Host Resistance and Pathogen Virulence in Pythium Blight of Bean

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ABSTRACT

Greenhouse and field studies of *Phaseolus vulgaris* strains and commercial cultivars showed that two beans were resistant to the *Pythium* blight disease. Bush Green Pod and N 203 withstood inoculation by five *Pythium* isolates, including the species *P. debaryanum, P. aphanidermatum,* and *P. ultimum,* whereas the Idaho Refugee cultivar was the most susceptible. Isolate H_2b of *P. debaryanum* was the most virulent isolate, inciting an average disease index of 56 in 31 bean cultivars. Phytopathology 60:1477-1479.

The *Pythium* blight disease of processing bean, *Phaseolus vulgaris* L., was recently described in detail by Adegbola & Hagedorn (1). This disease occurs each year in varying amounts in several bean-growing areas of Wisconsin, but is most often important in bean fields under overhead irrigation. Warm, wet conditions favor its development in the field. In greenhouse experiments, incubation of inoculated plants at 95 to 100 relative humidity for 3 days at 24 to 28 C favored disease initiation and development. Considering the potentially important economic significance of this disease, selected commercial bean cultivars and breeding lines were studied in an effort to discover resistance to the *Pythium* spp. pathogens. The comparative virulence of five *Pythium* pathogens was also determined.

Greenhouse studies.—In the greenhouse, 31 commercial bean cultivars and strains were tested against five *Pythium* isolates representing three *Pythium* species. The isolates used were P_1 and H_2b of *Pythium debaryanum* Hesse, isolates P_5 and Ox 6365 of *P. ultimum* Trow, and isolate PaH of *P. aphanidermatum* (Edson) Fritz. Origin of the isolates, methods used for growing and preparing standardized inoculum, and inoculation techniques have been described by Adegbola & Hagedorn (1). The greenhouse-grown bean plants were planted in compost soil contained in 6-inch earthenware pots. Thirty-one such pots, each containing five 6-week-old plants of a given cultivar, were arranged at random on a greenhouse bench, and the plants were inoculated with one of the five *Pythium* isolates. Similar sets of the test bean cultivars were inoculated with the other test fungus isolates. The experiment was performed 3 times.

The reaction of a given bean cultivar to *Pythium* inoculation was recorded as a disease index (DI) in order to take into account numbers of diseased plants and severity of infections on these plants (4). A DI of 0 indicated that all plants were healthy, a DI of 100 that all plants were severely diseased or dead.

Results of the three greenhouse studies (Table 1) indicated that only two bean cultivars or strains were resistant to all five isolates of the *Pythium* pathogens. The most resistant bean strain was N 203, which completely resisted infection by four of the five *Pythium* isolates and had a DI of only 7 when inoculated with *P. debaryanum* isolate H_2b, the most pathogenic isolate. The other bean which displayed a rather consistent resistance was the cultivar Bush Green Pod. It was not attacked by isolates P_5 or PaH, showed a DI of 7 after inoculation by *Pythium* isolates P_1 and Ox 6365, and developed a DI of 13 when inoculated with isolate H_2b.

The most susceptible bean cultivar in these greenhouse studies was Idaho Refugee, which showed DI's ranging from 53 upon inoculation with *Pythium* isolate P_1 to 93 with isolate H_2b, and averaging 77 when all five isolates were considered.

In some cultivars there was evidence for host specificity in resistance to isolates of *Pythium,* whereas in others resistance or susceptibility was fairly uniformly expressed toward all five isolates.

The comparative virulence of the five *Pythium* isolates was determined by studying the reaction of 31 bean cultivars to each of the isolates. The most virulent pathogen was *P. debaryanum* isolate H_2b, which caused a DI of 60 or higher on 18 bean cultivars and an average DI of 56 for all cultivars tested (Table 1). The least virulent was *P. aphanidermatum* isolate PaH, with an average DI of 23. Isolates P_1, P_5, and Ox 6365 may be considered of intermediate virulence on the basis of average DI's of 39, 40, and 46, respectively.

In another greenhouse study, nine additional bean cultivars were compared for their ability to withstand inoculation with *P. debaryanum* isolate H_2b. These included the cultivars Encore No. E21, E23, E24, and E26, Black Turtle Soup, Pinto University of Idaho (U.I.) No. 114, Red Mexican (R.M.) Bigbend, R.M. U.I. No. 36, and R.M. No. 5. None of these beans was resistant, but the last two mentioned, plus Pinto U.I. No. 114, were judged tolerant.

Field trials.—At the University of Wisconsin's Forest Products Laboratory plots in Madison and at the Hancock Experiment Station, each of the 31 bean cultivars was planted in 15-foot rows. Half the plants in each planting were spray-inoculated with the H_2b isolate when they were 6 weeks old. About 6 hr before the plants were inoculated, they were watered heavily by overhead irrigation to provide a higher relative humidity around the plants. Inoculations were usually made in the early evening (7:00-8:00 PM) when relative humidity was higher than in the daytime. Two replicated and randomized trials (4 replications) were made at each location during 2 consecutive growing seasons.

