Temporary Depression of *Rhizoctonia solani* Field Populations by Soil Amendment with *Laetisaria arvalis*

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ABSTRACT

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Fall application of *Laetisaria arvalis* sclerotia to sugar beet field plots naturally infested with *Rhizoctonia solani* increased *L. arvalis* and reduced *R. solani* populations during winter and early spring. Spring application of *L. arvalis* increased *L. arvalis* populations throughout the summer and depressed *R. solani* populations in midsummer although the declines were not statistically significant. In both instances, *L. arvalis* populations peaked 3 mo after soil treatment and *R. solani* populations reached a minimum of 40–45% of control plot levels at that time or 1 mo later. Spring application of *L. arvalis* increased sugar beet survival in August, but neither fall nor spring application reduced sugar beet losses caused by *R. solani* at harvest.

Rhizoctonia solani Kühn is a serious pathogen of sugar beet (*Beta vulgaris* L.) in irrigated croplands of western Nebraska. It is not unusual to find individual fields almost destroyed by black rot (Rhizoctonia root or crown rot) even though national losses to this disease are relatively small (2). Because economical chemical control is unavailable, possible means of biological control have come under increasing study.

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Soil application of the basidiomycete *Laetisaria arvalis* Burdsall, earlier identified as *Corticium* sp. (1,4,7), has shown promise for use in integrated control of Rhizoctonia rots of cucumber and sugar beets (4,7). Lewis and Papavizas (4) obtained a 33% reduction in Rhizoctonia fruit rot of cucumber through broadcast application of *L. arvalis* sclerotia to disked field soils infested with *R. solani.* Odvody et al (7) banded *L. arvalis* inoculum and ground sugar beet pulp (SBP) food base in the rows 5 cm below the seeds at spring planting and enhanced sugar beet survival through midseason (August) but not at harvest (October). In an as yet unpublished study by our laboratory during 1980–1982, M. F. Allen, M. G. Boosalis, E. D. Kerr, and H. J. Larsen broadcast *L. arvalis* inoculum and SBP food base over field soil in the fall and incorporated it into the top 2.5 cm of soil by hand raking. A ninefold increase in *L. arvalis* populations over control plot populations and a concomitant decrease of 40–50% in *R. solani* populations from the control throughout the winter and early spring were observed, but the populations of both organisms returned to pretreatment levels by midsummer. Sugar beet survival in the study was enhanced through midseason (August) but not at harvest (October). These studies suggested the need for additional investigation.

The purpose of our study was to further investigate the effects of soil amendment with *L. arvalis* inoculum on populations of *R. solani* and *L. arvalis* and on the incidence of black rot of sugar beet throughout the 1982 growing season. We addressed the following specific questions: Would fall application of *L. arvalis* inoculum without SBP food base affect soil populations of *L. arvalis* and *R. solani* as strongly as found earlier when SBP food base was added? Also, would a spring preplant broadcast application of *L. arvalis* inoculum with SBP food base shift the population peak of this potential control organism closer to midsummer and decrease *R. solani* populations during the time the beets needed protection? Finally, what effect would a spring broadcast application have on beet survival at harvest?

MATERIALS AND METHODS

Production and processing of *L. arvalis* inoculum and SBP food base followed the methods of Odvody et al (7). *L. arvalis* was grown in still cultures of 50 ml of potato-dextrose broth in 250-ml flasks at 24–27 C under normal room fluorescent illumination. Cultures were harvested after 21–28 days, air-dried, ground through a 0.85-mm pore size (20-mesh) screen in a Wiley mill, and stored in plastic containers at 24–27 C until needed. Viability of this stored sclerotial inoculum was >90% at the time of field application. Dried SBP pellets were also ground through a 0.85-mm pore size (20-mesh) screen and stored at 24–27 C in heavy paper bags until needed.

