Phytophthora Root Rot of Cabbage and Cauliflower in Oregon

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ABSTRACT

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Root rot of cabbage (*Brassica oleracea* var. *capitata*) and cauliflower (*B. oleracea* var. *botrytis*) caused by *Phytophthora megasperma* is reported for the first time in Oregon. Naturally infected cabbage plants were confined to low areas in fields where water accumulated. Root rot of cauliflower was especially destructive in low-lying areas but also extended to higher ground. Cabbage was more tolerant than cauliflower to infection by *P. megasperma* in pathogenicity tests. Differences in susceptibility to Phytophthora root rot among cultivars of cabbage and cauliflower are reported.

Phytophthora root rot of cabbage (*Brassica oleracea* L. var. *capitata*) and cauliflower (*B. oleracea* L. var. *botrytis*) caused by *Phytophthora megasperma* Drechs. emend Hamm & Hansen (2) was first reported in California in 1936 (7). Few subsequent reports exist, although in England (6) and Ireland (1), this fungus has been identified as causing root rot of cauliflower and broccoli (*B. oleracea* L. var. *italica*), respectively. Recently, Kontaxis and Rubatzky (4) reported Phytophthora root rot of summer cauliflower as a problem in some areas of California and compared a number of cauliflower cultivars for susceptibility to *P. megasperma*.

In western Oregon, cauliflower is planted both in the spring for summer harvest and in the fall for early spring harvest. Cabbage grown for seed is planted in the fall and harvested the following summer. Root disease problems have been minor in cabbage, as well as in spring-sown cauliflower; however, winter cauliflower (fall-planted), a recently introduced cropping system, has sustained substantial losses. The work reported in this paper was undertaken to identify the causal agent of the root rot problem of these hosts in Oregon and to compare the susceptibility of cultivars of these hosts to the pathogen.

MATERIALS AND METHODS

Isolation and identification. Dead and dying cabbage plants were collected from three fields in western Oregon. Plants were carefully washed, symptoms recorded, and direct isolations attempted from randomly selected subsamples. Small (3-mm^2) sections of root tissue from the margin between healthy and diseased areas were placed on cornmeal agar containing 20 μg/ml pimaricin and 200 μg/ml vancomycin (Vancocin HCl). After 4 days, suspected *Phytophthora* colonies were subcultured and incubated at 20 C to await identification.

Root-rotted winter cauliflower cultivars (Maya, Arminda, and Markanta) with root rot symptoms were collected from two locations in early spring, and a summer cultivar (Snowball) was collected from three separate fields in late summer. Isolation and culture storage were similar to the methods reported for cabbage.

Phytophthora colonies obtained from direct isolation were transferred to clarified V-8 agar (V8A) (5) and pea broth (8) to observe oogonial and sporangial characteristics, respectively. Oogonia were observed after 3 wk of incubation at 20 C. Sporangia developed after 7 days by rinsing colonies with distilled water and flooding with soil-extract water (equal amounts of soil and water left overnight, then filtered) for 24 hr.

Pathogenicity testing. Seeds of four cabbage lines (AGS 2, 3, 4, and 5) and six winter cauliflower cultivars (Armado April, Markanta, Maya, Armado May, Arminda, and April), selected because of their availability and present use, were planted in moderately coarse sand for 3–4 wk. Concurrently, cornmeal sand (CMS) inoculum was prepared (3) and inoculated with a mixture of both cabbage and cauliflower isolates of *P. megasperma*. After 6 wk at room temperature, CMS inoculum was mixed 1:16 with steam-pasteurized soil mix (peat, sand, and clay mixed 1:1:1), and two plants per cultivar were transplanted in each of 15 160-ml plastic pots. Five pots per cultivar contained uninoculated CMS and soil for

Fig. 1. Cauliflower field with large area damaged by *Phytophthora megasperma*. Note wilting of infected cauliflower in right foreground.

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controls. Pots were placed in tanks of water (control and inoculated pots separated) to allow flooding for 48 hr. Pots were then randomized and placed into growth chambers with a 16-hr photoperiod at 18 C. Plants were watered at least every third day to maintain high soil moisture. After 8 wk, root systems were scored on a scale of 0–5, where 0 = <1%, 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, 4 = 76–100% root rot, and 5 = dead plants. Reisolation of *P. megasperma* was attempted from a random subsample of severely infected cabbage and cauliflower plants.