TABLE 1. Disease indices of 31 *Phaseolus vulgaris* cultivars after inoculation in the greenhouse with five incitants of *Pythium* bean blight[a]

Bean varieties	*P. debaryanum* isolates		*P. ultimum* isolates		*P. aphanidermatum* isolate
	P_1	H_2b	P_5	Ox 6365	PaH
Bush Bean BK4	13	67	47	53	40
Blue Lake	40	47	33	40	0
Blue Lake 274	33	40	40	40	0
Bush Blue Lake	33	60	40	7	0
Bush Green Pod	7	13	0	7	0
Cascade	37	67	53	47	53
Corneli 14	47	80	40	67	47
Comet	33	80	60	47	0
Early Harvest	33	73	40	53	0
Early Gallatin	67	73	34	67	60
Earliwax	33	60	0	40	0
Earligreen	33	80	47	73	0
Gallatin Valley 50	50	80	60	78	60
Harvest King	40	47	53	73	60
Higrade	57	80	60	80	43
Idaho Refugee	53	93	73	87	80
Kinghorn Wax	33	27	7	7	0
N 203	0	7	0	0	0
Sprite	53	67	27	60	13
Ore. State Univ. 949	13	27	20	7	0
Ore. State Univ. 2065	13	17	40	13	20
Processor	47	53	47	60	0
Red Kidney	47	40	43	37	13
Slender-White	47	40	40	27	40
Slimgreen	20	47	47	43	60
Slimgreen 1160	13	67	40	40	27
Tendercrop	60	60	47	60	0
Tenderette	73	67	67	73	40
Wadex	47	67	30	60	20
White Seeded Tendercrop	80	73	47	80	47
White Seeded Tendergreen	67	47	60	7	0
Avg DI	39	56	40	46	23
LSD 5% level	16	15	12	19	20
LSD 1% level	21	19	17	26	26

[a] Data are the means of three separate trials. F values for cultivars were highly significant within each isolate. F values for trials within isolates were not significant except in the case of isolate P_5.

Twice as much disease developed in the Madison Forest Products plots (mean DI for all cultivars was 40), as was apparent in the Hancock Experiment Station plots (mean DI was 20). Only one bean, Bush Green Pod, remained completely free of infection through all four trials. (In greenhouse trials it had shown an average DI of 13.) The other four resistant beans were N 203, Ore. St. Univ. 949, OSU 2065, and Earliwax. Earliwax showed an average DI of 5 at both test plot sites, while the other three bean lines each showed a DI of 5 at one location and 0 at the other. In the greenhouse, however, where optimal environal conditions for disease development could be maintained, OSU 949 had a DI of 27 and Earliwax a DI of 60. Thus, N 203, OSU 2065, and Bush Green Pod were the most resistant bean strains to *P. debaryanum* isolate H_2b.

DISCUSSION.—Our results with pathogen virulence are in general agreement with experiments reported earlier (1) in which several *Pythium* isolates were tested against the Red Mexican bean. In those studies, *P. debaryanum* was most virulent, and *P. ultimum* isolates were intermediate in virulence. The present experiments gave similar results, except that one *P. debaryanum* isolate (P_1) was also considered in the intermediate category. When Hare (3) studied *Pythium* tip blight of pea in Wisconsin, he found *P. ultimum* to be the main incitant, but noted that *P. debaryanum* could also incite the disease. Drechsler (2) repeatedly isolated *P. ultimum* and *P. butleri* from blighted beans in Maryland and Delaware, and considered them the primary incitants of the disease he observed there.

The discovery of resistance to the *Pythium* blight disease of bean is of economic significance, since breeding for resistance in commercially acceptable canning and freezing cultivars can be undertaken without delay. The most resistant bean in these studies, N 203, an introduction from Mexico, is also highly resistant to bean *Fusarium* root rot, *Fusarium solani* f. sp. *phaseoli*. It has been widely used as a resistant parent in efforts to develop commercially acceptable beans resistant to this widespread root disease. Since some of the undesirable characteristics of N 203 appear to be rather difficult to separate from the resistance factor, it may be well to include the resistant Bush Green Pod in breeding programs designed to incorporate *Pythium* blight resistance into processing bean cultivars.

LITERATURE CITED

1. ADEGBOLA, M. O. K., & D. J. HAGEDORN. 1969. Symptomatology and epidemiology of *Pythium* bean blight. Phytopathology 59:1113-1118.
2. DRECHSLER, S. C. 1952. Bean stem rot in Maryland and Delaware caused by several *Pythium* species. Plant Dis. Reptr. 36:13.
3. HARE, W. W. 1949. Tip blight of garden pea. J. Agr. Res. 78:311-324.
4. SHERWOOD, R. T., & D. J. HAGEDORN. 1958. Determining the common root rot potential of pea fields. Wis. Agr. Exp. Sta. Bull. 531. 12 p.