EPIDEMIOLOGY OF INDIAN PEANUT CLUMP VIRUS TRANSMITTED BY *POLYMYXA* sp.

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Summary

The peanut clump virus disease, caused by Indian peanut clump virus (IPCV) is widespread in the Indian subcontinent. It occurs in sandy soils. Epidemiology of the Hyderabad isolate of IPCV has been studied in rainy and postrainy seasons in India. The virus produces severe symptoms not only on groundnut but also on pigeon pea, wheat and barley under field conditions. Sorghum, pearl millet, finger millet, foxtail millet, maize, rice, cowpea, chickpea, soya bean, mung bean and rapeseed were infected by the virus without showing any overt symptoms. Sunflower was not infected by the virus. Various monocotyledonous weeds naturally infected by IPCV were *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Digitaria ciliaris*, *Eragrostis ciliaris* and *E. unilodes*. The dicotyledonous ones were *Celosia argentea*, *Macroptilium atropurpureum* and *Oldenlandia corymbosa*. The virus is seed-transmitted in groundnut, pearl millet, finger millet, foxtail millet and wheat. *Polymyxa* sp. is often detected in the roots of monocotyledonous hosts. The fungus has only been detected once in groundnut roots and not in the roots of other dicotyledonous plants collected from IPCV infested patches. The infection of roots by *Polymyxa* sp. in India is influenced by the climatic conditions, especially those of rainfall distribution and temperatures.

Introduction

Peanut clump is a seedborne (Reddy, 1991 and Konaté and Barro, 1993) and soilborne virus causing severe damage to the crop in semi-arid areas of West-Africa (PCV) (Thouvenel *et al.*, 1988). In the Indian subcontinent, where it is referred to as Indian peanut clump virus (IPCV), at least three distinct serotypes are known (Nolt *et al.*, 1988) and none of the IPCV isolates cross react with those reported from West Africa. This high variability complicates detection of the virus by serology (Miller *et al.*, this volume). IPCV is known to infect many monocotyledonous and dicotyledonous plants but the fungus, *Polymyxa* sp., which was shown to be the vector of IPCV, is known to prefer monocotyledonous plants to complete its life cycle (Ratna *et al.*, 1991). However, those hosts which play a crucial role in perpetuation of the fungus and transmission of the virus with severe incidence are yet to be identified. IPCV has been shown to be seed-transmitted in groundnut and several monocotyledonous hosts, however it is not known if seedborne inoculum can initiate the disease in areas where non-viruliferous populations of *Polymyxa* sp. occur. Resistance to IPCV has so far not been located in cultivated or wild *Arachis* sp. Control may have to rely on cultural practices and information generated from epidemiological studies is likely to guide disease management.

Geographical Distribution and Cropping Systems

The Durgapura isolate (D-IPCV) is a member of the most widespread serotype of IPCV. It occurs in the Indian States of Gujarat (Talod), Rajasthan (Boraj, Dausa, Durgapura, Kallavas and Ranoli), Andhra Pradesh (Bapatla, Chinnaganjam, Ganapavaram, Pallipalem, Ramapuram and Tsundupalle), Tamil Nadu (Pondicherry) and in the Punjab Province of Pakistan in Attock, Chakwal and Rawalpindi districts (Delfosse *et al.*, 1995a). A second serotype, which occurs in Punjab in India (Jalandhar, Ludhiana and Sangrur), is

referred to as Ludhiana isolate (L-IPCV) and is also present in Pakistan in Attock district. In Hyderabad, Andhra Pradesh (A.P.), a third serotype (H-IPCV) occurs. The disease in India and Pakistan is very severe in the areas where groundnut is rotated with cereals and particularly with wheat. In Punjab the disease caused severe damage to groundnut until the early eighties when the wheat-groundnut rotation was replaced by a wheat-rice system.

