GROUNDNUT VIRAL DISEASES IN WEST AFRICA

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ABSTRACT

This paper describes groundnut viral diseases observed in West Africa. Six viruses are identified and their main properties are reported here: peanut clump, groundnut rosette, groundnut eyespot, groundnut crinkle, tomato spotted wilt and groundnut chlorotic spotting viruses. Four other diseases are described in part: groundnut streak, groundnut mosaic, groundnut flecking and groundnut golden mosaic diseases. Some of them are economically very important such as the two types of rosette, peanut clump and tomato spotted wilt diseases.

Others are apparently of minor importance though they occur relatively frequently and show a wide distribution, such as groundnut eyespot, groundnut crinkle, groundnut streak and groundnut golden mosaic diseases. The others appear occasionally but are nevertheless described: some which are very infectious, as groundnut chlorotic spotting disease could become very important within a few years.

Introduction

Groundnut which is one of the most popular legumes grown in West Africa, is naturally affected by a large number of virus or virus-like diseases. It is one of the most severely infected tropical plants in terms of viral diseases. Some of them have been studied and the viruses identified: peanut clump virus (Thouvenel *et al.,* 1976), groundnut eye spot virus (Dubern and Dollet, 1980), groundnut crinkle virus (Dubern and Dollet, 1981), groundnut rosette virus (Dubern, 1980), tomato spotted wilt virus (Dubern and Fauquet, 1985) and groundnut chlorotic spotting virus (Fauquet *et al.,* 1985). The most important properties are reported. Some other diseases are only described in parts: groundnut streak (Fauquet and Thouvenel, 1985), groundnut mosaic, groundnut flecking and groundnut golden diseases (Dubern, 1979). There are also various symptoms which could be attributed to viral diseases such as rugose leaf, groundnut leaf-curl, groundnut bushy stunt; their etiology is at present unknown.

Peanut clump virus

Peanut Clump Virus (PCV), R/1: 2.1/4: E/E: S/Fu. Intermediate between hordeivirus and tobamovirus groups (furovirus?)

1 Main disease and geographical distribution

The disease reappears in the same place in succeeding crops. Infected peanut plants are stunted, with small dark green leaves (Fig. 1A). Number and size of pods are greatly reduced; in the case of early infections the crop loss is very important, up to 60%. PCV is also identified in great millet (*Sorghum arundinaceum*) which is taking a prominent part in the epidemiology of the disease (Dollet *et al.,* 1976).

PCV was first described in Senegal. It occurs in several West African countries: Burkina Faso, Gambia, Ivory Coast and Senegal (Thouvenel *et al.,* 1976).

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2 Host range and symptomatology

The virus is mechanically transmitted to a wide host range in the families of Aizoaceae, Amaranthaceae, Chenopodiaceae, Cucurbitaceae, Gramineae, Leguminosae, Scrophulariaceae and Solanaceae. Symptoms on *Chenopodium amaranticolor* (concentric ringspots and line-pattern extending along the veins) are characteristic and could be useful for the identification (Thouvenel and Fauquet, 1981).

3 Serology

An antiserum with a titer of 1/2048 was produced. There is no serological relationship with any rod-shaped virus, including the strain isolated in India (Reddy *et al.*, 1983).

4 Transmission by vectors

A fungus, *Polymyxa graminis* is thought to be the natural vector of PCV (Fig. 1B). PVC is seed-borne in groundnut, but not in great millet.

5 Causal agent

PCV is a virus with rod-shaped particles of 2 predominant lengths, 190 and 245nm (Fig. 1C). They are about 21nm wide. The single-stranded RNA accounts for about 4% of the particle weight, with 2 components of about 1.7 and 2.1 10^6d.

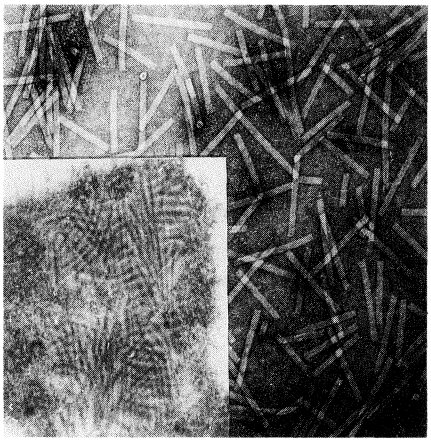
The molecular weight of the coat protein is 24 Kd (Fauquet and Thouvenel, 1985). Virus particles in systemic hosts are arranged in angle-layered aggregates (Dollet and Thouvenel, unpublished) (Fig. 1C).

