Pythium Species Causing Damping-Off of Seedling Bedding Plants in Ohio Greenhouses

CHRISTINE TAYLOR STEPHENS, Research Associate, and CHARLES C. POWELL, Associate Professor, Department of Plant Pathology, The Ohio State University, Columbus 43210, and the Ohio Agricultural Research and Development Center, Wooster 44691

ABSTRACT

Stephens, C. T., and Powell, C. C. 1982. *Pythium* species causing damping-off of seedling bedding plants in Ohio greenhouses. Plant Disease 66:731-733.

Among 22 isolates comprising 12 *Pythium* species causing damping-off of bedding plants, the *P. ultimum* isolates were most consistently virulent. In a survey of Ohio bedding plant greenhouses, *P. ultimum* was isolated most frequently. All *P. ultimum* isolates collected demonstrated consistent virulence. Because the test conditions closely approximated the seed germination and incubation conditions in most of the greenhouses, the results suggest that *P. ultimum* is the primary damping-off *Pythium* species in Ohio bedding plant greenhouses.

Additional key words: ageratum, cabbage, celosia, eggplant, impatiens, salvia, tomato, vinca; flower, seedling, and vegetable diseases

Seedling damping-off is a serious disease problem for the bedding plant industry (3,5,7,11), and at least 10 *Pythium* species cause damping-off of bedding plants (1,2,4,6,8,12). Formulation of improved disease management strategies is complicated by the lack of information on relative prevalence of these species in bedding-plant greenhouses. Knowledge of speciation is needed to investigate the possibility of host specificity in bedding plants and to aid in understanding the epidemiology and virulence of the pathogens. A technique recently developed in our laboratory allows rapid testing of many fungal isolates on many types of plants for their ability to cause postemergence damping-off (14). Using this method, we investigated isolates of *Pythium* species reported to cause postemergence damping-off and isolates we collected from Ohio greenhouses that produce bedding plants.

MATERIALS AND METHODS

Isolates of *Pythium* species reported to cause damping-off (1,2,4,6,8,12) were obtained from A. F. Schmitthenner (Ohio Agricultural Research and Development Center, Wooster 44691). The species we tested were *P. ultimum* Trow, *P. irregulare* Buisman, *P. debaryanum* Hesse, *P. aphanidermatum* (Edson) Fitzp., *P. spinosum* Sawada, *P. vexans* deBary, *P. sylvanicum* Campbell and Hendrix, *P. mamillatum* Meurs, Wortelrot, *P. pulchrum* von Mindon, *P. paroecandrum* Drechs., *P. heterothallicum* Campbell and Hendrix, and *P. graminicola* Subr.

The isolates were tested for virulence by a postemergence inoculation method we developed (14). In this method, seeds of host plants were sown thickly in rows in 10-cm-diameter pots containing a water-saturated peat-vermiculite medium (Jiffy Mix, Jiffy Products Corp., Chicago, IL). At seedling emergence, inoculum (12 mm thick, 12 mm in diameter) removed from the advancing edge of a 36-hr potato-dextrose agar (PDA) culture was buried 0.5 cm deep at one end of the seedling row. After inoculum was introduced, the pots were watered well, placed in a plastic bag, and incubated on a shaded greenhouse bench at 26 C. After 9 days, the length of the seedling row with damping-off was recorded. Four replications were made of each isolate in each test.

In initial studies, 22 isolates of *Pythium* were used to inoculate nine commonly grown bedding plants (seeds obtained from George J. Ball Co., Chicago, IL): tomato (*Lycopersicon esculentum* Mill. 'Early Girl'), pepper (*Capsicum frutescens* L. 'California Wonder'), cabbage (*Brassica oleracea* var. *capitata* L. 'Golden Acre'), ageratum (*Ageratum houstonianum* Mill. 'Blue Blazer'), impatiens (*Impatiens wallerana* Hook. 'Dwarf Blaze'), celosia (*Celosia argentea* L. Ann. 'Red Fox'), salvia (*Salvia splendens* F. Sellow ex Roem. & Schult 'Fireball'), eggplant (*Solanum melongena* var. *esculentum* Nees 'Black Beauty'), and vinca (*Vinca major* L. 'Little Blanche'). These species were chosen because they were regarded in the industry as problem crops. The test was repeated and *Pythium* isolates that were not pathogenic in these first two tests were tested a third time on impatiens, pepper, ageratum, and tomato.