Natural Host Range

Various naturally occurring weeds were tested at ICRISAT Asia Center (IAC) for the presence of H-IPCV and *Polymyxa* sp. Results for monocotyledonous weeds (Table 1) show that highly pernicious weeds can act as carry-over hosts for the virus and its vector. Moreover all vegetatively reproducing rhizomes of *C. dactylon* arising from an infected plant contained the virus and recent experiments indicate that rhizomes carrying the virus but not the vector contributed to the establishment of the disease in soil harbouring nonviruliferous *Polymyxa* sp. For *Cyperus rotundus*, roots were rarely found to be infected by the virus and tubers and leaves were never found to be positive in ELISA and ISEM. Various dicotyledonous weeds (*Celosia argentea, Desmodium sp., Eclipta alba, Euphorbia hirta, Flaveria australasica, Indigofera sp., Macroptilium atropurpureum, Merriemia gangetica, Oldenlandia corymbosa, Phyllanthus niruri, Tridax procumbens, and Vernonia cinerea*) collected in H-IPCV infested areas did not show the presence of the vector. *Celosia argentea, Macroptilium atropurpureum* and *Oldenlandia corymbosa* were symptomless hosts for the virus.

Table 1. Results of monitoring of *Polymyxa* sp. in the roots of various monocotyledonous weeds collected from a clump infested field at ICRISAT Asia Center and, HIPCV in roots and leaves, by ELISA.

	Number of plants infected (n)/Number of plants tested (N)			
	Polymyxa sp.		H-IPCV	
Species	n/N	Degree of infection	Leaves	Roots
Cynodon dactylon	6/26	+	11/26	12/26
Cyperus rotundus	19/28	+ to +++	0/28	2/28
Cyperus diffusus	1/2	+++	0/2	0/2
Dactyloctenium aegyptium	13/22	+ to +++	5/22	6/22
Digitaria ciliaris	3/22	+ to +++	1/22	2/22±
Eragrostis ciliaris	3/13	+ to ++	11/13	11/13
Eragrostis uniloides	2/22	++ to +++	10/22	11/22

(+ : low infection, ++ : medium infection, +++ : high infection).

The virus incidence in roots and leaves of various monocotyledonous crops and groundnut from an H-IPCV infested field was monitored during the 1995 rainy season. Twelve days after sowing, plants containing the viral antigen in their roots were found in all the crops when tested by ELISA. The virus was also detected in the leaves of barley (13%), maize (6%) and wheat (31%). Wheat showed the highest virus incidence in the roots (94%) followed by maize (50%). Two months after germination it was possible to detect the virus in wheat and barley leaves but no longer in roots. For others species the virus incidence stayed higher in roots than leaves. Over the entire season, the incidence of the virus in roots and in leaves was: 62% and %56 in barley, 28% and 21% in finger millet, 21% and 8% in groundnut, 38% and 4% in maize, 3% and 0% in pearl millet, 3% and 1% in rice, 26% and 6% in sorghum and 85% and 76% in wheat. The same samples were also analysed for the presence of *Polymyxa* sp. Maize, pearl millet and sorghum were seldom found to be infected by the fungus but those plants with infection showed a very high number of resting spores in their roots. Though the other crops were infected by the virus, *Polymyxa* sp. could not be found in the roots. However evidence has been obtained to show (Rama *et al.*, 1991) that both the vector and the virus can infect most of these crops so there is a high risk that rotation with these crops would lead to an

increase in the disease incidence. When barley was grown under irrigation during the postrainy season, H-IPCV infected plants showed symptoms very similar to those of wheat plants (stunting and dark green leaves with yellow stripes turning necrotic as the plants aged, Delfosse *et al.*, 1995b).

When a selected number of dicotyledonous crop plants was raised in an infested field during the 1995 rainy season, the proportion of infected plants was: chickpea (4%), cowpea (6%), groundnut (28%), mung bean (1%), pigeon pea (26%), rapeseed (1%) and soya bean (4%). Interestingly, sunflower was the only crop not infected, although it could be manually infected with H-IPCV in the laboratory. Infected pigeon pea plants were severely stunted compared to healthy plants and showed mosaic symptoms on young leaves. Presence of H-IPCV particles in leaves of stunted pigeon pea plants was confirmed by ISEM.

