

# PURPLE TOP ROLL DISEASE OF POTATOES

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A graft transmitted disease of potato designated as purple top roll is prevalent in several potato varieties grown in the hilly tracts. The common symptoms are rolling of the basal parts of younger leaves, sometimes accompanied by pink or purple pigmentation. The plants are stunted with profuse growth of axillary branches and aerial tubers. The losses in yield vary from about 40 to 70 per cent. Five to twenty per cent of the tubers from diseased plants develop hairy sprouts. Tuber transmission of the pathogen varies from 6 to 33 per cent, depending on the variety. *Datura*, tomato and white clover, etc. are susceptible plants. *N. rustica* is tolerant or a symptomless carrier. Sunnhemp, petunia and sesamum are immune to the pathogen, which is transmitted by the leafhoppers, *Orosius albicinctus* Distant but not by *Cuscuta* spp. or by sap inoculation.

Application of chloramphenicol, tetracycline and antimioebin results in remission of symptoms and increased tuber yields, indicating possible association of a mycoplasma-like organism. These observations were borne out by the fact that mycoplasma-like bodies were found in several hosts affected by the pathogen but not in the healthy ones.

## INTRODUCTION

Rolling of leaves frequently accompanied by purple pigmentation, in the potato varieties was noticed in several areas in Assam, Bihar, Himachal Pradesh, Maharashtra, Punjab, and Uttar Pradesh. Incidence of the disease was higher in the hills than in the plains. The affected plants were stunted, had developed aerial tubers and lacked vigour. The average incidence of the disease in varieties 'Kufri Neelamani', 'Up-to-date', 'Kufri Chandramukhi', 'President' and 'Kufri Sindhuri' was 45, 35, 35, 21 and 19 per cent, respectively, during 1968. In a few fields of variety 'Kufri Neelamani' the incidence was as high as 86 per cent. No fungal, bacterial or nematode pathogens were found to be associated with the disease. The incitant (hereafter referred to as PTR) was transmitted by graft as well as leafhoppers to several herbaceous plants indicating the possibility of a virus or mycoplasma-like biotic factor being involved (Giri and Nagaich 1971).

## MATERIALS AND METHODS

Culture of the PTR was maintained on tomato and *Datura* spp. in glasshouse and propagated, usually, by grafts, as the pathogen is not sap transmissible.

Since leafhoppers were known to transmit similar pathogens these insects were collected from and around the fields having PTR affected potato plants and were caged on several hosts. The leafhoppers, however, died within 5-6 days after libera-

tion on potato. *Trifolium sp.*, *Crotalaria sp.* and *Lolium* grass were found to be the suitable host plants for rearing the leafhoppers in glasshouses. *Crotalaria juncea* L. (sunnhemp) was however found to be the best for *Orosius albicinctus* Distant which transmitted the PTR. Therefore, for multiplying healthy colonies of this leafhopper, sunnhemp plants were employed.

## RESULTS

### Symptoms

PTR was indicated by rolling of the basal parts of leaflets of young leaves frequently accompanied by light to intense pink or purple pigmentation and development of branches. Purplish pigmentation of young leaves may be preceded by smalling of the leaflets and marginal flavescence of the lamina. Some of the varieties, however, showed rolling without pigmentation. The infected plants became erect and stiff with many axillary shoots, aerial tubers and shortened internodes. Such plants were invariably stunted and lacked vigour. An early flowering was also observed in severely infected plants. The varieties which normally do not flower, under short day conditions prevalent in the plains, developed flower buds on infection with PTR. In advance stages the pigmentation rapidly intensified and sometimes a few plants were slightly wilted. Disappearance of the symptoms was also observed in the plants kept in glasshouses where temperature reached as high as 36 to 40°C for about 4 hr daily. The mother tubers or seed pieces producing diseased plants, generally, remained hard and intact even at the time of harvest of the plants. The tubers produced by the affected plants were smaller and aggregated around the main stem attached on short stolons. Yield losses caused by PTR in varieties 'Kufri Neelamani', 'Kufri Chandramukhi', 'Kufri Kundan', 'Great Scot' and 'Kufri Naveen' were 37, 56, 62, 67 and 71 per cent, respectively. Varieties 'Kufri Sindhuri', 'Kufri Chandramukhi', 'Kufri Neelamani' and 'Kufri Kundan' produced, respectively 5, 13, 20 and 21 per cent of hairy sprout (HS) tubers in the produce of PTR affected plants. Depending on the variety, 6 to 33 per cent of the tubers from diseased plants produced PTR affected plants in the next generation. In the second generation and onward practically all the tubers become free from the pathogen (Table I).

