

# Phytophthora Root Rot of Alfalfa in Central New York

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## ABSTRACT

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Nine counties in New York's Erie-Ontario Plain and Mohawk Valley were surveyed for Phytophthora root rot of alfalfa, caused by *Phytophthora megasperma*. Diseased plants were observed in 66% of alfalfa fields that had been saturated for a week or more. First-year stands were the most severely attacked, but Phytophthora root rot appeared to be an important factor in alfalfa stand decline regardless of the age of the stand. Most severe root rot was associated with sandy clay loam soils with fair to moderately poor drainage. *Phytophthora* activity in soil, as detected by a seedling baiting assay, was positively correlated with the severity of root rot in the field. *P. megasperma* was isolated from 82% of the fields seeded with alfalfa and 71% of the fields seeded to other crops or left fallow. Resistant varieties and tile drainage did not appear to be satisfactory solutions for control.

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Approximately 400,000 ha of alfalfa are cultivated in New York. Alfalfa stands are usually managed for 3-4 yr, after which they become unproductive owing to stand decline. Numerous biotic and abiotic factors affect alfalfa stand longevity. Recently, Phytophthora root

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rot (PRR) was found in New York (2,3).

Soils are frequently saturated for a week or more. The extent and duration of high soil moisture suggested that PRR may be a contributing factor in alfalfa stand decline. The objectives of this study were to determine the incidence and severity of PRR in selected areas of central New York and to collect information on climatic and edaphic conditions and cultural practices associated with PRR.

## MATERIALS AND METHODS

The study was made during 1976-1978 in nine counties representative of the prime alfalfa acreage in the Erie-Ontario Plain and Mohawk Valley areas of New York (Fig. 1).

**Precipitation.** Data were collected by the Division of Atmospheric Sciences,

Department of Agronomy, Cornell University, Ithaca, NY. In general, these areas of New York received 38-60 cm of rainfall during May-October. The frequency and amounts of rainfall in individual fields were not recorded. Estimations were based on data collected at nearby extension weather stations.

**Soil descriptions.** The soils examined generally were in the great group Hapludalf. They are of glacial till origin and predominantly alfisols. The pH ranged from 5.6 to 7.3, as measured with a Cornell University pH Test Kit employing chlorophenol red and bromthymol blue indicators. Each field was tested at five different locations, representing areas with and without PRR. Soil pH where PRR had developed ranged from 5.2 to 6.3 (mean, 5.6). This correlation between PRR and acid soil was also observed in Wisconsin alfalfa fields by C. R. Grau (*personal communication*).

The textural classes ranged from sandy loam to clay loam. These soils were described as occasionally to commonly wet and with poor to good natural drainage (1).

**Estimation of disease.** PRR was estimated from a random sample of 100 plants in each field by determining the distribution of plants with root rot, recording foliar symptoms, and estimating the severity of rot on plant roots. The severity was estimated according to a scale in which 1 = 1-25, 2 = 26-50, 3 = 51-75, 4 = 76-100% root rot (8,9).

Root samples were brought to the

laboratory for isolation and identification of *P. megasperma*. Where PRR was severe, weed roots were also examined for *P. megasperma*. Root samples were cut into pieces (0.5–1.0 cm) and incubated in sterile water or a basal salts solution to induce formation of sporangia (7). Acidified V-8 juice agar (6) was used to isolate the fungi from surface-sterilized (10% sodium hypochloride for 8–10 min) pieces of diseased roots. In addition, individual sporangia were removed by means of tweezers from the surface of infected roots and plated on the acidified agar.

Isolates were identified as *P. megasperma* on the basis of morphology as described by Waterhouse (10). Pathogenicity was determined for isolates that resembled *P. megasperma* morphologically. Iroquois alfalfa seedlings, 6 wk old, were inoculated with a mycelium sus-

pension. The suspension contained one mycelium mat that was cultured in 50 ml of V-8 juice media for 7 days at 20 C and washed with 250 ml of sterile water before fragmentation. The inoculated seedlings were flooded every third day and examined for PRR 15 days after inoculation.

**Determination of *Phytophthora* activity.** Soil was collected from all fields including those left fallow or planted to crops other than alfalfa. Soils were sieved through a 2-mm screen and assayed for *P. megasperma* with the alfalfa seedling baiting assay described by Marks and Mitchell (5) except that the seedlings were not injured and were incubated for only 72–84 hr. All assays, in triplicate, were done on the day that soil was collected. To quantitate the level of *Phytophthora* activity, soil samples were diluted (1:0, 1:2, 1:26, 1:49, v/v) with sterile sand.