A *t* test was used to determine significant differences ($P = 0.05$) between controls (uninoculated) and inoculated treatments. Duncan's new multiple range test ($P = 0.05$) compared root rot severity rating among cabbage lines and cauliflower cultivars.

RESULTS

Isolation and identification. Cabbage plants with root rot symptoms were confined to low-lying areas in fields where irrigation water or rainfall accumulated. Diseased cauliflower plants were also found in low areas but severe infection was not confined to these areas but centered around them (Fig. 1). Severely diseased plants of both crops showed extreme wilt symptoms above the ground, whereas roots lacked lateral and taproot development (Fig. 2). Cabbage root systems were seldom rotted to the extent found on cauliflower. Symptoms were similar to those reported in 1936 for Phytophthora root rot of cauliflower (7).

A *Phytophthora* species was consistently isolated from diseased plants. These isolates were identified as *P. megasperma* (2) on the basis of production of large oogonia ($\bar{x}$ 47 μm) with paragynous antheridia in single-strain culture and ovoid- to ellipsoid-shaped sporangia ($\bar{x}$ 55 × 40 μm) (2).

Pathogenicity tests. Root rot severity induced in both *Brassica* crops is listed in Table 1. Of four cabbage lines tested, significant root rot occurred only in AGS 3. All cauliflower cultivars except Armado April were susceptible to *P. megasperma*. Differences in disease severity ratings between AGS lines 2, 4, 5, or the cauliflower cultivars, except Armado April, were statistically insignificant. *P. megasperma* was consistently recovered from inoculated cabbage and cauliflower plants with severe disease symptoms.

DISCUSSION

Phytophthora root rot of cabbage and cauliflower is reported for the first time in Oregon. The pathogen, *P. megasperma*, has also been reported to cause root rot of *Brassica* spp. in California (4,7), Ireland (1), and England (6). Specific morphological characteristics (large oogonia) were similar to isolates recovered from alfalfa and several conifer species in the same region (3). This group of isolates is generally less aggressive and has a larger host range than isolates producing small oospores (3). The occurrence of *P. megasperma* on cabbage and cauliflower in Oregon again demonstrates that this pathogen is widespread in agricultural

