Colonization of Host Tissues and Infectivity of
Rhizoctonia solani

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ABSTRACT

Saprophytic colonization of various host tissues by
Rhizoctonia solani and their influence on hypocotyl rot
of lima beans was studied. Leaf tissue was the most
suitable substrate for colonization by R. solani, whereas
root tissue was least susceptible. Soil amended with lima
bean leaf tissue gave the highest disease index on lima
bean hypocotyls and permitted the highest percentage of
beet seeds to be colonized. Soil amended with root
segments gave a lower disease rating on lima bean
hypocotyls than the control, but did not alter
colonization of the beet seeds.

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It is common practice in the Eastern United States
to grow two successive crops of beans per year. Plant
debris from the first crop is incorporated into the soil
either by plowing and disking or disking alone and
the second crop is planted 4 to 14 days after
mechanical harvest of the first crop. Field
observations indicate that the second of the two
successive crops of beans is usually more severely
damaged by Rhizoctonia than the first crop.

Studies of pathogenicity and competitive
saprophytic ability of Rhizoctonia solani Kuehn have
been reported (2, 3, 6). Saprophytic activity of this
pathogen has been estimated by its ability to survive
as sclerotia (4), colonize dead substrate buried in soil
(4, 5), colonize nonhost plants (5), and invade seeds
buried in soil (10).

Organic amendments generally influence symptom
development and the severity of root disease. Crop
residues (7, 11) have been added to soils in an
attempt to suppress diseases. The effect of specific
amendments on Rhizoctonia infection varies.
Infection may be reduced, or not affected, depending
on the residue used (6, 7, 8).

The importance of prior addition to soil of host
tissue in promoting maximum pathogenicity has been
demonstrated for some plant-pathogenic fungi (9, 18), but few studies have evaluated the influence of specific parts of the host plant on R. solani hypocotyl
rot of bean. The present study was conducted to
determine the extent of colonization by Rhizoctonia
of specific parts of the host plant (lima bean,
Phaseolus lunatus L.) in soil in successive cropping
regimes, and the influence of these host tissues on the
incidence of hypocotyl rot of lima bean seedlings.

MATERIALS AND METHODS.—In this study, a
sandy loam soil with a pH of 5.9 and a
moisture-holding capacity (MHC) of 36% was
artificially infested with R. solani. The soil was
cropped repeatedly to 'Fordhook 242' lima beans
until all seedlings were infected by Rhizoctonia.
Infested soil was mixed with noninfested soil (1:4,
w/w), and the MHC was adjusted to about 50%.

Tissue segments (1 to 2 cm long) of roots,
hypocotyls, petioles, and leaves were excised from
6-week-old 'Jackson Wonder' (resistant to R. solani)
and Fordhook 242 (susceptible to R. solani) lima
beans grown in autoclaved soil. Two grams of each
tissue were mixed with about 300 g of soil and
incubated 6, 24, and 48 hr in wide-mouth glass jars.
After the incubation period, the tissue segments were
recovered by sieving, washed for 20 min in running
tap water, transferred to paper towels, partly dried,
and placed in petri plates containing 15 ml of water
agar (2%), to which streptomycin sulfate and
 aureomycin hydrochloride (100 mg of each/liter) had
been added. A similar method for isolation of
Rhizoctonia from buckwheat segments was described
by Papavizas & Davey (14). Five segments of each
tissue were plated on each of five petri plates for the
two cultivars of lima bean. The plates were incubated
at 25 C for 24 hr, then examined microscopically for
growth of R. solani.

