YELLOWS TYPE OF DISEASES IN INDIA : EGGPLANT LITTLE LEAF

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Mycoplasma-like bodies (MLB) have been detected in phloem cells of roots of eggplant affected with little leaf. The size of the MLBs varied from 230 to 770 nm. Each MLB contained ribosomes and strands of nuclear material surrounded by 16.5 nm wide triple layered unit membrane. Treatment of eggplants affected with little leaf with achromycin, aureomycin, ledermycin and terramycin resulted in remission of symptoms. Best method of application of ledermycin was infiltration followed by spraying. Pre- and post-inoculation sprayings were better than post-inoculation sprayings alone. Treatment with gibberellic acid followed by ledermycin spraying gave better recovery than ledermycin alone. No recovery was obtained by treatment with garramycin and penicillin.

INTRODUCTION

Yellows type of diseases have always been serious problems but in recent years they have assumed greater importance due to the involvement of Mycoplasma-like bodies in their causation. Several such diseases have been described from India earlier (Table I) and association of mycoplasma-like bodies demonstrated with some of them—sandal spike (Varma *et al.* 1969; Hull *et al.* 1969), little leaf of brinjal (Varma *et al.* 1969), sugarcane grassy shoot (Corbett *et al.* 1972), cotton little leaf (Gourret and Mailet 1969 ; Capoor *et al.* 1972). These and citrus greening diseases have also responded to treatments with tetracycline antibiotics (Raychaudhuri *et al.* 1972; Nariani *et al.* 1971), further suggesting their mycoplasmal etiology. Although most of these diseases await confirmation of mycoplasmal etiology the increased awareness to such diseases has resulted in discovery of several new diseases which hitherto remained unnoticed.

In India alone nearly twenty newer species of plants were observed to be affected with yellows type of malady (Table I) and possibly there must be many more still awaiting attention. Luckily these diseases, though devastating, unlike viruses are responsive to antibiotics. Results of investigations on eggplant little leaf are reported in this paper.

MATERIALS AND METHODS

For electron microscopy small pieces of roots from healthy and diseased eggplants were fixed in 6 per cent glutaraldehyde in cold for 12 hr, dehydrated in acetone saturated with uranyl acetate, embedded in Spurr's low viscosity embedding medium and cut with glass knives using LKB ultrotome. Sections were post stained with uranyl acetate and lead citrate and examined in Philips EM 300.