Plots were established in October 1981 at a western Nebraska site with an Alliance fine sandy loam (fine silty, mixed, mesic aridic argiustolls) soil type. A randomized design with four replicates per treatment was used. Plots measuring 9.29 m^2 were staked out for the following soil treatments: untreated control, fall-applied *L. arvalis* inoculum (215 kg/ha), and fall-applied SBP food base (1,940 kg/ha). These treatments were applied in early November 1981 with the treatment materials broadcast over the plots and incorporated into the top 2.5 cm of soil by hand raking.

Similar plots of four replicates for a spring application of *L. arvalis* (215 kg/ha) with SBP (1,940 kg/ha) were established in March 1982. Treatment materials were applied as in the fall, and all plots were seeded in April 1982.

Soil samples were collected near the first of each month from November 1981 through October 1982, except May 1982. Five samples (200–250 ml) per plot were taken at random in the rows and bulked in the field to provide about a 1-L soil sample for each plot. Samples were stored in plastic bags at 5–8 C until processed for laboratory use.

A modified sugar beet seed colonization method was used to estimate populations of *L. arvalis* and *R. solani* (7). Autoclaved sugar beet seeds were incubated in homogenized subsamples of plot soils for 3 days and 114 seeds for each plot were then scored for presence of *R. solani* and *L. arvalis*.

Sugar beet stand counts were taken monthly from July through October 1982. The July counts began after June thinning, and the last count was taken just before harvest in October.

Data were analyzed by standard statistical methods using SAS (3,8). All counts and totals were increased by one to eliminate zero values, and percentage values were arc sine-transformed before analysis. All differences are reported at the $P<0.05$ level of confidence.

