PHYTOPLASMA (=MLO) DISEASES OF POTATO

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Normally these pathogens are considered to be of minor importance in potato. However, there have been periodic "outbreaks" of phytoplasma (=mycoplasmalike organisms) in diverse regions of the North-American continent. These diseases in potato have been identified with many common names and are caused by two groups of phytoplasma: Purple Top, PT (=aster yellows, haywire, stolbur, apical leafroll,) among others, and Witches Broom, WB (=northern stolbur as well as dwarf shrub virosis) (Wright *et al.* 1981). There is recent DNA evidence that suggests that WB is indistinguishable from beet leafhopper transmitted virescence agent (BLTVA) (Smart *et al.* 1993). However, Lee, *et al.* (1991), reported that WB is closely related to, if not identical, to a strain of clover proliferation phytoplasma. Phytoplasma (=MLO), grouped under bacteria, are membrane-bounded and are prokaryotic. Neither PT nor WB phytoplasma can be mechanically (contact) transmitted from plant to plant. The leafhopper vectors acquire these pathogens from other plant species and transmit them to potato. Typically, there are long incubation periods in the leafhopper vectors (10-27 days) before they transmit phytoplasma. At least in PT, the disease agent circulates and multiplies in leafhoppers which remain infectious for many weeks if not for the life of the insect. Phytoplasma are sensitive to tetracycline antibiotics.

Purple-top: This disease appears to be of minor importance in the northwest United States, but has flared periodically in other areas. The aster yellows (AY) phytoplasma that causes PT, perhaps, causes more frequent problems in carrots and lettuce as well as in ornamentals than in potatoes. The AY phytoplasma can infect at least 350 plant species. Barley, durum wheat as well as several other grasses are hosts, in which the disease can easily be mistaken for barley yellow dwarf, a virus disease. The principal vectors are leafhoppers, the most, important of which is the aster leafhopper, *Macrosteles quadrilineatus* (=*M. fascifrons*). It normally does not prefer potatoes but will feed in them when forced. When grain and weed hosts, which are preferred, begin to mature leafhoppers leave and move into more succulent vegetation including potatoes. If sufficient numbers of leafhoppers are infectious with AY, potato plants become infected and develop symptoms called purple top.

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This name is appropriate in some cultivars, e.g. Russet Burbank, and Monona, because symptoms include stunting, bunchy apical growth and reddish or purple apical foliage. However in others, e.g. Norchip and Kennebec, the apical foliage turns yellow although it is also "stunted and bunched". When potatoes are infected in growth early, aerial tubers or swollen stems may develop. Subterranean tubers are smaller, but appear normal otherwise. Infected tubers stored for chipping will produce bright chips until about January or February when the area of the vascular ring in chips will darken (Banttari *et al.* 1990). In later processing (March-May), the darkening will extend into the medullary and cortical areas of the chips which makes them unacceptable. Infected seed potatoes will often not sprout or will produce non-viable "hair-sprouts", and skips in planting will occur. No definitive diagnostic assay is yet available for verification of PT in potato plants. The aster leafhopper cannot acquire the aster yellows phytoplasma from potato, therefore transmission tests to indicator hosts have not been possible. In two years (1994-1995) of monitoring aster leafhopper populations in potato in the Red River Valley of North Dakota, it appears that the largest influx of aster leafhoppers into potatoes occurred in early to mid-August. This period coincides with the time when much of the spring grains, and some native grasses and broadleaf weeds are maturing. It is probable that the leafhoppers migrate from these sources into potato. Barley is a preferred host for the aster leafhopper and is susceptible and a probable source of AY-phytoplasma in late July and August. Foliar applications of FuradanÔ or MonitorÔ insecticides appeared to be effective in reduction of aster leafhoppers in these experiments in 1994-1995.

Witches broom: Witches broom is a disease caused by another phytoplasma (=MLO) that is transmitted by leafhoppers, *Scleroracus flavopictus*, *S. dasidus* and *S. balli*. The leafhoppers cannot acquire the phytoplasma from potato but probably acquire it from other natural hosts including alfalfa (*Medicago sativa* L.), white sweet clover (*Melilotus alba*), red clover (*Trifolium repens*) and birdsfoot trefoil (*Lotus corniculatus*).