6 Field control

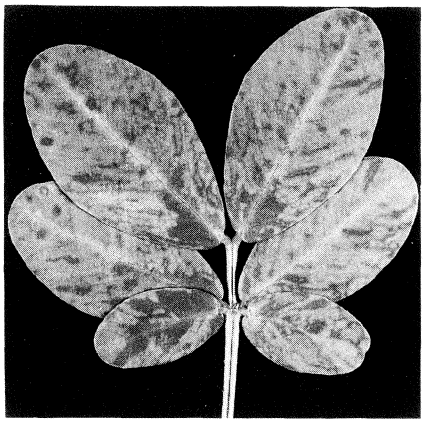
Clump disease is easily prevented, using selected seeds and by soil treatment with fungicides prior to the cultivation of the crop.

Fig. 1 (A) Typical symptoms of peanut clump virus, green strain (left), healthy plant on the right.

(B) Cystosori of *Polymyxa graminis* in *Sorghum arundinaceum* root cells.



(C) Rod-shaped particles of peanut clump virus. Inset: angle-layered particles in a *Chenopodium amaranticolor* parenchyma cell.



(D) Yellow symptoms on a groundnut leaf induced by PCV-AY.

7 Strain

Only in Burkina Faso has yellow mosaic disease been observed. Groundnut, with a slight reduction in size, shows bright yellow symptoms, with eyespots, discoloration along the veins and sometimes yellowing (Fig. 1D). There is no cross-protection between the green strain and the yellow strain and vice versa, consequently it is possible to find doubly infected plants with mixed symptoms. The presence and the effective transmission by *Polymyxa graminis* was also confirmed for this strain (Fauquet and Thouvenel, 1985).

Groundnut rosette virus

Groundnut Rosette Virus (GRV), */*: */*: S/S: S/Ap. Unclassified. Groundnut rosette disease is associated with a symptom-inducing virus (GRV) and a virus which does not cause any symptoms but acts in an auxiliary capacity for the development of the disease, i.e. luteovirus (GRAV) which is needed for aphid transmission (Dubern, 1980; Casper *et al.,* 1983).

1 Main disease and geographical distribution

Typical symptoms consist of stunting of the leaves, severe internal shortening making the plant almost acaulous (Fig. 2A). The limb of the leaves is chlorotic with green spots and the veins are green and conspicuous (groundnut chlorotic rosette virus strain -GCRV-). These symptoms differ with the strains, but stunting and rosette are always present. The number of seeds in a pod and the number of pods are severely dicreased 20-80%).
Groundnut rosette occurs thoughout West Africa.

2 Host range and symptomatology

For GCRV diagnostic species are *Arachis hypogaea* (chlorotic rosette), *Centrosema plumieri, Crotalaria juncea, Phaseolus mungo, Stylosanthes gracilis* and *Physalis floridana. Chenopodium amaranticolor, C.* murale and *C.* quinoa, especially are useful local lesion hosts. *Stylosanthes* sp. is a natural host (Dubern, 1980).

3 Transmission by vectors

The virus is aphid-transmitted in groundnut, some leguminous plants and *Physalis floridana* (Dubern, 1980). An auxiliary virus not mechanically transmitted is needed for transmission (Hull and Adams, 1968). Larvae and adults of *Aphis craccivora, A. gossypii* and *A. spiraecola* transmit the virus in a persistent manner. No seed or dodder transmission has been observed.

4 Causal agent

Isometric viruses 30nm in diameter (Fig. 2B), observed with the electron microscope, are members of the luteovirus group and seem related to the auxiliary component (GRAV) (Dubern, unpublished; Casper *et al.,* 1983). Double-stranded RNA is associated with the GRV (Breyel *et al.,* 1985).

5 Strain

The goundnut green rosette virus strain (GGRV) has been studied (Fauquet and Thouvenel, 1985). For short cycle varieties whole infected plant is chlorotic without green patches on the leaflets. For long cycle varieties, in case of early infection, the rosette shape is extremely clumped (Fig. 2C), the leaves are dark green and their surface is markedly reduced, proliferations are observed on the stems and necrosis occurs on the veins of the young leaves (Fig. 2D). GGRV is certainly a strain of GRV, due to the cross-protection between the strains.