Pythium species associated with damping-off in bedding-plant greenhouses in northwest Ohio were collected during the 1974–1975 production season. Several diseased seedlings were removed from seedling flats at each greenhouse, shaken to remove excess soil, and placed on separate plates of PDA (Difco Laboratories, Detroit, MI) and *Pythium* selective sucrose, asparagine, pentachloronitrobenzene, benomyl, neomycin, chloroamphenicol agar media (13). The plates were stored at 24 C and examined once every 24 hr for 4 days. Emerging fungal colonies were transferred each day to fresh PDA or the *Pythium* selective medium for identification.

The *Pythium* isolates obtained were identified to species, then tested for pathogenicity on impatiens. Any isolate that appeared to be nonpathogenic on impatiens was retested on ageratum, pepper, and tomato.

RESULTS

In initial studies with the 22 *Pythium* isolates, *P. aphanidermatum* isolate 246 and six *P. ultimum* isolates caused damping-off of all nine bedding plant species, with the exception of isolate 32 on ageratum (Table 1). *P. irregulare* isolate 197 was pathogenic on all nine species and isolate 250 was pathogenic on eight of the nine. *P. debaryanum* isolate 228 was pathogenic on six crops. *P. spinosum* isolate 28 caused damping-off of all the plant species except ageratum.

Several other *Pythium* isolates caused little or no damping-off and were not included in Table 1. *P. vexans* isolates 129 and 72 from geranium, *P. sylvanticum* isolates 78 and 79 (*source unknown*) and *P. mamillatum* isolate 37 caused slight damping-off of impatiens. They were not pathogenic on the other eight test hosts. *P. irregulare* isolate 33 from geranium, *P. pulchrum* isolate 93 from bedding crop

Present address of senior author: Department of Botany and Plant Pathology, Michigan State University, East Lansing 48824.

Portion of M.Sc. thesis by the senior author.

Approved for publication as Journal Article 195-81 of the Ohio Agricultural Research and Development Center, Wooster 44691.

Accepted for publication 4 December 1981.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/82/08073103/$03.00/0

Table 1. Pathogenicity of *Pythium* species on commonly grown bedding plants in Ohio

Species[a] Isolate number	Length (cm) of seedling row with damping-off[b] after 9-day incubation at 26 C								
	Tomato	Ageratum	Pepper	Impatiens	Cabbage	Celosia	Salvia	Vinca	Eggplant
P. ultimum									
248 (tomato)	3.8 ± 1.8	2.0 ± 1.3	7.0 ± 0.4	7.5 ± 0.0	3.5 ± 2.7	5.0 ± 2.1	5.3 ± 1.4	5.8 ± 1.1	5.5 ± 1.5
32 (chrysanthemum)	0.3 ± 0.3	0.0	5.8 ± 1.2	5.8 ± 1.0	1.5 ± 1.2	2.5 ± 0.6	3.8 ± 1.2	3.8 ± 1.2	3.8 ± 1.1
166 (pansy)	3.5 ± 0.5	4.8 ± 2.5	2.3 ± 0.7	3.8 ± 0.8	5.0 ± 2.0	7.0 ± 0.1	2.0 ± 0.6	2.5 ± 1.2	2.8 ± 2.1
249 (vinca)	6.3 ± 1.0	7.5 ± 0.0	3.8 ± 1.6	3.8 ± 2.2	3.5 ± 0.7	5.0 ± 1.7	5.8 ± 0.6	5.8 ± 1.0	5.8 ± 1.2
247 (pepper)	2.5 ± 0.7	3.5 ± 1.5	2.0 ± 0.4	2.0 ± 0.7	2.5 ± 1.7	3.8 ± 2.0	6.8 ± 0.4	7.0 ± 0.7	4.8 ± 1.5
251 (bedding-plant soil)	0.3 ± 0.4	4.5 ± 3.2	6.0 ± 1.0	4.5 ± 2.0	3.5 ± 0.7	5.5 ± 1.2	6.5 ± 0.4	7.3 ± 0.3	5.8 ± 0.6
P. irregulare									
197 (heather)	3.8 ± 1.0	3.5 ± 1.7	0.8 ± 0.7	3.8 ± 0.7	2.0 ± 0.8	0.8 ± 0.7	5.8 ± 1.2	7.5 ± 0.0	5.5 ± 1.6
250 (ivy geranium)	1.5 ± 0.6	1.3 ± 0.9	0.0	0.8 ± 0.3	0.8 ± 0.7	1.5 ± 0.8	7.5 ± 0.0	7.5 ± 0.0	7.5 ± 0.0
P. debaryanum									
213 (potato)	4.5 ± 0.9	3.8 ± 1.1	5.8 ± 4.1	7.0 ± 0.9	3.8 ± 2.1	3.8 ± 1.2	7.3 ± 0.3	7.5 ± 0.0	6.3 ± 1.2
228[c]	0.0	0.0	0.0	2.0 ± 1.6	1.0 ± 0.7	0.8 ± 0.5	0.8 ± 0.3	6.0 ± 1.6	2.0 ± 0.8
P. aphanidermatum									
246 (pepper)	1.3 ± 0.5	1.3 ± 0.8	5.3 ± 2.8	7.3 ± 0.2	6.0 ± 1.2	7.4 ± 0.2	5.8 ± 1.4	5.8 ± 1.8	5.8 ± 0.3
P. spinosum									
28[c]	0.3 ± 0.4	0.0	2.8 ± 1.8	5.8 ± 1.8	1.3 ± 1.0	4.1 ± 2.5	6.5 ± 0.8	6.8 ± 1.2	6.0 ± 1.1