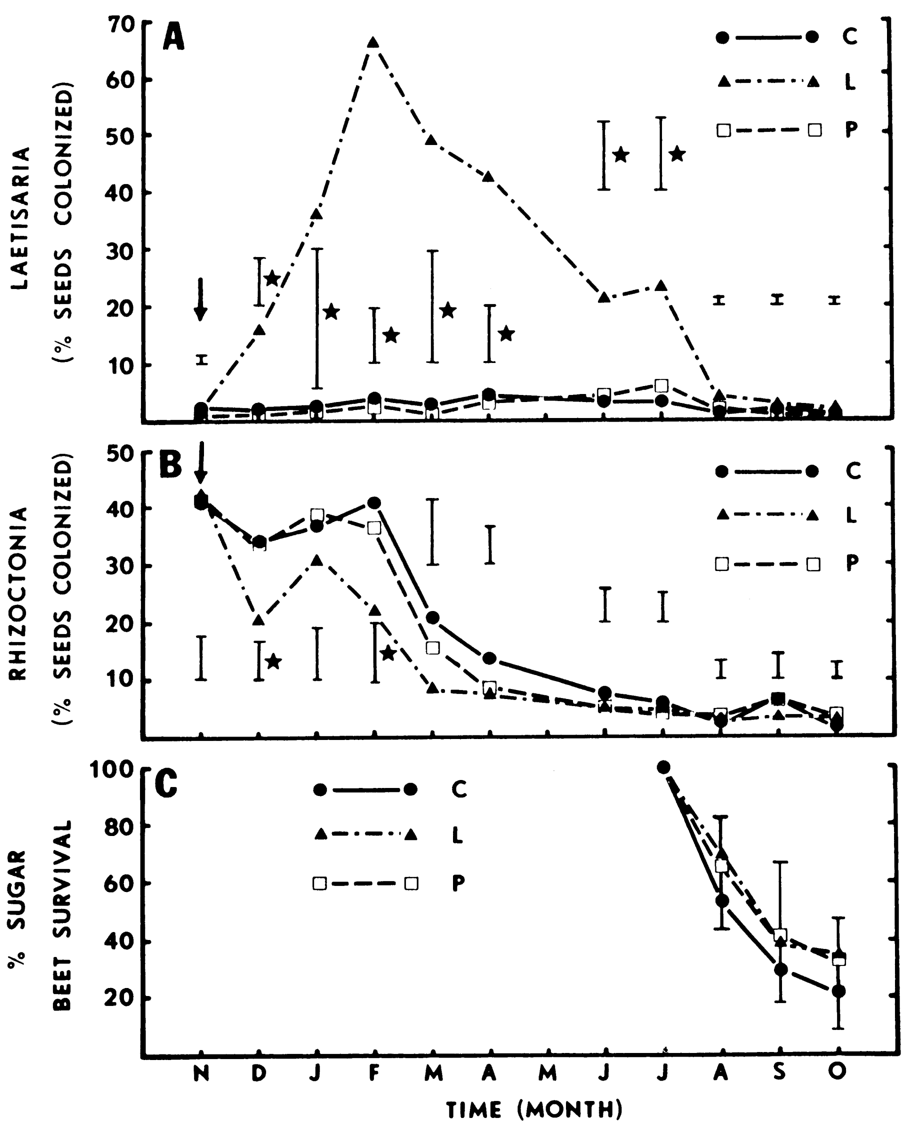

Fig. 1. Effects of fall field soil amendment with *Laetisaria arvalis* and sugar beet pulp (SBP) on populations of *L. arvalis* and *Rhizoctonia solani* and on sugar beet plant survival. **(A)** *L. arvalis* populations, **(B)** *R. solani* populations, and **(C)** sugar beet survival as percent of July stand counts. Treatments: C = control, L = *L. arvalis* inoculum, and P = SBP food base. Arrow indicates treatment time, and bars represent LSD values for each month. Stars indicate months with significant differences in means ($P<0.05$).

RESULTS

Fall soil amendment with *L. arvalis* temporarily increased field populations of this fungus, whereas application of SBP food base had no effect on these field populations (Fig. 1A). Populations of *L. arvalis* in inoculum-treated plots peaked at 66% seed colonization 3 mo after inoculum application (compared with 4% for control plots) and returned to control plot levels in August. In contrast, no differences between *L. arvalis* populations in control plots and those treated with SBP food base alone were found throughout the year; they ranged from 1 to 6% seed colonization. Maximum seed colonization for plots amended with SBP food base alone was 6% compared with 3% for the control plots. The natural populations in these plots had higher levels of seed colonization during the spring and declined throughout the summer to a midfall minimum. However, no statistical differences could be found between monthly population levels.

Populations of *R. solani* were temporarily reduced in these inoculum-treated plots but not in the SBP-treated plots (Fig. 1B). These reductions of the *R. solani* populations to 60% of control plot levels in December (1 mo after treatment) and to 55% of control plot levels in February (3 mo after treatment) were significant, but the decrease to 43% of control plot levels in March was not significant. Populations of *R. solani* in all plots including the control declined throughout the study, especially in the spring and summer of 1982.

Fall treatment of plot soils with either

L. arvalis inoculum or SBP food base did not significantly affect sugar beet survival (Fig. 1C). Both treatments slightly enhanced beet survival at harvest, with 135 and 127% of control plot survival for the inoculum-treated and SBP-treated plots, respectively.

Spring application of inoculum with SBP food base likewise increased *L. arvalis* and depressed *R. solani* populations temporarily (Fig. 2A,B). *L. arvalis* populations in these plots were 5% immediately before treatment and rose rapidly afterward to give 46% seed colonization in July compared with 3% seed colonization for control plots. They then dropped to 7% the next month compared with 1.5% for control plots and remained at that level for the remainder of the study. The *R. solani* populations dropped to 43% of control plot populations in July and then rose to four times the control plot levels in October, but the differences from the control were not significant. Spring application of inoculum significantly increased beet survival in August to 151% of control plot levels, but beet survival in these plots did not differ from the control thereafter (Fig. 2C).