6 Groundnut varieties resistant to rosette disease

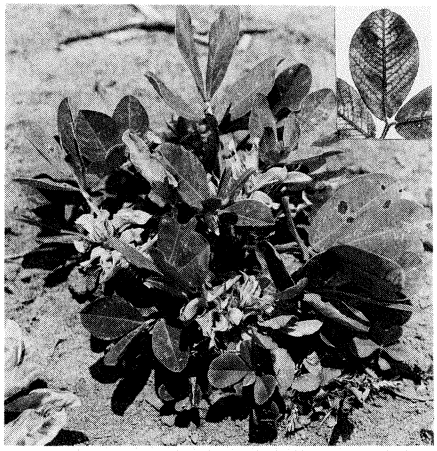
Methods of chemical control against the aphid vector are efficient but costly and it is impossible to prevent the transfer of aphids by the wind, though high density sowing promotes the establishment of a microclimate which prevents the aphid from growing wings and limits transmission. The only efficient and radical means of control is to plant resistant varieties.

Surveys in South Burkina and North Ivory Coast have enabled to identify resistant plants, all of the Virginia type, with a long cycle and low production. A first breeding phase in Bambey (Senegal) and in Niangoloko (Burkina) from populations enabled long cycle resistant varieties to be made available; they were distributed during the sixties (Bambey variety 48-37, Niangoloko series 1030-1045).

In a second phase, very productive resistant hybrids were developed and adapted to different climatic zones:

- KH series (149 A, 241 C, etc.), Spanish type with a cycle of 90 days;
- 69-101, Virginia type with a cycle of 120 days;
- RMP series (12, 91, etc.), Virginia type with a cycle of 140 days (Dhery and Gillier, 1971; Gillier and Bockelee-Morvan, 1975).

The objective of the breeding programs in progress is to develop varieties resistant both to groundnut rosette disease and to the most damaging cryptogamic diseases: rust and cercospora leaf spot.



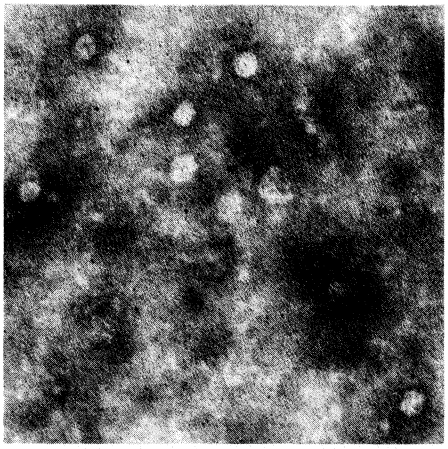
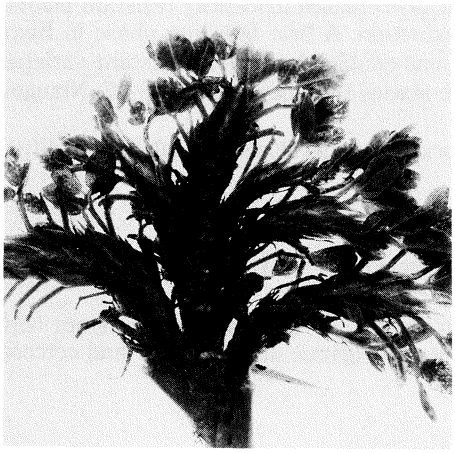
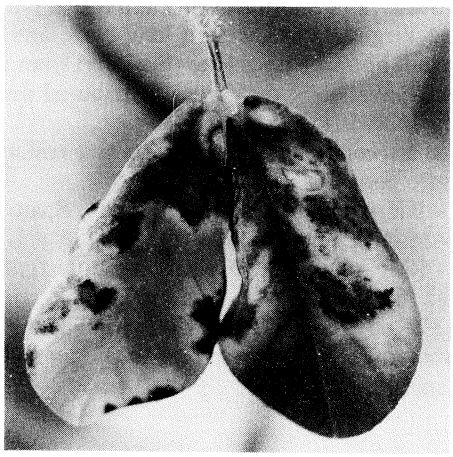


Fig. 2 (A) Groundnut chlorotic rosette virus : young stems with typical rosette and chlorotic leaflets with mottle.