TABLE I  
Percentage of PTR and HS in successive generations in the produce of PTR affected plants

Varieties	Percentage of tubers/plants in different generations with symptoms					
	I Generation		II Generation		III Generation	
	HS	PTR	HS	PTR	HS	PTR
Kufri Kundan	33	33	0	0	0	0
Kufri Chandramukhi	13	13	0	0	0	0
Kufri Neelamani	20	6	0	0	0	0

*Graft and other transmissions*—Grafts were mostly made on *Datura stramonium* L., *D. metel* L., *Lycopersicon esculentum* Mill., *Cyphomandra betacea* (Cav.) Sendt., *Nicotiana rustica* L., *Crotalaria juncea* L., *Trifolium repens* L., *Petunia hybrida* Vilm., sesamum and *Capsicum* spp. In glasshouse, artificially infected plants of *D. stramonium* developed bright interveinal chlorosis of leaves, profuse proliferation of axillary shoots all along the stem and cessation of growth. The affected plants produced non-functional phylloid flowers. On *L. esculentum* the leaves were rendered small, narrow and distorted. The plants were severely stunted. The axillary branches grew profusely and flowers were phylloid and green. The plants developed a rosette appearance. *T. repens* produced yellowing at the margins of leaves. In later stages the symptoms became much more pronounced with smalling and chlorosis of entire lamina followed by pink pigmentation. The plants were stunted but flowers did not show any abnormality. *N. rustica* (local variety) did not develop any symptom in many attempts. However, the variety known to be susceptible to the aster yellows, in Illinois, produced only mild symptoms of narrowing of leaves and proliferation of axillary shoots. Therefore, the same were assayed by back inoculation on tomato and found to be carrier or tolerant to the PTR agent. Sunnhemp, sesamum, petunia, aster (local collections) and *Capsicum* spp. were found to be non-susceptible. *Cuscuta hyalina* Rothm., *C. reflexa* Roxb. and sap inoculation did not transmit the PTR.

Observations on clover plants growing under natural conditions showed symptoms of leaf-chlorosis followed by pink pigmentation. Healthy *O. albicinctus* fed on such naturally infected clover plants were put on healthy seedlings of test plants for 12 days. The symptoms developing on *Datura* and clover after feeding viruliferous leafhoppers or after grafting with diseased scions, were similar to those produced by PTR.

#### *Leafhopper transmission*

Healthy *O. albicinctus* and other leafhoppers were allowed to feed on PTR affected potato plants for 4-5 days and brought back to sunnhemp or other plants for the successful completion of incubation period. After about 10 to 12 days the leafhoppers were caged on a set of test plants of *Datura*, clover and potato planted in the same pots. After another 12 days the same insects were transferred to another set of test plants for the same period. *O. albicinctus* transmitted PTR whereas *Psammotettix provicialis* Ribaut and others did not. The symptoms produced on *Datura* and clover were the same as described under graft transmission studies, whereas potato plants did not show any symptoms in the same season. The tubers of these potato plants were potted after 2-3 months and some plants developing from them showed rolling, purplish pigmentation of primary leaves and remained stunted.

#### *Effect of antibiotics on symptoms and yield*

Apparently healthy as well as infected plants of potato varieties 'Kufri Chandramukhi', 'Kufri Naveen' and 'Kufri Neelamani' were labelled in the fields. The diseased plants were sprayed thrice at weekly intervals, with antiamoebin, DPB (a

product of the Hindustan Antibiotics Ltd., Poona), chloramphenicol and tetracycline in increasing concentrations. The solutions of 100, 200 and 300 ppm of the first two antibiotics and 500, 750 and 1,000 ppm of the last two antibiotics were used along with 1 per cent glycerine in all the cases. Some diseased plants were also sprayed with water to serve as control. Sprayed as well as unsprayed plants were observed regularly for growth and symptoms. Although the diseased plants did not attain normal growth after the sprays of antibiotics, nearly half of the plants showed no symptoms in the new growth. The yield data collected for two years showed that the effect of antibiotics varied from variety to variety (Table II). On the whole chloramphenicol, tetracycline and anti amoebic increased the yield. These trials are being made on larger scale and economics being worked out.