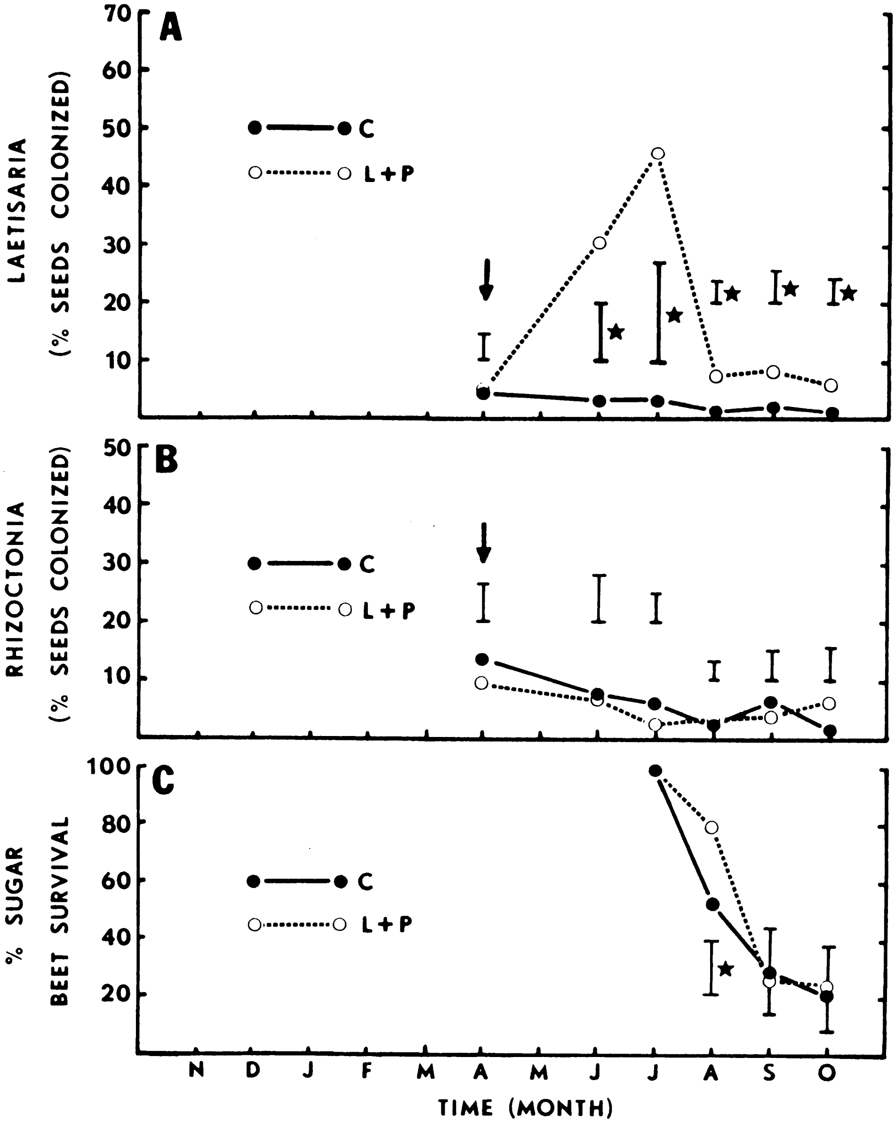

Fig. 2. Effects of spring field soil amendment with *Laetisaria arvalis* plus sugar beet pulp (SBP) on populations of *L. arvalis* and *Rhizoctonia solani* and on sugar beet plant survival. **(A)** *L. arvalis* populations, **(B)** *R. solani* populations, and **(C)** sugar beet survival as percent of July stand counts. Treatments: C = control and L+P = spring-applied *L. arvalis* plus SBP. Arrow indicates treatment time, and bars represent LSD values for each month. Stars indicate months with significant differences in means ($P < 0.05$).

