

PEANUT CLUMP VIRUS

Peanut clump virus R/1:2.1/4:E/E:S/C, Ve/Fu, (tobamovirus group).

Described by Thouvenel, Germani & Pfeiffer (1974) and Thouvenel, Dollet & Fauquet (1976).

A virus with straight tubular particles of two lengths, containing single-stranded RNA. It is mechanically transmissible and has a relatively wide host range. It is seed-borne and soil-borne, and the fungus *Polymyxa graminis* is thought to be its vector. Found in West Africa.

MAIN DISEASES: The common strain causes stunting ('clump') in groundnut (*Arachis hypogaea*); naturally infected groundnuts are patchily distributed in crops. A yellowing strain found in Upper-Volta (J. C. Thouvenel & C. Fauquet, unpublished results) causes concentric yellow line-patterns in old leaves but no stunting. Great millet (*Sorghum arundinaceum*) is a symptomless natural host (Dollet, Fauquet & Thouvenel, 1976).

GEOGRAPHICAL DISTRIBUTION: Found in West Africa (Ivory Coast, Senegal, Upper Volta).

HOST RANGE AND SYMPTOMATOLOGY: Infects several species in the families Aizoaceae, Amaranthaceae, Chenopodiaceae, Cucurbitaceae, Gramineae, Leguminosae, Scrophulariaceae and Solanaceae. Mechanical transmission is difficult from *Arachis hypogaea* and *Chenopodium amaranticolor* because of inhibitors in the sap; purified preparations may be needed to obtain good transmission (Thouvenel & Fauquet, 1981). Typical symptoms are ringspots and line-patterns, and stunting of the plant.

Diagnostic species

Arachis hypogaea (groundnut). No local symptom, but mottle and chlorotic ringspots appear on new tip leaves 7-10 days after inoculation; these symptoms rapidly fade, then disappear when the leaves mature. The plant then stops growing and looks stunted (Fig. 1). With the yellow strain, mottle and chlorotic ringspots appear on new tip leaves and persist, the yellow colour becoming more prominent.

Chenopodium amaranticolor. Local yellow spots 2 days after inoculation, developing later into ringspots and line-patterns which extend along the veins (Fig. 2). Not systemic.

Nicotiana benthamiana. Systemic mosaic and deformation (Fig. 3).

Nicotiana glutinosa. Systemic mosaic.

Phaseolus vulgaris (bean). Systemic mosaic.

Triticum aestivum (wheat). Systemic mosaic and stunting (Fig. 4).

Propagation species

Nicotiana benthamiana and *Phaseolus vulgaris* are good sources of virus.

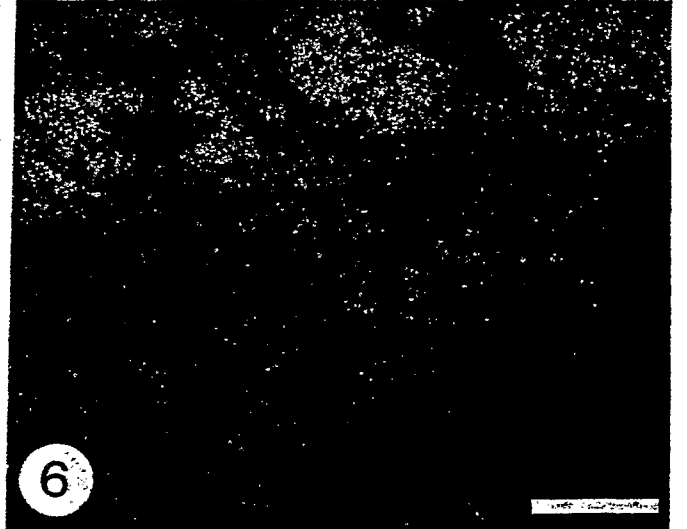
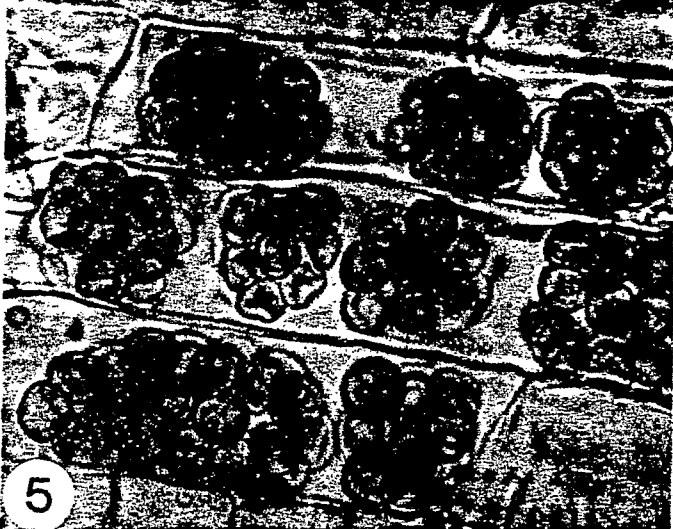
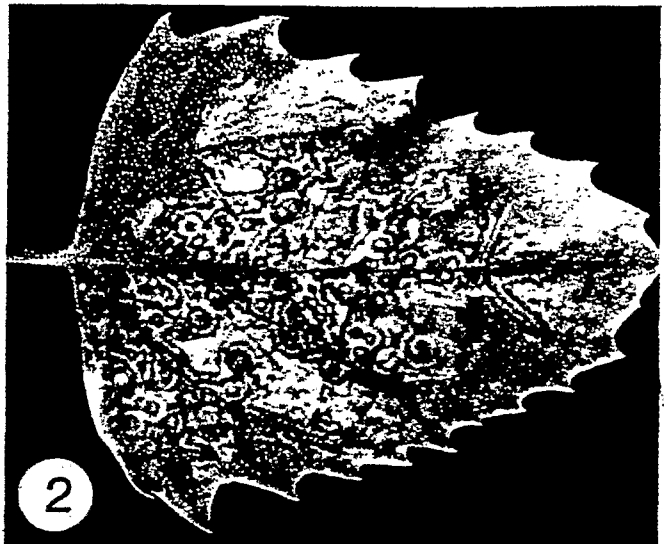
Assay species