(B) Groundnut rosette virus : isometric particles 28—30 nm in diameter.





(C) Typical symptoms of groundnut green rosette virus on a long cycle cv. groundnut.

(D) Necrosis symptoms appearing on the first leaves, infected with groundnut green rosette virus.

Groundnut eyespot virus

Groundnut Eyespot Virus (GEV), R/1: 3.1/6: E/E: S/Ap. Potyvirus group.

1 Main disease and geographical distribution

Typical symptoms consist of dark green spots surrounded by a chlorotic halo (Fig. 3A). Sometimes many leaflets show green line pattterns. No stunting is observed. Crop yield can be reduced and infected plants can reach 100%. *Physalis floridana* is a natural host.

The disease was observed only in the Center and the North of the Ivory Coast, in Burkina Faso and Mali.

2 Host range and symptomatology

Diagnostic species are *Arachis hypogaea* (eyespots), *Physalis alkekingie, P. floridana, Petunia hybrida, Nicotiana clevelandii, Tetragona expansa, Anthirrhinum majus. Arachis hypogaea* and *Physalis alkekingie* are suitable for testing infectivity.

3 Transmission by vectors

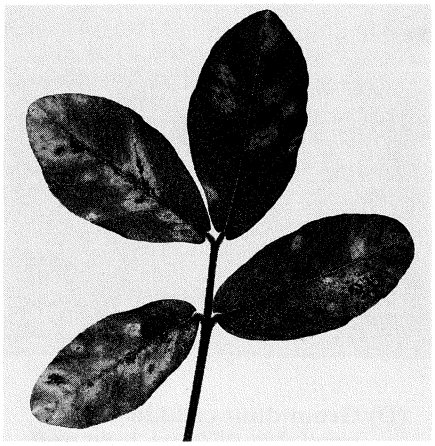
Transmission by *Aphis craccivora* and *A. citricola* is in the non persistent manner. No seed transmission has been recorded.

4 Serology

GEV is closely related to several African potyviruses (Fauquet and Thouvenel, 1980) as pepper veinal mottle, guinea grass mosaic, passion fruit ringspot, canavalia mosaic and cucurbita mosaic viruses but does not react with antisera to many other potyviruses including peanut mottle virus.

5 Causal agent

The virus particles are flexuous filaments about 12.5nm wide and 750–780nm long (Dubern and Dollet, 1980). The nucleic acid accounts for 5.5 to 6.5% of the weight of the particles. The molecular weight of the coat protein is 32 Kd. Cylindrical inclusions and scrolls have been observed (Fig. 3B).



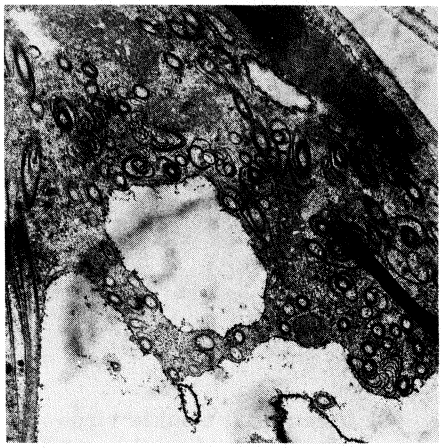


Fig. 3 (A) Groundnut eyespot virus : typical symptoms of dark-green zones into chlorotic halos.

(B) Groundnut eye spot virus: pinwheels inclusions, typical of potyviruses.

Groundnut crinkle virus

Groundnut Crinkle Virus (GCV), R/1: */6: E/E: S/AI. Carlavirus group.

1 Main disease and geographical distribution

Leaf crinkling and stippling symptoms are observed on leaves (Fig. 3C). Crinkling is very slight, as if the primary vein were too short. The frequency of diseases plants often exceeds 50%, and the production is slightly reduced. *Centrosema pubescens* is a natural host. The disease was observed in the southern part of the Ivory Coast.

2 Host range and symptomatology

Diagnostic species are *Arachis hypogaea, Canavalia ensiformis, Centrosema pubescens, Dolichos jacquinii, Phaseolus vulgaris, P. latheroides, Psophocarpus tetragonolobus, Soja max, Vigna unguiculata.* Only leguminous plants are infected.