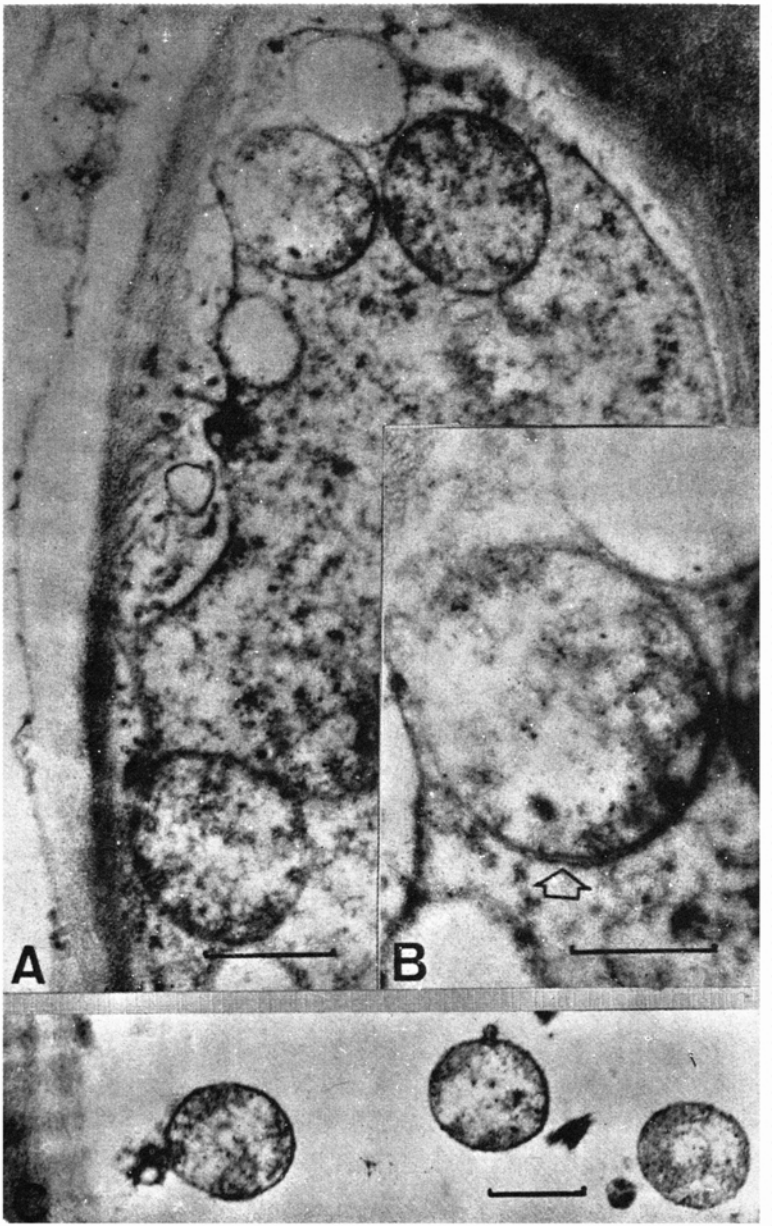

FIG. 1. A, Cross section of a sieve tube from diseased roots of brinjal, showing typical mycoplasma-like bodies. The bar represents 500 nm; B, One mycoplasma-like body from Fig. A, showing triple-layered unit membrane (arrow). The bar represents 250 nm; C, Typical mycoplrsma-like bodies in an area devoid of cellular contents. Granular ribosomes and strands of nuclear meterial are clearly resolved in mycoplasma-like bodies. The bar represents 500 nm.

Achromycin, aureomycin, benlate, gibberellic acid, ledermycin and terramycin were tried for their effect against the disease. These chemicals, in distilled water,

were applied by foliar spraying, soil drenching, leaf dipping and infiltration in different concentrations. Control plants were similarly treated with distilled water alone. The disease was transmitted by grafting to test plants.

RESULTS

Electron microscopy

The roots of diseased eggplants, like the shoots were also found severely affected. The root system was considerably reduced as compared to that of healthy plants of comparative age. To check whether mycoplasma-like bodies, earlier observed in the leaves of diseased plants (Varma *et al.* 1969), were also present in the roots or not, ultrathin sections through the phloem tissues of healthy and diseased roots were examined. Typical mycoplasma-like bodies were observed (Fig. 1) in the diseased tissues and no such bodies were seen in healthy tissues. These MLBs were pleomorphic, though a majority of them were roundish in appearance. The size of these bodies varied from 230 to 770 nm. Each MLB contained ribosomes and strands of nuclear material (Fig. 1C) surrounded by a triple layered unit membrane 16.5 nm wide (Fig. 1B) with electron dense outer and inner layers.

Chemotherapy

Achromycin, aureomycin, garramycin, ledermycin, penicillin and terramycin were applied to plants infected with little leaf disease (Table II). Garramycin and penicillin had no effect on disease development as all the treated plants developed typical disease symptoms. There was reduction in number of plants developing symptoms in other treatments. Pre- and post-inoculation sprayings with mycoplasmastatic substances were more effective than post-inoculation sprayings alone. Pre-inoculation infiltration, however, did not affect the disease development and post-inoculation infiltration with aureomycin, ledermycin and terramycin completely prevented the disease development.

Of the various methods (Table III) tried for application of ledermycin, best was infiltration followed by spraying and soil drenching. Root dip and leaf dip methods had no apparent effect on the symptom development whereas application of paste was toxic.

Diseased plants sprayed with 50 ppm gibberellic acid also showed recovery in symptoms and when the plants were treated with gibberellic acid followed by ledermycin recovery in symptoms was better than by ledermycin alone. The incidence of the disease under natural conditions was 20 per cent in plants sprayed with water or penicillin (250 ppm) whereas plants sprayed with 250 ppm solutions of tetracyclines—achromycin, aureomycin, ledermycin and terramycin remained free from the disease.

DISCUSSION

MLBs were found earlier by Varma *et al.* (1969) in phloem cells of leaves of diseased eggplants. Presence of typical mycoplasma like bodies in the phloem cells of roots further strengthen the mycoplasmal etiology of the disease and indicates uniform

