# DISEASES OF THE WINGED BEAN IN IVORY COAST

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## ABSTRACT

Incidence of diseases and pathogens on the winged bean, Psophocarpus tetragonolobus, recently introduced into Ivory Coast was observed. Root-knot nematodes (Meloidogyne spp.) severely damaged roots and tubers of the bean. Three viral diseases were observed, which sometimes produced very heavy damage. A leaf anthracnose caused by Colletotrichum gloeosporioides did not reduce yield.

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The winged bean (Psophocarpus tetragonolobus) is a backyard crop grown in Southeast Asia, from Papua to Sri Lanka. In 1975 a panel of the National Academy of Sciences in Washington, D.C., on underexploited tropical plants, recognized the potential of the winged bean as a food crop throughout the humid tropical zone, where it could ease the problem of protein malnutrition. The panel recommended testing this plant in experiment stations in diverse regions of the tropics. The winged bean is rich in protein in seeds (29.8-37.4%), tubers (12.2-15.0%), leaves (5.7-15.0%), and flowers (5.6%). Immature pods are rich in vitamins, and seeds are a source of edible oil (15-20.4% fat) (1).

The Nestle Foundation introduced the culture of winged bean in the Ivory Coast in 1976, for the purpose of improving the protein content of the diet of people living in the forest zone (4). Field tests were initiated in 1976 at Kpouebo. A backyard planting in that village, on soil previously used to grow tomato, eggplant, and okra, was sown with P. tetragonolobus in February 1977. In May 1977, a 1-hectare field 2 km from Kpouebo, where the forest had been cleared 2 years previously for upland rice culture, was sown with winged bean. Two cultivars, one from Papua (New Guinea) and one from Ghana (of Chinese origin) were used. Geneticists from Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) also established a plot at Adiopodoume, to evaluate various cultivars. Mean annual rainfall is 1500 mm at Kpouebo and 2300 mm at Adiopodoume.

At the request of M. Sylla, an agronomist at the Nestle Foundation, the authors made observations on the incidence of various diseases and pathogens on this new crop.

## NEMATODES

In July 1977, beans cultivated in the backyard planting at Kpouebo were heavily infected with root-knot nematodes. Symptoms are illustrated in Figure 1b. Oostenbrink (2) had previously reported an attack by Meloidogyne javanica on P. tetragonolobus in New Guinea. The species present in Ivory Coast were determined by Dr. D. P. Taylor (ORSTOM, Dakar, Senegal) as belonging to the Meloidogyne javanica - M. incognita - M. arenaria complex, which is very common in Africa. Pratylenchus brachyurus was also present in small numbers. At that time, in the field plot in the forest near Kpouebo, roots were apparently free of Meloidogyne.

At harvest time, in November, heavily galled roots were found in the field plot. On some roots the attack was severe enough to render the tubers unfit for consumption (Fig. 1b). No assessment of reduction in yield of pods, seeds, or leaves was made.

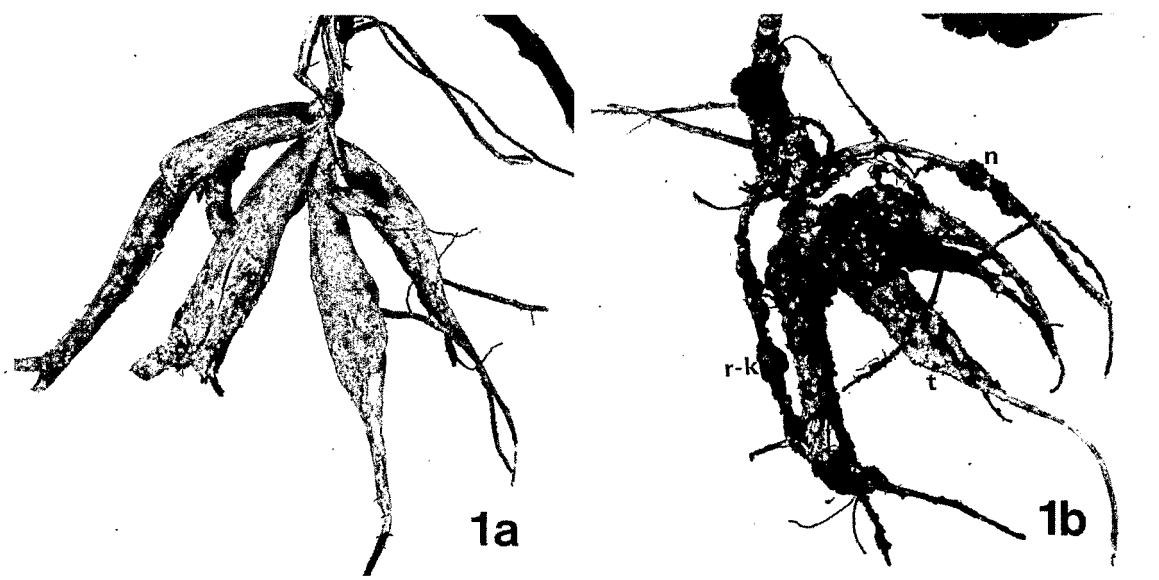


FIGURE 1. Damage caused by nematodes on Psophocarpus tetragonolobus. 1a) Healthy roots and tubers. 1b) Roots attacked by root-knot nematodes. t = damaged tubers, r-k = root-knot attack on roots, n = bacterial nodules.