TABLE II

*Average yield of PTR affected (control) plants as well as of those sprayed with antibiotics*

Varieties	Yield (in g) of diseased plants sprayed with				
	Antiamoebic	DPB	Chloramphenicol	Tetracycline	Water (Control)
Kufri	297	216	—	139	176
Chandramukhi	(+68.70)	(+22.80)	—	(-21.10)	(0)
Kufri	391	383	456	488	424
Neelamani	(-7.78)	(+9.66)	(+7.54)	(+14.85)	(0)
Kufri Naveen	210	90	188	108	129
	(+62.77)	(-31.00)	(+46.00)	(-17.00)	(0)
Average	(+6.26)	(-13.40)	(+13.72)	(+11.25)	(0)

(+) indicates per cent increases in yields and (-) indicates per cent decreases in yields over control.

*Presence of mycoplasma-like bodies in diseased plants*—To ascertain the presence of viral or mycoplasma-like organism in the diseased plants, infected potato and tomato leaves were fixed in glutaraldehyde-osmic acid and the ultrathin sections stained in uranyl acetate. On examination of these sections in Siemens Elmiskop electron microscope mycoplasma-like bodies were found in the sieve elements but the same were not present in the healthy plant tissues.

#### DISCUSSION

PTR is an endemic disease in the cooler hilly regions, its incidence being highest in 1967-68. Most probably *T. repens*, which grows abundantly on the risers, acts as collateral as well as alternate host and allows the PTR agent to overwinter. The symptoms developing on infected *Datura* spp. and *T. repens* are very much similar to the symptoms of purple top wilt (also referred to as yellow top or purple dwarf or

late breaking disease) described from Japan (Murayama *et al.* 1967) and also from several other countries. Fedderson (1959) reported as high as 16 per cent hairy sprout development in the produce of purple top wilt-affected plants. This is in agreement with our results on PTR. The PTR-affected potato plants produce tubers which show 6-20 per cent hairy sprouts depending on the variety. Intensity of red or purple pigmentation of potato leaves varies in different varieties but upward rolling is invariably present.

Petunia, aster and *N. rustica* are highly susceptible to purple top wilt or aster yellows (MacLeod 1950; Younkin 1943) but are respectively immune and symptomless carrier or tolerant to PTR. Tuber transmission of purple top wilt as well as PTR pathogens is erratic. Norris (1954) and Murayama *et al.* (1967) reported, respectively, 8 and 3 per cent tuber transmission of purple top wilt, whereas PTR produces 6 to 30 per cent plants with PTR symptoms in the next generation. According to Richardson and Racicot (1958) the pathogen is transmitted up to five generations. In the case of PTR, however, the plants become free from the pathogen in the second generation or onward, in the absence of fresh infection. These results are in agreement with those of Robinson and Campbell (1958) who reported that the purple top wilt is self eliminating and the stocks become free in about two years.

*O. albicinctus*, the vector of PTR, is also the vector of phyllody of sesamum (Sahambi, 1967). But sesamum, sunnhemp and petunia (the main hosts of sesamum phyllody) are immune to PTR. This vector is not known to transmit any other pathogen affecting potato or related plants, although another species (*O. argentatus*) of the same genus is known to transmit purple top wilt (tomato big bud) in Australia (Conroy 1954; Norris 1954). PTR affected potato plants seldom wilt, *Datura* reacts with phyllody of flowers on infection with PTR. *Cuscuta* spp. do not transmit PTR. All these facts indicate that PTR is quite similar to the purple top wilt and can be classified in the same group of diseases. At the same time the pathogens have many differences to be called as distinct entities.

The remission of symptoms and increases in yield by application of antibiotics point out the possible association of mycoplasma-like organism with the disease, as is known in the case of aster yellows. Presence of mycoplasma-like bodies, in the diseased plants and not in the healthy plants is a good indication for association of mycoplasma-like organism with the purple top roll.

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