Factors influencing virus transmission and disease occurrence

The temporal and climatic factors influencing H-IPCV transmission by *Polymyxa* sp. to groundnut, sorghum, pearl millet and finger millet, were studied during the 1994 rainy season. The groundnut crop was scored at 2 weeks intervals for virus incidence. Most infection occurred in July with the onset of monsoon rains (80% of the total infected plants during the season). Cereals were sampled at weekly intervals and analysed for the presence of the fungus in their roots and the virus in their leaves. Infection by *Polymyxa* sp. varied greatly during the season and was correlated with the cumulative weekly rainfall (CWR) recorded 15 days before sampling, in agreement with the time needed (10 to 12 days) to form cystosori. This correlation was supported by another experiment where seedlings were raised in a glasshouse for one week, then exposed for one week in a virus infested field and finally transplanted into sterile sand. They were subsequently maintained in a glasshouse to allow the fungus to complete its life cycle. Results of this experiment showed that the incidence of *Polymyxa* sp. in the roots of sorghum and pearl millet was correlated with the CWR recorded during the week of exposure in the field. In both cases, a CWR of 14 mm was sufficient to induce *Polymyxa* sp. infection. The incidence of the fungus recorded during the entire season was higher in pearl millet (21%) and sorghum (18%) compared to finger millet (5%). However the virus incidence was higher in the millets (6%) than in sorghum (3%). The fungus was present in plants grown both in virus infested and virus free areas. During the rainy season the daily mean soil temperature ranged from 24 to 29°C but generally remained higher than 25°C, a conducive condition for infection by *Polymyxa* (Legrève *et al.*, this volume).

The incidence of IPCV in groundnut is influenced by the date of sowing. April sown crops in Pakistan showed low incidence while those sown in July with the onset of the monsoon rains were severely affected. However in India, crops sown after initial heavy rains, until 15 days after the onset of the monsoon, were weakly affected by the disease. In India, the soil temperature in summer reaches 40 to 50°C and this dry heat induces the breakdown of fungal spore dormancy (Legrève *et al.*, unpublished data). Heavy rains at the onset of monsoon, are assumed to induce the release of many primary zoospores, which infect even nonpreferred hosts such as groundnut. Barley, wheat and sorghum grown in the postrainy season under irrigation in A.P. were infected by the virus while groundnut was not. In this case, the germination of resting spores is likely to be induced by the root exudates from the cereal hosts. In Rajasthan where the air temperature in postrainy season is much lower than in A.P., no virus infection was found in thousands of wheat and barley samples, roots and leaves, either at early stage or close to maturity. The virus can multiply at temperature close to 15°C (Reddy et al., 1988) but such low temperature would not have been conducive to activation of *Polymyxa* sp. (Legrève et al., this volume) so transmission of the virus did not occur.

Perspectives and Management

Resistance in nearly 9000 *A. hypogaea* germplasm lines could not be identified for IPCV, and biocides, though effective in reducing disease incidence are hazardous and not economical. Therefore it is imperative to identify cultural methods for the control of IPCV. Although H-IPCV was detected in several

dicotyledonous plants, resting spores of *Polymyxa* sp. were rarely detected in such plants (Ratna et al., 1991). They were few in number so they probably contribute little to increase the incidence of H-IPCV. Additionally roots of naturally infected groundnut plants failed to induce incidence when incorporated into sterile sandy soils. Preliminary observations at IAC have shown that it is possible to reduce disease incidence by growing a crop which does not support *Polymyxa* sp. multiplication in the postrainy season prior to a rainy season groundnut crop. The disease incidence in plots where the postrainy season crop was groundnut was much lower than in plots where sorghum was grown. On the other hand, in the rainy season, a bait crop (pearl millet) grown for 15 days and then ploughed into the soil prior to sowing groundnut reduced disease incidence from 22-36% to 4-8%. The presence of a preferred host such as pearl millet could have induced the germination of *Polymyxa* sp. cystosori and before the fungus completed its life cycle the host was killed by ploughing it into the soil. Clean cultivation is recommended since monocotyledonous weeds, such as *C. dactylon* can contribute to disease establishment. The virus was found to be seed transmitted in finger millet, foxtail millet, groundnut, pearl millet and wheat. The use of virus free seed is essential to prevent the spread of the disease. In preliminary experiments infected groundnut seed failed to provide the inoculum for *Polymyxa* sp. in uninfested soils but this aspect needs further investigation. Currently influence of cereal seed, in contributing to disease establishment, is being tested.

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