TABLE I

Yellows type of diseases in India

Disease	Natural host	First report of the disease	First report for mycoplasmal etiology
Arecanut yellow leaf	*Areca catechu*	—	Nayar (1971)
Acalypha witches' broom	*Acalypha indica*	—	—
Banana bunchy top	*Musa paradisiaca*	Magee (1927)	—
Brinjal (eggplant) little leaf	*Solanum melongena*	Thomas and Krishnaswami (1939)	Anjaneyulu and Ramakrishnan (1969); Varma *et al.* (1969)
Broombush witches' broom	*Parthenium hysterophorus*	Varma *et al.* (1974)	Varma *et al.* (1974)
Citrus greening	*Citrus sinensis*	Fraser *et al.* (1966)	Lafleche and Bove (1970)
Cotton stenosis	*Gossypium* spp.	Uppal *et al.* (1944)	Capoor *et al.* (1974)
Cowpea witches' broom	*Vigna sinensis*	—	—
Dodonea witches' broom	*Dodonea viscosa*	Hull *et. al.* (1970)	—
Duranta little leaf	*Duranta plumieri*	—	Hull *et al.* (1970)
Eclipta phyllody	*Eclipta prostrata*	—	—
Gyanandropsis witches' broom	*Gynandropsis gynandra*	—	—
Justicia little leaf	*Justicia gendrarussa*	—	—
Linaria little leaf	*Linaria* sp.	—	—
Mirabilis little leaf	*Mirabilis jalapa*	Ghosh *et al.* (1975)	Ghosh *et al.* (1975).
Mung (green gram) phyllody	*Phaseolus aureus*	Shyam and Bhatnagar (1965)	—
Namesia phyllody	*Namesia* sp.	—	—
Petunia little leaf	*Petunia* sp.	—	—
Phyllanthus little leaf	*Phyllanthus* sp.	—	—
Pigeon pea steriiity	*Cajanuscja an*	Capoor (1952)	—
Potato purple top	*Solanum tuberosum*	Giri and Nagaich (1971)	Nagaich and Giri (1974)
Rice yellow dwarf	*Oryza sativa*	Hashioka (1964)	Shikata *et al.* (1969)
Rubia little leaf	*Rubia* sp.	—	—
Salix virescence	*Salix babylonica*	—	—
Sandal spike	*Santalum album*	Barber (1903)	Varma *et al.* (1969)
Sunnhemp phyllody	*Crotalaria juncea*	Bose and Misra (1938)	
Sesamum phyllody	*Sesamum indicum*	Pal and Pushkarnath (1935)	Cousin *et al.* (1970)
Soybean phyllody	*Glycine soja*	A. K. Sarbhoy (unpublished)	—
Sugarcane grassy shoot	*Saccharum officinarum*	Vasudeva (1956)	Corbett *et al.* (1972)
Tagetes phyllody	*Tagetes erecta*	—	—
Tori phyllody	*Luffa aegyptiaca*	—	—
Turnip phyllody	*Brassica campestris*	—	—
Urid (black gram) phyllody	*Phaseolus mungo*	Singh *et al.* (1954)	
Periwinkle virescence	*Vinca rosea*	—	
Zizyphus witches' broom	*Zizyphus oenoplea*	Hull *et al.* (1970)	Hull *et al.* (1970)

TABLE II

Effect of treatment with various antibiotics on development of symptoms of little leaf in eggplants

Antibiotics*	% Plants infected			
	Sprayed		Infiltrated	
	Pre- & post-inoculation	Post-inoculation	Pre-inoculation	Post-inoculation
Achromycin	20	60	100	66
Aureomycin	40	40	90	0
Garramycin	100	—	—	—
Ledermycin	20	60	100	0
Penicillin	100	—	—	—
Terramycin	40	100	—	0

*Concentration equivalent to 250 ppm. Spraying was done twice a week for six weeks in post-inoculation treatments and for one week in pre-inoculation treatments. Infiltration was done only once.

TABLE III

Effect of treatment with Ledermycin by different methods on brinjal plants at advanced stage of the little leaf disease

Spraying[1]	Method of application				
	Soil drenching[2]	leaf dip[3]	Root dip[4]	Infiltration[5]	Girdling paste[6]
Partial recovery	Slight recovery	No recovery	No recovery	Good recovery	Toxic

1. Concentration of ledermycin was 100 and 50 ppm. Higher concentrations were toxic. In all other treatments, except girdling, 250 ppm was used.
2. Treated every day for one week.
3. Treated continuously for one week.
4. Given once for 3 hr, longer durations were toxic.
5. and 6. One treatment.

distribution of the MLBs in all parts of the diseased plants. Thus for effective cure of the diseased plants the therapeutant has to act in the entire plant. Temporary remission in symptoms by tetracycline treatments of plants affected with eggplant little leaf (Anjaneyulu and Ramakrishnan 1969; Raychaudhuri *et al.* 1970) could be due to the action of the tetracyclines in parts sprayed and reappearance of the symptoms by the movement of the pathogen to cured parts from parts unaffected by the treatment. Apparently, in spite of repeated spraying, tetracyclines do not acquire concentration effective enough to completely eliminate the pathogen from

the plants. This is elucidated by better recovery of plants infiltrated with tetracyclines. Here, even a single treatment resulted in complete elimination of the pathogen as the plants remained healthy after recovery.

In practice, for annuals like eggplant one is more concerned about the control of the disease by prophylactic treatments rather than cure of affected plants. In nature the plants are likely to be infected in the nursery or after transplanting. A properly devised method for infiltrating the plants with tetracyclines before transplanting would eliminate the chances of carrying the disease from nursery to field. Thereafter a schedule needs to be worked out in relation to the appearance of vectors, for spraying with mycoplasmastatic substances for keeping the plants free from the disease.

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