DISCUSSION

Results from these studies confirm that field populations of *L. arvalis* and *R. solani* may be temporarily altered through soil amendment with *L. arvalis* inoculum. The native populations of *L. arvalis* in this western Nebraska soil fluctuate to give 1–6% seed colonization with low points in late summer and fall. Addition of *L. arvalis* to these soils in either fall or spring, either with or without SBP food base, increased *L. arvalis* populations to 15–17 times the corresponding control plot levels 3 mo after treatment. This compares with a ninefold increase over the control 4 mo after fall treatment observed in our earlier unpublished study. Fall application of *L. arvalis* without SBP in the current study depressed *R. solani* populations to 40% of control plot population levels 4 mo after soil treatment compared with 56% of control plot levels 5 mo after treatment in our earlier study. Similarly, early spring application of *L. arvalis* inoculum with SBP food base decreased *R. solani* populations to 43% of the corresponding control plot levels 3 mo after treatment. Thus, in each of these studies, the *L. arvalis* populations peaked 3–4 mo after soil amendment, and the *R. solani* populations reached their minimum percentages of the control populations either then or 1 mo later. However, populations of both fungi subsequently returned to their original levels. Martin et al (5) observed similar population dynamics for *L. arvalis* in their greenhouse study on the effect of *L. arvalis* soil amendment on reproduction levels of *Pythium ultimum* in table beet field soils. The reason for the general decline in *R. solani* populations during the spring and the rapid decline in *L. arvalis* populations between early July and early August is not known. The midsummer decline in *L. arvalis* corresponds with the annual maximum in soil temperatures at 5 cm deep for a nearby site (6), but a temperature/growth response study for *L. arvalis* needs to be done.

The results also demonstrate the difficulty in transferring biological control potential into effective control in the field, even when the potential control organism is naturally present in the target environment at low levels (less than 5% seed colonization). In this investigation, that by Odvody et al (7), and our previous unpublished study, soil amendment with an isolate of *L. arvalis* originally obtained from western Nebraska beet fields failed to significantly reduce sugar beet loss to black rot at harvest there despite reduction of soil populations of the pathogen and increased plant stand counts earlier in the season. The season-long susceptibility of this crop to the pathogen may be a factor in this lack of disease control at harvest, and multiple applications of the *L. arvalis* inoculum at several points in the growing season might be effective in reducing disease loss. Additional understanding of the interactions of these two fungi, the sugar beet crop, and possibly tillage methods will be required if the potential for biological control of black rot of sugar beet through soil amendment with *L. arvalis* is to be realized.

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LITERATURE CITED

1. Burdsall, H. H., Jr., Hoch, H. C., Boosalis, M. G., and Settliff, E. C. 1980. *Laetisaria arvalis* (Aphyllophorales, Corticiaceae): A possible biological control agent for *Rhizoctonia solani* and *Pythium* species. Mycologia 72:728-736.
2. Hecker, R. J., and Ruppel, E. G. 1980. Rhizoctonia root rot of sugarbeets as affected by rate and nitrogen fertilizer carrier. J. Am. Soc. Sugar Beet Technol. 20:571-577.
3. Helwig, J. T., and Council, K. A., eds. 1979. SAS Users Guide. SAS Institute, Raleigh, NC. 494 pp.
4. Lewis, J. A., and Papavizas, G. C. 1980. Integrated control of Rhizoctonia fruit rot of cucumber. Phytopathology 70:85-89.
5. Martin, S. B., Hoch, H. C., and Abawi, G. S. 1983. Population dynamics of *Laetisaria arvalis* and low-temperature *Pythium* spp. in untreated and pasteurized beet field soils. Phytopathology 73:1445-1449.
6. National Climatic Data Center (NOAA). 1982 (1983). Annual summary: Nebraska 1982. Climatological Data. Nebraska 87(13):1-31.
7. Odvody, G. N., Boosalis, M. G., and Kerr, E. D. 1980. Biological control of *Rhizoctonia solani* with a soil inhabiting basidiomycete. Phytopathology 70:655-658.
8. Steel, R. G. D., and Torrie, J. H. 1980. Principles and Procedures of Statistics. 2nd ed. McGraw-Hill, New York. 633 pp.