[a] Isolates originally obtained from A. F. Schmitthenner, Wooster, OH. Only isolates exhibiting pathogenicity are included.
[b] Maximum length of row was 7.5 cm in a peat-vermiculite medium in 10-cm-diameter plastic pots. Each number is the mean of four replications, followed by the standard deviation of the replicates.
[c] Original host plant not known.

Table 2. Damping-off of impatiens caused by *Pythium* species isolated from bedding plants in Ohio greenhouses

Species Isolate number[a]	Length (cm) of seedling row[b] with damping-off after 9-day incubation at 26 C
P. ultimum	
1	4.0 ± 0.8
2	7.5 ± 0.0
3	7.3 ± 0.3
6	7.5 ± 0.0
8	5.5 ± 0.9
12	7.0 ± 0.2
13	7.3 ± 0.2
14	6.3 ± 0.7
15	7.5 ± 0.0
16	7.0 ± 0.1
18	5.3 ± 0.5
P. aphanidermatum	
4	7.5 ± 0.0
P. oligandrum	
5	0.0
P. irregulare	
7	3.8 ± 1.1
9	5.8 ± 0.2
17	3.3 ± 0.8
Pythium sp.	
10[c]	7.5 ± 0.0
11[c]	5.0 ± 0.3
Control	0.0

[a] Number for isolate in collection made during this survey.
[b] Maximum length of row was 7.5 cm in a peat-vermiculite medium in 10-cm-diameter plastic pots. Each number is the mean of four replications, followed by the standard deviation of the replicates.
[c] Nonsporangium-producing isolates from soil.

soil, *P. paroecandrum* isolate 94 (*source unknown*), *P. heterothallicum* isolates 110 and 111 (*source unknown*), and *P. graminicola* isolate 223 from turf caused no damping-off on any of the test plants.

The data in Table 1 were gathered in a series of experiments and thus were not statistically compared. The trends in the data suggest that vinca, eggplant, and salvia were more susceptible to most *Pythium* species and that tomato and ageratum were less susceptible. However, specific host-pathogen combinations did not follow these trends. For instance, *P. debaryanum* isolate 228 caused only slight damping-off of most crops tested but severe damping-off of the vinca. *P. ultimum* isolate 249 caused severe damping-off of tomato and ageratum plants, the least susceptible crops, and only moderate damping-off of impatiens, which is one of the most susceptible crops.

Eleven isolates of *P. ultimum*, one of *P. aphanidermatum*, one of *P. oligandrum* Drechs., three of *P. irregulare*, and two soilborne (nonsporangium-producing) *Pythium* spp. were isolated from seedlings with damping-off collected in the survey. All but the *P. oligandrum* isolate were pathogenic on impatiens (Table 2). The *P. oligandrum* isolate was also not pathogenic on tomato, ageratum, and pepper.

