between 55°C and 60°C; the dilution end-point is 10^{-2} to 10^{-3}; and longevity *in vitro* is less than 1 day at 25°C, *c.* 40 days at 4°C and over 150 days at −30°C.



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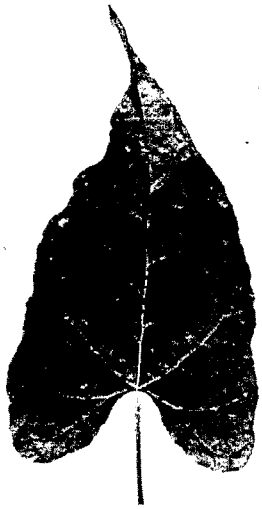

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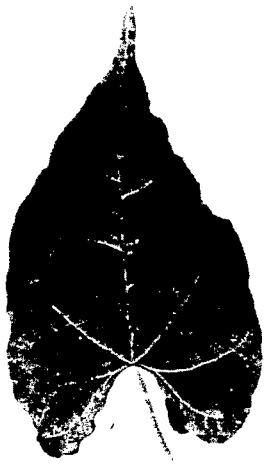

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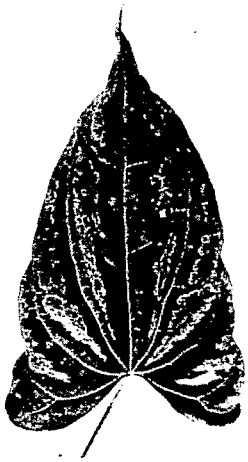

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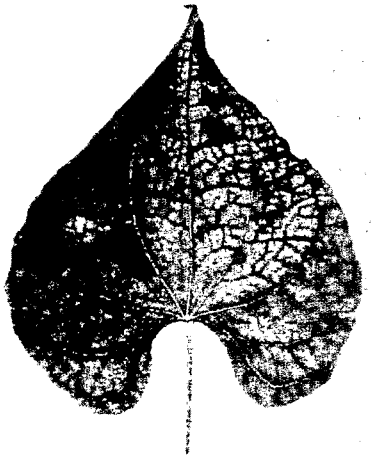

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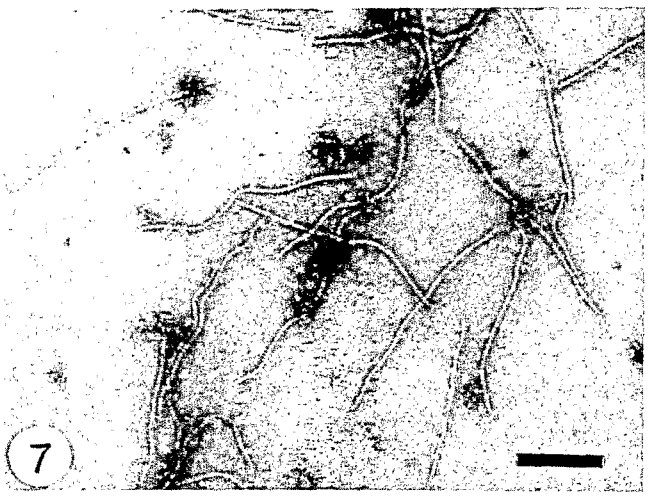

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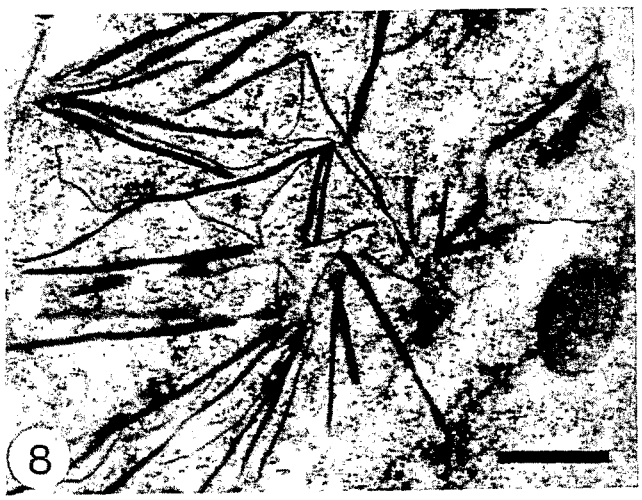