3 Transmission by vectors

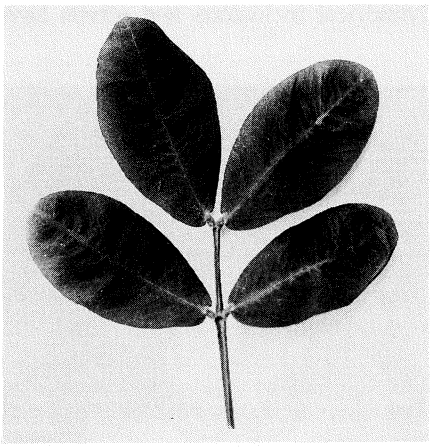
Bemisia tabaci (Aleyrodidae) transmits the disease in a non persistent manner (Fauquet and Thouvenel, 1985). No. seed transmission has been observed.

4 Serology

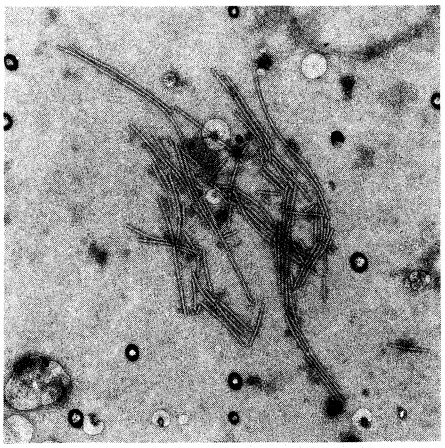
GCV is related to cowpea mild mottle virus (SDI = 2) and to voandzeia mosaic virus (SDI = 4).

5 Causal agent

The virus particles are flexuous filaments about 13.5nm wide and 650 ± 25nm long. Polymeric forms are observed with lengths of 1,300, 2,000, 2,600 and 3,200nm (Fig. 3D) (Dubern and Dollet, 1981). The nucleic acid accounts for 6% of the weight of the particles. The molecular weight of the coat protein is 34 Kd.



(C) Groundnut crinkle virus : symptoms of crinkling and stippling on groundnut leaves.



(D) Groundnut crinkle virus : particles 650 nm long and polymeric forms.

Groundnut chlorotic spotting virus

Groundnut Chlorotic spotting virus (GCSV), R/1: */7.5: E/E: 1/Ap. Potexvirus.

1 Main disease and geographical distribution

Small chlorotic spots appear (Fig. 4A) first on the young leaves, then chlorosis, mottle, ringspot, vein-banding and line patterns develop. The virus has been isolated in Ivory Coast only.

2 Host range and symptomatology

The virus is easily mechanically transmitted to a rather wide host range in the Solanaceae (*Physalis floridana, Nicotiana megalosiphon, Nicotiana benthamiana*) and Chenopodiaceae.

3 Transmission by vector

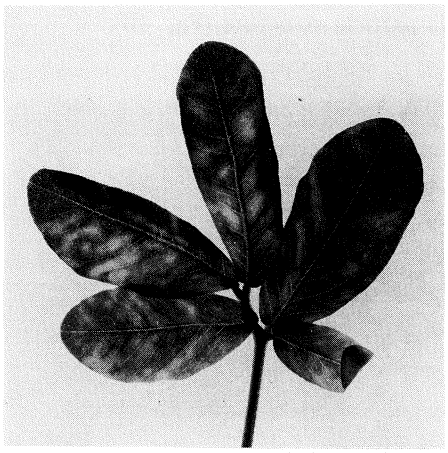
The virus is 100% transmitted by the aphids: *Aphis craccivora* and *Aphis spiraecola,* in a non persistent manner. Seed transmission has not been tested.

4 Serology

An antiserum with a titer of 1/512 has been produced. No serological relationship with potex and carlaviruses has been obtained.

5 Causal agent

The virus particles are filamentous particles 534 20nm in length and 13 ± 2nm in width (Fig. 4B) (Fauquet *et al.,* 1985).



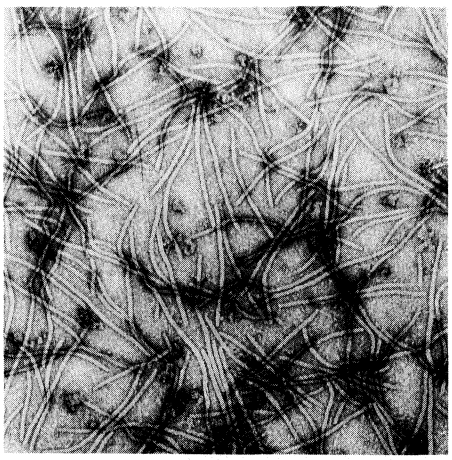


Fig. 4 (A) Symptoms of groundnut chlorotic spotting virus on groundnut leaf.