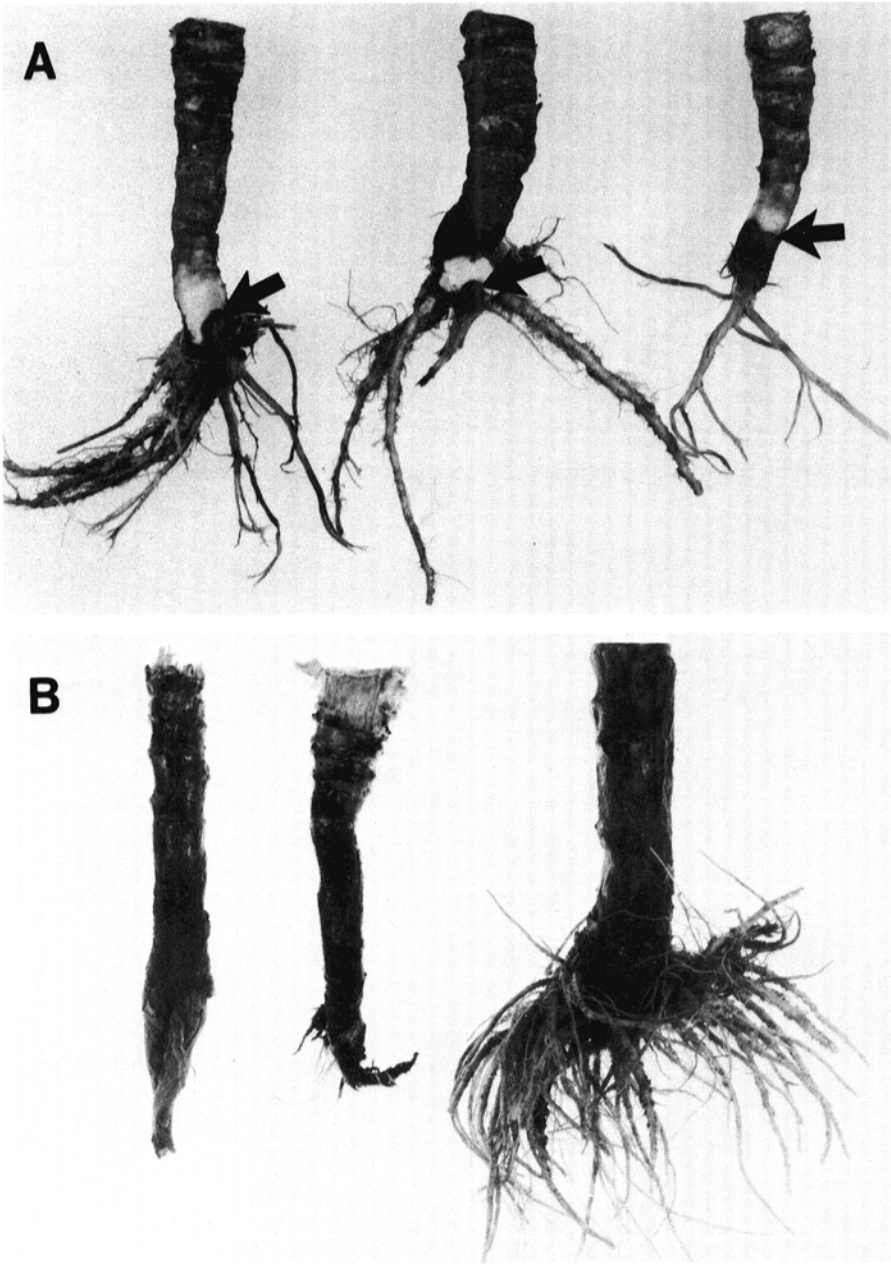

Fig. 2. Belowground symptoms associated with *Phytophthora megasperma* root rot of **(A)** cabbage and **(B)** cauliflower. Note healthy cabbage roots above lesion (arrow) and severely rotted and healthy cauliflower roots.

Table 1. Comparative severity of disease among cabbage lines and cauliflower cultivars after inoculation with *Phytophthora megasperma*

Cabbage lines	Controls[y]	Inoculated[z]
AGS 2	0.6	0.9 ab
AGS 3	0.2	1.5*c
AGS 4	0.0	0.3 a
AGS 5	0.4	0.8 ab
		$\bar{x}$ 0.90
Cauliflower cultivars		
Armado April	1.0	1.5 a
Markanta	0.9	2.0*b
Maya	0.9	4.0*bc
Armado May	0.8	3.0*b
Arminda	0.8	3.0*b
April	1.0	3.2*b
		$\bar{x}$ 2.9

[y] Seedlings transplanted in uninfested (control) or infested soil. Root systems were rated on a scale of 0–5, where 0 = <1%, 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, 4 = 76–100% root rot, and 5 = dead plants. Thirty inoculated replicated plants; 10 uninoculated control plants.

[z] * = Lines or cultivars with significant root disease ratings ($P = 0.05$) compared with controls. Lines or cultivars not followed by the same letter were not significantly different ($P = 0.05$) according to Duncan's new multiple range test.

areas of western Oregon with long agricultural cropping histories.

Cabbage lines were less affected by *P. megasperma* than was cauliflower. Field observations indicated that root rot of cabbage was substantially confined to low-lying areas where water accumulates. Root rot of cauliflower, however, extended beyond such areas. Similarly, cabbage was generally less affected by *P. megasperma* in greenhouse tests than was cauliflower.

Relatively small acreages of cabbage or summer cauliflower currently diseased by *P. megasperma* do not warrant elaborate control strategies unless future rotations include other susceptible plant species. Reducing standing water through tillage or land-leveling should lessen disease severity. However, fall-planted cauliflower, exposed to high soil moisture and cool temperatures common to winters of western Oregon, does sustain large yield losses. Significant control should be possible by planting winter cauliflower in fields with leveled and/or well-drained soils to prevent or lessen initial disease development and spread. In addition, winter cauliflower should not be grown in fields previously planted to crops reported susceptible to *P. megasperma* (Douglas-fir and alfalfa [3]). Further greenhouse or field evaluations of cauliflower cultivars for resistance to *P. megasperma* would seem desirable. The cultivar Armado April was found to be markedly tolerant to *P. megasperma* infections during 8-wk tests in growth chambers, but field testing to confirm significant resistance for several months (typical of a field situation) is needed. Chemical control may be possible (4), but large areas with continued root rot problems should be avoided.

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