Pseudoperonospora cubensis in Rust-Infected Bean

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ABSTRACT


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 unstressed leaves. Pseudoperonospora cubensis formed sporangiospores 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 beans 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 sporangiospores and sporangia of P. cubensis were formed on the lower leaf surface, though not as many as on the corresponding 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>
<thead>
<tr>
<th>Leaf surface inoculated with Uromyces phaseoli</th>
<th>Leaf surface inoculated with P. cubensis</th>
<th>Colonies (lesions) of P. cubensis* (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 July</td>
<td>19 July</td>
<td>24 July</td>
</tr>
<tr>
<td>upper</td>
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<td>0</td>
</tr>
<tr>
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<td>lower</td>
<td>111</td>
</tr>
<tr>
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<td>upper</td>
<td>0</td>
</tr>
<tr>
<td>lower</td>
<td>lower</td>
<td>12</td>
</tr>
</tbody>
</table>

*The number of pustules of U. phaseoli was about 25/cm² throughout the series.
viruses (1), Colletotrichum lindenmuthianum (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