(B) Groundnut chlorotic spotting virus particles 453 nm in length.

Tomato spotted wilt virus

Tomato Spotted Wilt Virus (TSWV): R/1: 7.4/*: Se/*: (1), S/Ve/th. Tomato spotted wilt virus group.

1 Main disease and geographical distribution

On groundnut TSWV induces faint but distinct ringspot and line pattern symptoms. Sometimes, there are necrotic spots or streaks, with or without stunting. In some cases, groundnut develops chlorotic spots, resembling the strokes of a brush (Fig. 4C). Yield of diseased plants is low, about 10% of that of healthy plants. The percentage of diseased plants in Senegal is about 5%.

In West Africa, the presence of TSWV was newly recognized (Dubern and Fauquet, 1985). TSWV is widespread in Senegal and Gambia.

2 Host range and symptomatology

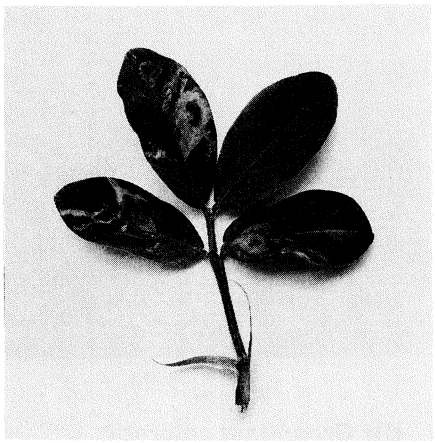
Diagnostic species are *Petunia hybrida* (local necrotic lesions), *Arachis hypogaea, Nicotiana tabacum* cv. Samsun NN, *N. clevelandii, Vinca rosea, Tropaelum majus.*

3 Transmission by vectors

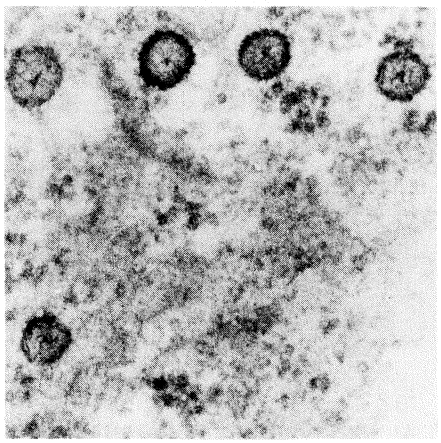
Authors have obtained the transmission with thrips: *Thrips tabaci, Frankliniella schultzei, F. occidentalis* and *F. fusca* (Best, 1968). The larvae but not the adults acquire the virus; whereas only the adults transmit the disease. They do not transmit the disease through their progeny. Seed transmission has been reported in tomato but not in groundnut (Helms, 1960; Best, 1968).

4 Causal agent

Virus particles are isometric and 80-90nm in diameter, apparently bounded by a membrane. TSWV is the only plant virus known to have this particle structure (Fig. 4D).



(C) Groundnut infected with tomato spotted wilt virus showing strokes of a brush.



(D) Tomato spotted wilt virus particles with a diameter of 80—95 nm, observed in groundnut cytoplasm.

Groundnut virus-like diseases

These diseases were partly identified and observed in the Ivory Coast (Dubern, 1979; Fauquet and Thouvenel, 1985). Graft and mechanical transmission, and sometimes electron microscopic observations have been studied.

1 Symptomatology

Groundnut streak disease: The leaflets of the infected plants show necrotic or chlorotic streaks extending from the main vein to the minor veins. Symptoms are very severe on young seedling but disappear on old plants (Fig. 5A).

Groundnut mosaic disease: A typical mosaic is observed on the leaves, delimiting irregular dark green spots on the limb, and causing malformation and elongation of the leaflets (Fig. 5B).

Groundnut golden disease: On diseased plants, leaflets seem not completely spread out; apical part of the leaflets is yellow while the basal part is green (Fig. 5C).