A final survey, in January 1978, showed the field to be very heavily infested. Many plants had been killed and tubers were reduced in number (an estimated 50% of the tubers of the Papua cultivar and 60-70% of the Ghana cultivar failed to develop).

Root-knot nematode damage on tubers was evident, even in a field that had a very low level of infestation at sowing time. Reduction in yield of the other edible parts of the plant (pods, beans, and so forth) probably occurred, and it appeared imperative to control the nematodes either by chemicals, by using resistant cultivars, or by rotation with nonhost plants.

At Adiopodoume, the plot was treated with 5 g of 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate (3% carbofuran) per plant at planting. No infestation was observed during the growing season; however, it is not known whether this was due to the nematicide or to a low level of infestation in the soil.

## VIRUSES

Three virus diseases were observed on winged bean. Preliminary results obtained in the study of their causal agent are presented.

A. Psophocarpus necrotic mosaic virus: The disease appeared only at Adiopodoume. It affected 9% of the young plants distributed throughout the entire field. Leaves of diseased plants were necrotic and distorted, with an occasional yellow mosaic pattern (Fig. 2a). The leaf surfaces were noticeably reduced, and the plants were underdeveloped. Severity of the disease appeared to be correlated with the time of infection. On older plants, the number of flowers was reduced, and consequently the yield was greatly reduced.

The disease was found to be mechanically transmissible from Psophocarpus to Psophocarpus, as well as to a limited number of other plants belonging to the families Leguminosae and Solanaceae. Apart from Psophocarpus, the only host plant showing symptoms was Canavalia ensiformis; other infected plants remained symptomless.

There was no transmission of the disease by seeds collected from infected Psophocarpus. Aphis gossypii and Aphis craccivora failed to transmit the disease in either a nonpersistent or a persistent manner.

Purification of the virus was possible from infected leaves of Canavalia ensiformis and from infected leaves of Nicotiana megalosiphon. The grinding buffer used was phosphate 0.2 M pH 7.5, the crude sap was clarified by chloroform and concentrated with ammonium sulfate 20%. The final purification used a sucrose density gradient of 10-40% for 2 hours. The yield was about 10 mg/kg.

The ultraviolet spectra of purified preparations were typical of nucleoprotein with an helical symmetry.

Virus preparations, negatively stained with 2.5 uranyl acetate, were observed under an electron microscope and revealed elongated particles with a width of 14 nm and a length of 614-645 nm (Fig. 2b). A purified suspension inoculated to young seedlings of Psophocarpus induced typical symptoms of necrosis.

No such virus has previously been known to infect winged bean, and the disease is described here for the first time. In a comparison of the host range and symptoms of other filamentous viruses infecting legumes, we were unable to find any similarity with the present virus. No virus has been described with the same length and the same properties; therefore, we believe that Psophocarpus necrosis is caused by a filamentous virus previously undescribed, probably a carlavirus. We propose the name Psophocarpus necrotic mosaic virus.

B. Psophocarpus ringspot mosaic virus: A second disease was observed at Kpouebo. Every plant in both fields of winged bean in this village was infected. Contamination apparently occurred early, because symptoms could be observed on the first leaves. Leaves of diseased plants had light-green ringspots (Fig. 2c). The spots often coalesced to form a yellow mosaic. The exact reduction in yield caused by the disease is not known, but is estimated at about 10-20%. All plants were infected and the total loss was rather severe.

The virus was easily transmitted mechanically from Psophocarpus to Psophocarpus by using a phosphate buffer 0.1 M pH 7.1. Every inoculated seedling became diseased. The host range of this virus was found to be rather wide because it was able to infect plants within the families Leguminosae, Solanaceae, and Chenopodiaceae. Seeds harvested from naturally infected Psophocarpus had a virus transmission rate of about 1%. Aphis craccivora transmitted the disease in a nonpersistent manner, producing the same symptoms. For these experiments, 10 aphids were placed on each plant after a feeding time of 15 minutes on diseased plants. The thermal inactivation point was between 50° and 55°C. The longevity in vitro at 20°C was 29 hours; the virus was still infectious after freezing. For purification, the crude sap of infected

leaves was clarified by chloroform, and the virus was concentrated by alternating high and low centrifugations. The purification buffer was phosphate 0.2 M pH 7.5. The virus was finally purified on a sucrose density gradient 10-40% for 2 hours. The yield of virus was about 25 mg/kg, and the ultraviolet absorption spectra of purified suspension was typical of nucleoprotein and isometric particles. Under the electron microscope, virus preparations negatively stained with 2.5% uranyl acetate appeared to be composed of spherical particles with a diameter of 24 nm (Fig. 2d).