DISCUSSION

The pathogenicity studies on the initially tested *Pythium* isolates suggest that *P. ultimum* is a species of primary concern on bedding plants. All of the *P. ultimum* isolates caused moderate to severe damping-off on all of the host plants, with one host plant exception. Our survey further demonstrated that *P. ultimum* was the *Pythium* species most often associated with diseased seedlings in Ohio bedding-plant greenhouses. The results of the pathogenicity tests on the isolates gathered in the survey closely paralleled the results of the initial isolate studies. In spite of the reports in the literature, *P. pulchrum, P. splendens* Braun, *P. paroecandrum, P. heterothallicum*, and *P. graminicola* were not pathogenic on the plants by our testing method, which closely reflects the seed germination and incubation conditions in Ohio greenhouses. In addition, the five species were not isolated from seedlings with damping-off in Ohio greenhouses. The species may, of course, be pathogenic in other environmental conditions or on other hosts. Many of the reported pathogenicity tests with these species involved wounding, heavy infestation of soil in preemergence damping-off tests, or flooded soils (7–11). These conditions are not common in bedding plant greenhouses.

Certain hosts appeared to be generally more susceptible to Pythium damping-off, and our results with some of the isolates suggest fungal specificity for certain crops. In several instances, an isolate caused damping-off of only a few plants of many of the bedding plant species tested but caused damping-off of many plants of one or two species. The significance of such host specificity on the epidemiology of *Pythium* species causing damping-off of bedding plants cannot be evaluated further until more detailed host-pathogen relationship studies are conducted that permit statistical comparisons.

LITERATURE CITED

1. Alexander, L. J., Young, H. C., and Kiger, C. M. 1932. Causes and control of damping off of tomato seedlings. Phytopathology 22:1.
2. Anonymous. 1970. Index of Plant Diseases in the United States. U.S. Dep. Agric. Handb. 165. Crops Res. Div. Agric. Res. Serv. 531 pp.
3. Anonymous. 1973. Bedding Plant News. Nov. 1973. Bedding Plants, Inc., Okemos, MI.
4. Atkinson, G. F. 1895. Damping-off. NY (Cornell) Agric. Exp. Stn. Bull. 94:233-272.
5. Brooks, W. M., Tayama, H. K., Lindquist, R. K., Powell, C. C., Peterson, J., Farley, J. D., and Robertson, J. L. 1981. Tips on growing bedding plants. Ohio Coop. Ext. Serv., Ohio State Univ. Bull. MM-265. 34 pp.

6. Drechsler, C. 1927. *Pythium ultimum* and *P. debaryanum*. Phytopathology 17:54.
7. Horsfall, J. G. 1938. Combatting damping-off. N.Y. Agric. Exp. Stn. (Geneva) Bull. 683:1-46.
8. Horst, K. W., and Westcott, C. 1971. Plant Disease Handbook. Van Nostrand Co., New York. 843 pp.
9. Johnson, J. 1914. The control of damping-off in plant beds. Wisc. Agric. Exp. Stn. Res. Bull. 31:29-61.
10. Kadow, K. J., and Anderson, H. W. 1907. Damping-off control: An evaluation of seeds and seed treatment. Ill. Agric. Exp. Stn. Bull. 439:291-348.
11. Person, L. H., and Chilton, S. J. P. 1940. Seed and soil treatment for the control of damping-off. La. Agric. Exp. Stn. Bull. 349:3-16.
12. Porter, R. H. 1945. Germinability of treated and untreated lots of vegetable seeds in *Pythium*-infested soil in the field. Iowa Agric. Exp. Stn. Bull. 345:951-982.
13. Schmitthenner, A. F. 1973. Isolation and identification methods for *Phytophthora* and *Pythium*. Proc. 1st Woody Ornamentals Workshop, U. Missouri, Columbia. Jan. 24-25, 1973.
14. Stephens, C. T., Powell, C. C., and Schmitthenner, A. F. 1981. A method of evaluating postemergence damping-off pathogens. Phytopathology 71:1225-1228.