The effect of host tissue on competitive
saprophytic ability of R. solani was studied by
burying the beet seeds in soil, a method similar to
that described by Pan (12). Tissue segments (2 cm
long) were mixed with lightly infested soil and
incubated at 25 C for 3 weeks. During that time
Rhizoctonia colonized a percentage of the tissue
segments in the presence of other soil
microorganisms. At the end of the incubation period,
nondecomposed tissue segments were recovered from
the soil and discarded. Nearly all of the leaf tissue had
decomposed. One gram of beet seed was mixed with
300 g of sieved soil from each treatment and
incubated for 3 days at 25 C. After incubation, the
beet seeds were recovered and washed for 20 min in
running tap water. The seeds were then prepared and
plated on the water agar similar to the method
described for tissue segments. The plates were
examined 24 hr after incubation, and the percentage
of beet seed colonized by Rhizoctonia determined.

The effect of various tissue segments on the
pathogenicity of Rhizoctonia in soil was studied by
growing lima beans in soil previously amended with
segments (0.5%, w/w) and incubated for 3 weeks. Ten
seeds of Jackson Wonder or Fordhook 242 lima bean were planted. Each treatment consisted of four replications in a randomized block design. Infection was evaluated by washing the seedlings and indexing typical lesions of R. solani on the hypocotyls. Disease severity was estimated, using an infection rating scale from 0 (no visible infection) to 5 (plants completely girdled) as originally suggested by Davey & Papavizas (7).

RESULTS.—Isolation of Rhizoctonia spp. from host tissue buried in infested soil.—The amount of colonization of plant segments after 6, 24, and 48 hr of incubation in Rhizoctonia-infested soil, as measured by the percentage of plant segments colonized, was influenced by the kind of host tissue used and the length of the incubation period (Table 1). Leaf tissue of both resistant and susceptible cultivars was the most suitable for isolating R. solani and was 96 to 100% colonized, respectively. Petiole segments of both resistant and susceptible cultivars (51 and 60%, respectively), and the hypocotyl segments of Fordhook 242 (53%) were extensively colonized after 48 hr. Root and hypocotyl segments of Jackson Wonder yielded the lowest percentage of Rhizoctonia isolates (14 and 12%, respectively).

None of the tissue was colonized when incubated for less than 6 hr. Hypocotyls and petioles were colonized more intensively 48 hr after incubation, which is consistent with similar results obtained by other workers (5, 7).

Effect of age of host tissue on colonization by Rhizoctonia.—Specific host tissues of different maturities, buried in soil (Fig. 1), were compared for their influence on colonization of beet seeds. Colonization of beet seeds was highest from soil previously amended with leaf tissue at all stages of maturity for both cultivars. On the other hand, colonization of beet seeds was lowest in soil amended with root segments. The source of tissue, and stage of hypocotyl or petiole maturity, significantly influenced beet-seed colonization. The percentage of beet seeds colonized by Rhizoctonia in soil amended with immature hypocotyl tissue, was greater than in soil amended with mature tissue. For example, the percentage of beet seeds colonized in soil amended

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Incubation time (hr)</th>
<th>Incubation time (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jackson Wonder</td>
<td>Fordhook 242</td>
</tr>
<tr>
<td></td>
<td>(Resistant)</td>
<td>(Susceptible)</td>
</tr>
<tr>
<td>Leaf</td>
<td>6 24 48</td>
<td>6 24 48</td>
</tr>
<tr>
<td>Petiole</td>
<td>0 3 b 51 a</td>
<td>3 27 b 60 b</td>
</tr>
<tr>
<td>Hypocotyl</td>
<td>0 2 b 14 c</td>
<td>0 12 c 53 b</td>
</tr>
<tr>
<td>Root</td>
<td>0 2 b 12 c</td>
<td>0 8 c 27 c</td>
</tr>
</tbody>
</table>

*Percentage of buried segments of tissue colonized from 14-day-old plants.

*Numbers followed by the same letter are not significantly different at the 5% level.