The purified virus inoculated to young seedlings of Psophocarpus induced ringspot symptoms.

This virus was found to be serologically related to cucumber mosaic virus (CMV) strain d.

The disease is described on Psophocarpus for the first time. Many of its properties lead us to believe that the virus is a cucumovirus; however, there are several differences in the host range and symptomatology between the Psophocarpus isolate and the other CMV legume isolates. For this reason, we shall refer to the virus as CMV strain Psophocarpus.

C. Psophocarpus leaf-curl disease: This disease appeared only at Kpouebo. All plants were infected, but not before the beginning of flowering. Leaves became dark green, thickened, and coiled downward (Fig. 2e). The apex stopped growing and many flowers fell off. Greenpod and seed production appeared to be severely affected by the disease. Young leaves of the after-growth, however, were free of symptoms; symptoms reappeared later. This demonstrates that the development of the causal agent was rather slow.

All of the usual methods of mechanical transmission, grafting, and purification failed to prove the presence of a virus. Preliminary transmission by seed or insects was also unsuccessful, and no virus was observed on electron microscope preparations. Consequently, it cannot yet be concluded that there is a viral agent for this disease. Similarities with okra leaf-curl, however, which is white-fly-transmitted, support the virus hypothesis. In addition, it is improbable that this disease is an artificially-induced physiological disorder because no chemical fertilizer or pesticide was used.

Presently, very little is known about virus diseases that affect Psophocarpus. Several authors (1, 3) have described this plant as being rather free of virus diseases. Sinnadurai (1977, The Winged Bean Flyer,) however, mentioned a severe virus disease on Psophocarpus in Ghana, but he did not give further details. In the Ivory Coast, three important diseases have appeared after only 2 years of winged bean culture. Two of them are definitely caused by viral agents: the filamentous Psophocarpus necrotic mosaic virus and the spherical Psophocarpus ringspot mosaic virus strain of CMV. The causal agent of the third disease is still unknown.

The virus diseases described on Psophocarpus are important because they attack the plants severely and great numbers of plants are infected. Control of these diseases should enhance the development of Psophocarpus production in the Ivory Coast.

## FUNGUS

Little is known of the sensitivity of Psophocarpus tetragonolobus toward pathogenic fungi. We have observed only one fungal disease, which attacks leaves on older plants.

Brown necrotic polygonal-shaped leaf spots, a few centimeters wide and sometimes coalescing, were scattered irregularly on leaves. Newly formed spots were surrounded by a chlorotic diffuse area. The leaf tissues in the spot itself were first light yellow, and then turned brown and necrotic. On the largest spots, the foliar tissues shriveled, tore off, and fell. Leaves then appeared pitted.

Under the microscope, small glabrous acervuli, roundish or elongate, of the Colletotrichum-type, were visible on the necrotic tissues. The fungus was easily isolated and cultured. In culture, a dark brown thallus appeared which after a few days produced many separate acervuli with a diameter of 1-2 mm, excreting a light pink sporiferous jelly. This jelly enclosed hyaline conidia regularly cylindrical 12.4-16.5 $\mu$m long and 4-5.5 $\mu$m wide.

Also present on the thallus were black-brown glomerulae formed by spherical perithecia closely grouped. In the asci, eight hyaline ascospores were regularly arranged. These ascospores were markedly curved and were slightly larger than the conidia: 18-22 x 6-8 $\mu$m.

The conidial form observed on the diseased leaves was identified as Colletotrichum gloeosporioides Penz., and the sexual form as Glomerella cingulata (Ston.) Spauld. & Schrenk.

Pathogenicity of the Colletotrichum to P. tetragonolobus was ascertained as follows: A concentrated suspension of conidia was sprayed on 1- and 2- month-old plants, which were then kept in a moist chamber for 48 hours. Eight days after inoculation numerous necrotic leaf spots were observed. From the acervuli formed on these spots, the fungus was re-isolated.

After 15 days, the younger leaves and the tip of the stem were parched. Thus, under optimal conditions, the fungus appeared to be able to attack both leaves and stem; this was never observed in the field, however.

At this time, the disease apparently does not reduce yield because only the older leaves are attacked. Further observations should be made, particularly during the rainy season when high humidity may permit the fungus to infect young leaves and stems. If this happens, the severity of the disease will be far greater.

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