

Pseudoperonospora cubensis in Rust-Infected Bean

C. E. Yarwood

Professor Emeritus, Department of Plant Pathology, University of California, Berkeley, CA 94720.
Accepted for publication 7 February 1977.

ABSTRACT

YARWOOD, C. E. 1976. *Pseudoperonospora cubensis* in rust-infected bean. *Phytopathology* 67: 1021-1022.

When rust-infected bean leaves (uredinial stage of *Uromyces phaseoli* in *Phaseolus vulgaris* 'Pinto') were inoculated with sporangia of the cucumber downy mildew fungus (*Pseudoperonospora cubensis* in *Cucumis sativa* 'National Pickling') necrotic rings formed around isolated rust pustules, and heavily rusted areas of leaves were slowly killed, whereas no symptoms were caused by *P. cubensis* on nonrusted leaves. *Pseudoperonospora cubensis* formed

sporangiophores and sporangia in such rusted tissues and the sporangia showed normal infectivity. The optimum time from inoculation with *U. phaseoli* until inoculation with *P. cubensis* was about 1 day. Infection with *P. cubensis* was exclusively through the lower surface of bean leaves, whereas infection with *U. phaseoli* was about equally successful through the upper or lower surfaces.

Obligately parasitic fungi usually are very restricted in their host ranges. The extension of these host ranges by agricultural practices and experimental treatments (predisposition) is an important aspect of plant pathology. *Pseudoperonospora cubensis* (Berk and Curt.) Rostow, usually is considered to be restricted to members of the Cucurbitaceae. The extension of its host range to a member of the Leguminosae as a result of prior infection with *Uromyces phaseoli* (Pers.) Wint. is a dramatic example of predisposition.

MATERIALS AND METHODS

Beans were usually inoculated with *U. phaseoli* or *P. cubensis* by spraying the primary unifoliate leaves of 7- to 10-day-old greenhouse-grown plants with a water suspension of uredospores of *U. phaseoli* or sporangia of *P. cubensis*, and incubating the plants overnight in a moist chamber. For combined infection with both pathogens, inoculation was with a mixed spore suspension of both pathogens or with successive inoculations with spores of each pathogen separately.

RESULTS

When beans were inoculated with *P. cubensis* in ordinary inoculations, no macroscopically visible symptoms resulted. If the beans were heated 3-9 sec at 55 C before inoculation, small necrotic lesions formed but no sporulation resulted. When bean leaves were inoculated first with *P. cubensis* and 1 day later with *U. phaseoli*, normal infection with *Uromyces* resulted but no evidence of infection with *Pseudoperonospora* was observed. When beans were simultaneously inoculated with a suspension containing both *Uromyces* and *Pseudoperonospora*, abundant infection with *Uromyces* resulted but little infection with *Pseudoperonospora* was

observed. On the other hand when beans were inoculated with *U. phaseoli* on the upper surface and 1 or 2 days later with *P. cubensis* on the lower surface, heavy infection with both organisms resulted (Table 1).

Rust infection killed bean leaves slowly, but the speed of killing increased as the concentration of *U. phaseoli* increased. Infection of leaves by *Pseudoperonospora* increased the rate of killing of rusted tissue (Fig. 1). Infection of isolated rust pustules by *P. cubensis* caused the formation of necrotic rings around the rust pustules (Fig. 2) reminiscent of the formation of necrotic rings around rust pustules by tobacco mosaic virus (2).

When leaves infected with both *U. phaseoli* and *P. cubensis* were incubated overnight in a moist chamber, many apparently normal sporangiophores and sporangia of *P. cubensis* were formed on the lower leaf surface, though not as many per unit area as on cucumber leaves. Sporangia from these leaves were used as inoculum on cucumber and normal infection resulted.

DISCUSSION

Rust infection also predisposes beans to *Sphaerotheca fuliginea* (3), tobacco mosaic virus (2), several other

TABLE 1. Predisposition of bean leaves to attack by *Pseudoperonospora cubensis* as a result of prior inoculation with *Uromyces phaseoli*

| Leaf surface inoculated with <i>Uromyces phaseoli</i> | Leaf surface inoculated with <i>P. cubensis</i> | Colonies (lesions) of <i>P. cubensis</i> ^a (no.) |
|---|---|---|
| 17 July | 19 July | 24 July |
| upper | upper | 0 |
| upper | lower | 111 |
| lower | upper | 0 |
| lower | lower | 12 |

^aThe number of pustules of *U. phaseoli* was about 25/cm² throughout the series.



Fig. 1-2. Predisposition of bean leaves to attack by *Pseudoperonospora cubensis* by prior infection with *Uromyces phaseoli*. Labels 1A and 2A designate normal rust pustules caused by *U. phaseoli*. Labels 2A and 2B, rust pustules invaded by *P. cubensis*, resulting from inoculation with sporangia of *P. cubensis* on lower leaf surface 1) 1 day and 2) 2 days after inoculation with *U. phaseoli*. Photographed about 14 days (Fig. 1) and 16 days (Fig. 2) after inoculation with *U. phaseoli*.

viruses (1), *Colletotrichum lindemuthianum* (in anthracnoses-resistant bean varieties), and *Thielaviopsis basicola* (Yarwood, unpublished). Of these, *Sphaerotheca*, *Pseudoperonospora*, and all viruses are obligate parasites. With *Colletotrichum*, *Thielaviopsis*, and the viruses, the predisposition is relative, in that the pathogen makes some development in bean leaves in the absence of rust infection, and the rust infection merely increases the aggressiveness of these pathogens. With *Sphaerotheca* and *Pseudoperonospora* the predisposition is absolute, in that these pathogens make no macroscopic development or apparent reproduction in bean in the absence of rust infection. I believe the

predisposing effect of *Uromyces* infection to susceptibility of bean to other pathogens is greater than that of any other host:pathogen combination reported.

LITERATURE CITED

- GILL, C. C. 1965. Increased multiplication of viruses in rusted bean and sunflower tissue. *Phytopathology* 55:141-147.
- YARWOOD, C. E. 1951. Associations of rust and virus infections. *Science* 114:127-128.
- YARWOOD, C. E. 1965. Predisposition to mildew by rust infection, heat, abrasion, and pressure. *Phytopathology* 55:1372.