Chenopodium amaranticolor is a useful local lesion host; *Sorghum arundinaceum* is suitable for testing transmission to roots by vectors.

STRAINS: Most isolates of the virus from Senegal and Upper Volta differ little. An exceptional strain from Upper Volta causes yellowing symptoms in groundnut, completely different from the stunting induced by common strains, but its other properties are similar to those of the common strain and they are serologically indistinguishable.

TRANSMISSION BY VECTORS: The virus is thought to be transmitted by a plasmodiophoromycete fungus to graminaceous hosts and to groundnut. The infectivity of soil was related to the presence of *Polymyxa graminis*, resting spores of which were detected readily in roots of *Sorghum arundinaceum* bait plants that became infected with the virus (Fig. 5) (Thouvenel & Fauquet, 1980; 1981).





TRANSMISSION THROUGH SEED: Seed transmission is known only in groundnut (5-6%). Seeds collected from the diseased plants thus obtained (second generation seeds) produced \approx 20% of diseased seedlings (Thouvenel, Fauquet & Lamy, 1978; Thouvenel & Fauquet, 1981).

SEROLOGY: Highly immunogenic. Antiserum with a titre of 1/2048 in microprecipitin tests can be obtained.

RELATIONSHIPS: Peanut clump virus resembles other rod-shaped viruses with known or suspected fungus vectors, such as beet necrotic yellow vein, potato mop-top and wheat soil-borne mosaic viruses, but did not react with antisera to these viruses or to tobacco mosaic, tobacco rattle, pea early-browning or nicotiana velutina mosaic viruses (Thouvenel *et al.*, 1976; Thouvenel & Fauquet, 1981); antiserum to peanut clump virus did not react with barley stripe mosaic or tobacco mosaic viruses (Thouvenel & Fauquet, 1981). D. V. R. Reddy (personal communication) found no reaction between a virus associated with a 'clump' disease of groundnut in India and antiserum to peanut clump virus.

STABILITY IN SAP: In *C. amaranticolor* sap the thermal inactivation point (10 min) is 64°C, and the dilution end-point 10^4 . Infectivity is retained for 4 weeks at 27°C, and for more than a year in frozen sap or frozen leaves (Thouvenel *et al.*, 1976).

PURIFICATION: Grind frozen leaves in 0.5 M borate buffer (pH 8) containing reducing agents, and clarify the extract with butanol/chloroform (Thouvenel *et al.*, 1976), or by acidification to pH 4.2 (Thouvenel, Fauquet & Dollet, 1978). Concentrate the virus particles by 2 or 3 cycles of differential centrifugation, resuspending the high speed pellets in 0.05 M borate buffer (pH 8). Additional purification can be obtained by isopycnic centrifugation in 45% CsCl. About 20-25 mg of virus may be obtained from 1 kg leaves.