![Fig. 1](image-url)

Fig. 1. Saprophytic (3-day) colonization of beet \( (Beta vulgaris L. \) seed incubated in soil amended with specific plant parts of two lima bean cultivars \( (Phaseolus lunatus L. \) for 2, 4, or 8 weeks. Seedlings of cultivar 'Jackson Wonder' are resistant to invasion by Rhizoctonia solani, and those of 'Fordhook 242' are susceptible.
with hypocotyl segments 2, 4, and 8 weeks old were 33, 18, and 12 for Jackson Wonder and 61, 50, and 22 for Fordhook 242, respectively. Colonization of beet seed from soil amended with leaf tissue at different stages of maturity remained relatively stable, regardless of the cultivar.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Fordhook Wonder</th>
<th>Fordhook Wonder</th>
<th>Jackson Wonder</th>
<th>Jackson Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>0.32 a c</td>
<td>0.35 a</td>
<td>0.31 a</td>
<td>0.12 a</td>
</tr>
<tr>
<td>Hypocotyl</td>
<td>3.84 b</td>
<td>6.68 ab</td>
<td>0.62 b</td>
<td>0.31 b</td>
</tr>
<tr>
<td>Petiole</td>
<td>2.84 b</td>
<td>1.63 ab</td>
<td>1.28 b</td>
<td>0.97 c</td>
</tr>
<tr>
<td>Leaf</td>
<td>4.09 c</td>
<td>1.94 b</td>
<td>3.50 d</td>
<td>1.49 d</td>
</tr>
<tr>
<td>Control</td>
<td>3.22 c</td>
<td>1.26 ab</td>
<td>3.18 d</td>
<td>1.32 c</td>
</tr>
</tbody>
</table>

* Severity rating on individual plants on a scale of 0 (no disease symptoms) to 5 (hypocotyl completely girdled).
* Tissue incubated in soil for 3 weeks before planting lima bean seeds. Lima beans were grown in soil before adding tissue.
* Numbers followed by the same letter are not significantly different at the 5% level.

**Rhizoctonia invades lima bean leaf and petiole tissues readily.** Under warm, humid conditions it is capable of infecting all aerial plant parts of snap beans (19, 20) and soybeans (1), regardless of age. In the present investigation, lima bean leaves at all stages of maturity were suitable substrates for colonization by *R. solani*. In addition, the incidence of hypocotyl rot increased significantly compared to the control (Table 2), when a susceptible cultivar was grown in soil amended with immature leaf tissue and was greater than, or equal to, that of the control in all other treatments. Thus, colonized leaves and, to a lesser extent, petioles are probably important sources of inoculum in fields where two successive crops are grown per year. Since leaf tissues decompose rapidly, infected leaves are probably not a source of inoculum when only one crop is grown per year. Coons & Kotila (6) showed that when one crop of beans was grown each season, the incidence of hypocotyl rot was not increased. These findings may account for part of the differences in the incidence of hypocotyl rot between one planting and two successive plantings.

From the experiments on the influence of host tissue from resistant and susceptible cultivars, it was learned that the resistant cultivar provided a substrate less suitable for colonization of *R. solani* than susceptible cultivar tissue, except where leaf tissue was used. However, the percentage of *R. solani* colonies isolated, and the incidence of hypocotyl rot was always lower from Jackson Wonder segments than from those of Fordhook 242. The leaves and petioles of both cultivars were suitable substrates for colonization. Thus, resistance to *R. solani* did not extend to petiole and leaves in Jackson Wonder, nor was leaf maturity a factor. Other lima bean tissues showed clear differences in the percentage of infection and percent of colonization between the two cultivars.

Root segments were always less vigorously colonized by *Rhizoctonia* spp. than other segments in both susceptible and resistant cultivars. This suggests that roots and mature hypocotyls are not readily available substrates for *R. solani*. Bateman & Lumsden (3) showed that calcium content of hypocotyl tissue increased with age, and that susceptibility was inversely related to calcium content. Highly lignified tissues, such as roots and mature hypocotyls, are also less readily macerated by enzyme preparations.

It would be of particular interest to determine whether removal of petioles and leaves of bean would affect disease incidence under field conditions.

**LITERATURE CITED**