There appears to have been transmission of WB to the 1994 crop in some areas of the Northwest because seedlots from Idaho scored 0-7% WB in California winter tests. One possibility is that leafhoppers had access to the organism in legumes in Conservation Reserve Program (CRP) acreage and because of dry summer conditions moved into irrigated potatoes. However, some WB also occurred in locations in which there was no CRP acreage. Two types of symptoms have been observed. The typical type is characterized by dwarfed multi-stemmed plants that have many axillary branches. The leaves are rounded and chlorotic. Abnormally large numbers of small tubers are produced that do not exhibit dormancy. A second type of symptom has been observed in which the plants are not as severely stunted (tall WB), the leaves are somewhat rounded and become yellowed. Of the WB observed in Idaho in 1994, 80% was of the taller type. The severely dwarfed type predominated in British Columbia in 1994-1995. Fewer tubers were produced in the tall than in the severely dwarfed type and they were more nearly normal-sized. They also sprouted prematurely, that is they did not exhibit normal dormancy. The WB phytoplasma is tuber-borne.

One explanation for the taller plant symptom is that when the plant infection happens later in the growing season, milder symptoms and less severe dwarfing occur.

There is also the possibility that strain differences occur between the tall and severely dwarfed types or that even different phytoplasma are involved in a WB complex. Evidence to support the former hypothesis is that in British Columbia, when tubers from the tall type were planted, the plants that grew from them developed into the typical severely dwarfed and proliferated type (Kirkham, personal communication). If the tall type, when planted, continued to produce the tall type, it would be possible that strain variation occurs between the tall and severely dwarfed types. More relationships among different phytoplasma have been revealed by DNA comparisons made possible by recombinant DNA technology. It is possible that more than one phytoplasma is involved in the potato witches broom disease.

Smart, *et al.* (1993) showed via southern blot analysis of DNA extractions that WB in potato and alfalfa WB were indistinguishable from beet leafhopper (*Circulifer tenellus*) transmitted virescence agent (BLTVA). Golina, *et al.* (1989) showed the BLTVA had a rather broad host range including many commonly grown vegetables and flowers. Lee *et al.* (1991) presented DNA evidence that clover phyllody phytoplasma and WB in Alberta were closely related. If both BLTVA and clover phyllody phytoplasma are involved in WB it would broaden potential sources of WB and involve other leafhopper vectors. These findings could add to the complexity of the WB problem.

CONCLUSIONS:

Purple top, perhaps, is a minor problem in potatoes in the Northwest. However, it appears that it occurs periodically in the Central United States. The lack of a diagnostic test for PT makes it impossible to ascertain the incidence in potato.

Witches broom appears to be a larger disease problem in potato in the Northwest and was more abundant in 1994 than in the recent past. This carried over into winter tests as well as into seed planted into some commercial fields in 1995. There are some anomalies from our conventional concept that witches broom is a distinct phytoplasma related or identical to the phytoplasma causing witches broom in alfalfa. It is possible that two different, but distantly related phytoplasma cause witches broom diseases in potato. Because WB is tuber-borne and can, to a considerable extent, be detected by its symptoms in summer field inspections and in winter tests, excessively infected seedlots can be rejected. There is no danger of potato to potato spread and losses are somewhat proportional to the percent of infected plants. Sporadic outbreaks of WB may continue depending on the vagaries of leafhopper movements from alternate host plants.

REFERENCES:

1. Banttari, E. E., P. H. Orr, and D. A. Preston. 1990. Purple top as a cause of potato chip discoloration. Trans. of ASAE 33:221-226.

2. Golino, D. A., G. N. Oldfield, and D. J. Gumpf. 1989. Experimental hosts of the beet leafhopper-transmitted virescence agent. Plant Disease 73:850-854.

3. Lee, I-M, R. E. Davis, and C. Hiruki. 1991. Genetic interrelatednes among clover proliferation mycoplasmalike organisms (MLO) and other MLOs investigated by nucleic acid hybridization and restriction fragment length polymorphism analyses. Appl. and Environ. Microbiol. 57:3565-3569.

4. Smart, C. D., S. V. Thomson, K. Flint, and B. C. Kirkpatrick. 1993. The beet leafhopper transmitted virescence agent is associated with diseased potatoes in Utah. (Abstr.) Phytopathology 83:1399.

5. Wright, N. S., d. Raine, and V. Valenta. 1981. Mycoplasmas. Pages 91-93in: Compendium of Potato Diseases. W. J. Hooker, Ed., American Phytopathological Society Press, St. Paul, MN, 125 p.