PROPERTIES OF PARTICLES: The particles sediment as two components, with sedimentation coefficients ($s_{20,w}$) of 183 and 224 S. There is no information about the infectivity of the two types of particle.

Isoelectric point: pH 6.45 \pm 0.10.

A_{min} : 249 nm; A_{max} : 270 nm (corrected for light-scattering).

$A_{260}/A_{280} = 1.00$; $A_{270}/A_{249} = 1.32$.

Buoyant density in CsCl is about 1.32 g/cm³ (Thouvenel & Fauquet, 1981).

PARTICLE STRUCTURE: Particles are straight rods, helically constructed with a hollow core. They are about 21 nm wide and of two predominant lengths: 190 and 245 nm (Fig. 6) (Thouvenel *et al.*, 1976). The length distribution of the short particles is broad, and in some preparations an additional class of 160 nm particles is recognizable.

PARTICLE COMPOSITION:

Nucleic acid: RNA, single-stranded (determined by nuclease digestion), comprising about 4% of the weight of the particles (estimated from the absorption spectrum). In most RNA preparations, polyacrylamide gel electrophoresis reveals two components with estimated M. Wt of about 1.7×10^6 and 2.1×10^6 . In a few preparations, the smaller component can be resolved into 2 or 3 components (M. Wt $1.65-1.75 \times 10^6$) (J. C. Thouvenel & C. Fauquet, unpublished results).

Protein: Electrophoresis of coat protein preparations in polyacrylamide gels reveals one polypeptide of M. Wt \approx 23,000. Subunits have the following amino acid composition: asp 27 residues, thr 8; ser 13; glu 25; pro 12; gly 26; ala 21; cys ?; val 20; met 0; ile 11; leu 18; tyr 5; phe 7; his 5; lys 7; arg 19; trp ?; total 224 residues + cys + trp (J. C. Thouvenel & C. Fauquet, unpublished results).

RELATIONS WITH CELLS AND TISSUES: The virus is found in the cells of roots, stems and leaves of systemically infected graminaceous plants. Virus particles in wheat cells are found in the cytoplasm, near the nucleus or along the plasmalemma, and arranged in angled-layer aggregates (M. Dollet, personal communication).

Fig. 1 Symptoms of the clump disease of groundnut in the field.

Fig. 2 Symptoms in an inoculated leaf of *Chenopodium amaranticolor*.

Fig. 3 Systemic symptoms in *Nicotiana benthamiana*.

Fig. 4 Systemic symptoms in *Triticum aestivum* infected by mechanical inoculation (left); healthy plant (right).

Fig. 5 Resting spores of *Polymyxa graminis* in *Sorghum arundinaceum* roots.

Fig. 6 Electron micrograph of purified virus particles, stained with uranyl acetate. Bar represents 200 nm.

NOTES: The closest affinities of peanut clump virus are with beet necrotic yellow vein, broad bean necrosis, potato mop-top and soil-borne wheat mosaic viruses; it differs from all four in infecting *Phaseolus vulgaris* systemically. It is distinguishable from all other viruses of groundnut by its particle morphology, its antigenic specificity, its characteristic symptoms in *C. amaranticolor* and its wide host range (when inoculated in the form of purified virus). Clump disease is controlled by treating the soil with the fumigant nematicides dibromochlorophenol or DD, which may also have a fungicidal action (Germani, Thouvenel & Dhéry, 1975). It is not controlled by the use of systemic nematicides.

REFERENCES: Dollet, Fauquet & Thouvenel, *Pl. Dis. Repr.* 60: 1076, 1976; Germani, Thouvenel & Dhéry, *Oléagineux* 30: 259, 1975; Thouvenel & Fauquet, *Pl. Dis.* 64: 957, 1980; Thouvenel & Fauquet, *Ann. appl. Biol.* 97: 99, 1981; Thouvenel, Germani & Pfeiffer, *C.r. hebd. Séanc. Acad. Sci., Paris* 278: 2847, 1974; Thouvenel, Dollet & Fauquet, *Ann. appl. Biol.* 84: 311, 1976; Thouvenel, Fauquet & Dollet, *Annls Phytopath.* 10: 93, 1978; Thouvenel, Fauquet & Lamy, *Oléagineux* 33: 503, 1978.

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