## RESULTS AND DISCUSSION

**Distribution of PRR.** PRR occurred in all nine counties during 1976–1978 (Table 1) and was diagnosed in 66% of the alfalfa fields. This incidence is higher than that reported in Wisconsin (8). Eighty-two percent of the alfalfa fields contained *P. megasperma*. *P. megasperma* was isolated from 47% of the 34% of alfalfa fields that showed no PRR and from 71% of the fields with crops other than alfalfa (Table 1).

**Relationship of PRR to rainfall.** Development of PRR was associated with rainfall that kept the soil wet for approximately a week or more. Alfalfa planted in 1975, which had little or no PRR in May or early June of 1976, developed severe taproot lesions (rating 3–4) in late June and early July after receiving an average of 7.5 cm of rainfall in 12 days. Older stands in these wet soils had stunted top growth and expanding taproot lesions in late June and early July of 1976 compared with their appearance in May and early June. Most stands that displayed PRR did not decline further in the summer and fall of 1976, during which time average rainfall was about 10 cm and infrequent. Rainfall was below average and infrequent in May and June of 1977, and foliar symptoms and root rot development were not observed or reported for the central New York areas.

On the other hand, central New York received heavy rainfall during late July until early September of 1977. Stands of alfalfa that were planted in the spring of 1977 showed extensive root rot by October. Most plants lost more than 75% of their root system, and severe root pruning was evident. Plants with PRR that were alive the following spring (1978) exhibited sparse regrowth; plant density was reduced by as much as 80% compared with those areas of the same fields in which PRR had not developed. Average rainfall (6.2 cm) in May–July 1978 appeared to favor partial recovery of the damaged plants, which consistently produced numerous adventitious roots immediately above the taproot lesions. Rainfall was average (8.2 cm) in May–October of 1978, and as determined by foliar and root symptoms, root rot was negligible.

Plants with severe (rating 4) PRR were mostly in localized patches where soils were saturated for a week or more. This included areas where underground springs saturated the soil or where, owing to the topography, soil water collected. After prolonged periods of rainfall, PRR was observed in alfalfa fields with slopes as great as 35%. The root destruction, as measured by root pruning and taproot decay, never reduced the root system by more than 25% on plants in areas with 10–35% slope.

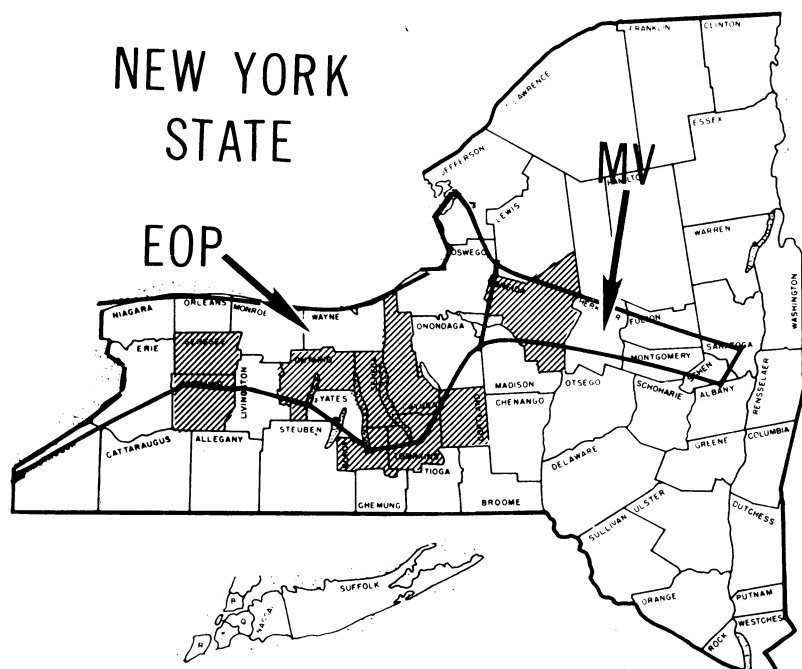
**Disease development.** Root rot was limited to the portion of the taproot 5–10 cm below the crown of the plant.