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PURIFICATION: Purification of the virus particles from yam leaves is difficult because of the presence of mucilaginous substances; *N. benthamiana* is a better source of virus for purification. Good results were obtained by the following method: blend fresh infected leaves in 0·2 M potassium phosphate buffer (pH 8) containing 1% mercaptoethanol in the presence of chloroform (2 ml/g leaf). Centrifuge the extract (10 min; 12 000 *g*) and add ammonium sulphate to 20% (w/v), or PEG, M. Wt 6000, to 6% (w/v) to the supernatant fluid. Centrifuge (15 min; 20 000 *g*), and resuspend the sediment in water; after a further low speed centrifugation, centrifuge the virus through a 'cushion' of 8 ml 20% sucrose in a swinging bucket rotor (2·5 h; 80 000 *g*). Further purification is obtained by centrifugation in sucrose density gradients. Yield of virus is about 15–25 mg/kg leaf.

PROPERTIES OF PARTICLES: Purified preparations contain a single sedimenting component.
Sedimentation coefficient ($s_{20,w}$): *c.* 150 *S* (estimated by centrifugation in sucrose gradients).
Isoelectric point, pH_i: 4·3 ± 0·3.
A_{260}/A_{280} : 1·20; A_{max} : 262 nm; A_{min} : 247 nm; A_{max}/A_{min} : 1·13 (uncorrected for light-scattering).

PARTICLE STRUCTURE: The particles are flexuous, with a modal length of 785 ± 15 nm and a diameter of 13 nm (Fig. 7).

PARTICLE COMPOSITION:
Nucleic acid: RNA, single-stranded (determined by polyacrylamide gel electrophoresis after nuclease digestion) comprising *c.* 6% of the particle weight (based on A_{260}/A_{280} ratio).

Protein: a single species, of M. Wt *c.* 34 000 (Thouvenel & Fauquet, 1979). This protein contains about 305 amino acid residues with the following composition: asp 35; thr 15; ser 19; glu 39; pro 14; gly 23; ala 26; cys 3; val 16; met 15; ileu 15; leu 24; tyr 13; phe 11; his 9; lys 16; arg 11; trp 1 (Fauquet & Thouvenel, 1980).

RELATIONS WITH CELLS AND TISSUES: The virus induces cytoplasmic pinwheel inclusions, scrolls and laminated aggregates which can be detected by electron microscopy (Fig. 8). The virus cannot be eliminated by exposure of infected tubers for 15 min at 55°C.

NOTES: Yam mosaic virus differs from dioscorea green-banding virus (Ruppel *et al.*, 1966) in not infecting *Crotalaria striata, Nicotiana glutinosa, Dioscorea composita* or *D. floribunda*. A virus from *D. trifida* in the Caribbean is morphologically similar and serologically related to yam mosaic virus, but there is little other information (Marchoux *et al.*, 1979). Harrison & Roberts (1983) reported a virus of the same size, and not sap-transmissible to plants in families outside the Dioscoreaceae, in *D. alata* imported into Britain from Barbados; similar particles were found in the leaves of *D. esculenta* from Sierra Leone. A relationship may exist between these viruses and yam mosaic virus but no serological comparisons have been made.

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Fig. 1 Systemic mosaic in leaf of *Dioscorea cayenensis*.
Fig. 2 Systemic dotting in leaf of *D. cayenensis*.
Fig. 3 Systemic flecking in leaf of *D. cayenensis*.
Fig. 4 Systemic vein mosaic in leaf of *D. cayenensis*.
Fig. 5 Systemic veinbanding in leaf of *D. cayenensis*.
Fig. 6 Systemic symptom in leaf of *D. esculenta*.
Fig. 7 Particles from a purified preparation, negatively stained with 1% uranyl acetate. Bar represents 200 nm.
Fig. 8 Electron micrograph of laminated aggregates in section of infected leaf of *D. cayenensis*. Bar represents 500 nm.

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