Groundnut flecking disease: A very faint flecking is observed on the basal parts of the leaflets, similar to the damage caused by thrips. Moreover the basal parts of the leaflets are narrow and the leaves are smaller than the healthy ones (Fig. 5D).

2 Transmission by vectors

Only groundnut mosaic and groundnut streak diseases are transmitted by *Aphis craccivora,* and the second one in a non persistent manner.

3 Particle structure

Filamentous viruses have been observed in groundnut streak disease without length determination (Fauquet and Thouvenel, 1985).

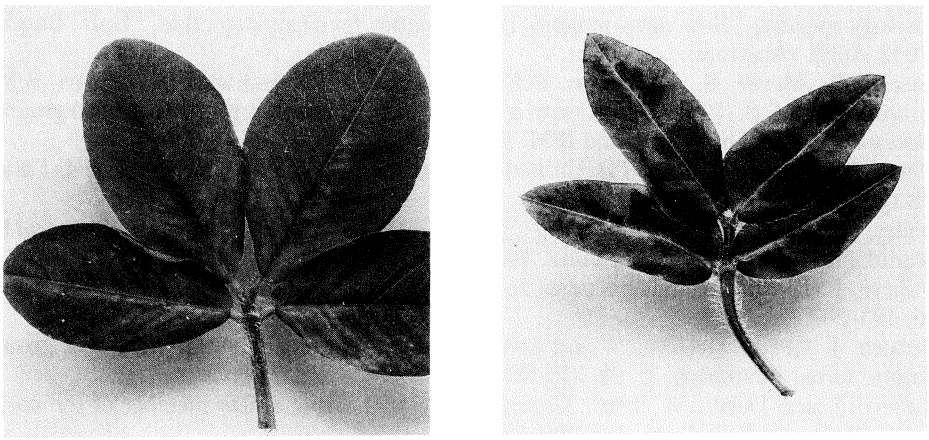
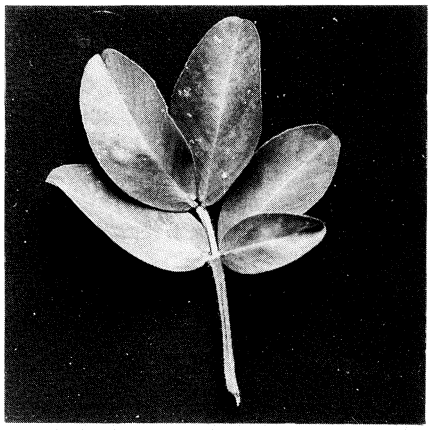
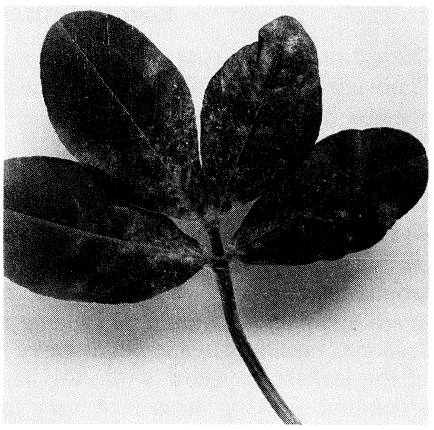


Fig. 5 (A) Groundnut streak disease with chlorotic and necrotic streaks between the secondary veins. (B) Groundnut mosaic disease with malformation, dark green and irregular spots without chlorosis.



(C) Groundnut golden mosaic disease with yellowing of the apical part of the leaflets which are not completely unfolded.



(D) Groundnut flecking disease, with faint flecking on the leaves and light narrowing of the basal parts of the leaflets.

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Discussion

Honda, Y. (Japan): The angle-layered aggregates of particles you showed in peanut clump resemble those reported in cowpea mild mottle virus. Did you detect virus particles in the rosette lesions?

Answer: Our attempts have been so far unsuccessful.

Reddy, D.V.R. (ICRISAT): Groundnut rosette is a very important disease. Recently the presence of two viruses (luteovirus group) has been confirmed and virus particles have been detected in samples from various countries, namely isolates from Nigeria and Malawi in both green and chlorotic rosette. The nucleic acid has been purified (double-stranded RNA). the particles are best observed in thin sections by immunosorbent electron microscopy using luteovirus antiserum. Also sap transmission which used to be difficult to obtain is now possible.