**Table 1.** Incidence of *Phytophthora* root rot (PRR) of alfalfa in nine counties of central New York and frequency of isolation of *Phytophthora megasperma* (*P. meg.*)

County	Alfalfa fields			Other fields	
	Total sampled	No. with PRR <sup>a</sup>	No. from which <i>P. meg.</i> <sup>b</sup> was isolated	Total sampled	No. from which <i>P. meg.</i> <sup>b</sup> was isolated
Cayuga	16	11	14	3	2
Cortland	29	20	27	10	8
Genesee	38	22	34	9	6
Oneida	19	16	17	5	4
Ontario	26	12	18	7	4
Schuyler	4	1	3	2	1
Seneca	58	41	44	19	15
Tompkins	6	4	4	2	1
Wyoming	23	18	19	6	4
Totals	219	145	180	63	45

<sup>a</sup>Based on foliar and root symptoms.

<sup>b</sup>Based on alfalfa seedling baiting (5) and isolate pathogenicity.



**Fig. 1.** Nine counties (shaded) in the Erie-Ontario Plain (EOP) and Mohawk Valley (MV) where *Phytophthora* root rot was observed.

However, in stands with plants younger than 6 mo, the entire taproot rotted under conditions conducive to PRR. Adventitious roots usually proliferated immediately above taproot lesions and usually occurred on plants older than 6 mo. This pattern of recovery also has been observed by others (3,4).

Foliar symptoms of anthocyanescence and browning were associated with the later development of PRR. Foliar symptoms appeared acropetally and were associated with severe taproot rot. If the soil water drained away before the plants succumbed, the foliage wilted.

PRR had two phases of development. An acute phase, which was characterized by severe root rot of plants less than 6 mo old, was usually lethal and caused rapid stand decline. A second chronic phase, which was characterized by development of PRR for several months to a year or more, sometimes resulted in plant death but more commonly reduced growth and vigor as part of a complex of biotic and abiotic stresses. Because conditions conducive to PRR seldom last longer than 2 wk, alfalfa plants might escape the acute phase and develop adventitious roots sufficiently to tolerate the chronic phase.

Pathogen activity was defined as that dilution endpoint of soil samples that results in no infected seedlings in the seedling baiting assay. It is not clear at this time how such pathogen activity relates to the density of *P. megasperma* or to its ability to cause PRR. *Phytophthora* activity values were correlated with the severity of the disease in the field; for ratings of 1, 2, 3, and 4 the dilution endpoints were about 1:0-1:2, 1:2-1:8, 1:8-1:26, and 1:49, respectively. This confirms the observation of Marks and Mitchell (5). In addition, fields cultivated to crops other than alfalfa or left fallow usually had a dilution endpoint of

1:0-1:2. These results represent samples that were taken after the soil had been saturated for a week or more. Based on these limited data, there appeared to be no differential effects on *Phytophthora* activity when alternative crops such as corn, wheat, or oats were grown. In addition, there has been renewed interest in planting mixtures of alfalfa with timothy, birdsfoot trefoil, or oats. In general, neither crop rotation nor the mixing of crops had any apparent effect on PRR severity.

Attempts to isolate *P. megasperma* from roots of several crops and weeds common to central New York were made only four times, representing four different fields for each crop. *P. megasperma* was isolated from 23% of the black medic (*Medicago lupulina*), representing 16 fields. The fungus could not be isolated from corn, oats, wheat, red clover, birdsfoot trefoil, pigweed (*Amaranthus retroflexus*), common lambsquarter (*Chenopodium album*), giant ragweed (*Ambrosia trifida*), or yellow nutsedge (*Cyperus esculentus*).

The cultivars planted in the fields sampled ranged from very susceptible to PRR (Saranac AR) to those reported to have some resistance (Agate). None of the cultivars withstood PRR when soil moisture was high for a week or more. However, under conditions conducive to PRR that did not last this long, cultivars with resistance outperformed susceptible cultivars during the seedling year, as has also been observed by R. P. Murphy (*personal communication*).

Installation of drainage tiles did not provide a control of PRR. Although the drains reduced the period when soil moisture levels were conducive to PRR, they appeared ineffective in soils with poor drainage or when the water content of the soil was too great for the tile drains

to remove water quickly. In these instances, plants immediately adjacent to the drains developed minor foliar symptoms and suffered less root rot than plants in saturated soil several feet from the drain.

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