Stagonospora convolvuli LA39 for Biocontrol of Field Bindweed Infesting *Cotoneaster* in a Cemetery

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Abstract. Field bindweed (*Convolvulus arvensis* L.) infests roadsides, hedges, and parks, and is difficult to control with herbicides. In this work, the potential of the mycoherbicide *Stagonospora convolvuli* Dearness & House strain LA39 for use as a biological control of field bindweed was tested in a cemetery, where a groundcover of cotoneaster was extensively infested by the weed. Application of *S. convolvuli* resulted in extensive necrosis of field bindweed leaves within 20 days, and necrosis became more extensive in the 20 following days. Bindweed density decreased continuously to about half of that in the uninoculated control plots within 40 days after application. No effect on emergence of field bindweed was observed in the year following the application of *S. convolvuli*. In conclusion, *S. convolvuli* may be useful as a mycoherbicide for the control of field bindweed in amenity areas but it would need to be applied every year.

Field bindweed is an important weed on roadsides, in hedges and parks. Chemical herbicides available for bindweed control affect many other plants, including some widely used as groundcovers in parks, where effective control of bindweeds often requires expensive and frequent hand weeding. Therefore, selective bindweed control through alternative strategies would be useful in this type of environment.

The mycoherbicide *S. convolvuli* strain LA39 (isolated in our laboratory from a leaf of a diseased *C. arvensis* plant) is specifically pathogenic to the bindweeds *C. arvensis* and *Calystegia sepium* (L.) R. Br. and other *Convolvulaceae* (Pfirter and Défago, 1998). Greenhouse and field trials have shown that strain LA39 is a promising biological control agent for bindweeds in agricultural systems (Pfirter et al., 1997). The objective of this study was to assess strain LA39 for biocontrol of *C. arvensis* in a nonagricultural environment.

Cemeteries were chosen as a model because, in Switzerland, *Cotoneaster dammeri* C.K. Schneider is often used as a groundcover

between graves, where favorable conditions exist for infestation by bindweeds. Graves are organized in rows, and within a row they are surrounded with *C. dammeri*, which covers about half the surface of the cemetery (cover photo). A cemetery located in Zürich, Switzerland, and where *C. dammeri* was heavily infested by *C. arvensis* was selected for the experiment.

Two treatments (mycoherbicide and control) were studied, using a block design. Six blocks, each with two 2-m² plots, were selected and the mycoherbicide was sprayed on one plot per block. The six control plots were treated with benomyl [1-(butylcarbamoyl)-2-benzimidazolecarbamate methyl ester] (225 g a.i. in 450 L of water per hectare). This systemic fungicide, which has no effect on growth of *C. dammeri* or *C. arvensis*, was used to prevent spread of the pathogen into control plots. Treatments were applied at 10:00 HR on 10 Aug. 1996, a day with 10 h of sunny, dry weather, and a mean temperature of 20 °C. During the experiment the average temperature was 15.8 °C, total rainfall was 120 mm, and sunshine averaged 5.2 h·d⁻¹.

The fungal inoculum was produced by growing LA39 on sterilized couscous grains (i.e., coarse wheat flour) for 14 d (20 °C, 70% relative humidity, continuous light), as described by Pfirter and Défago (1998). The grains were washed in sterile distilled water to dislodge the conidia and the suspension was filtered through two layers of cheesecloth. The conidial suspension was adjusted to 10⁸ conidia/mL (as determined with a haemocytometer), a concentration effective for infection of *C. arvensis* (Pfirter and Défago, 1998). The conidial suspension was incorporated into an oil emulsion (final concentration 10⁷ conidia/mL), as described by Lawrie et al. (1997). The plots were sprayed with the final preparation at a rate of 300 L·ha⁻¹ using a backpack sprayer (model M125; Birchmeier AG, Künten, Switzerland).

Each plot was evaluated immediately before spraying, 20 and 40 d after treatment, and

Fig. 1. (A) Percent necrotic leaf surface of *C. arvensis* and (B) bindweed density as a percentage of grid points occupied, in plots treated with *S. convolvuli* strain LA39 (triangles) and in nontreated control plots (squares). Error bars represent standard deviations. Asterisks indicate a significant effect of treatments ($P \leq 0.05$).

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at the start of the next growing season in Apr. 1997. At the start of the experiment there were no necrotic lesions on the leaves. A 50 × 100-cm grid (10-cm mesh size) was placed at the center of each plot. To assess bindweed density, presence of the weed was scored (presence or absence) at each of the 66 points of the grid. Bindweed density was calculated as the percentage of grid points where bindweed leaves were present. Disease severity (necrotic leaf surface; NLS) was assessed by visually rating the percentage of leaf surface that was necrotic for the leaf found at each grid point, or the closest leaf when no leaf was found there. The following scale was used: 0 = 0% NLS (no symptoms); 2.5 = 1% to 5% NLS; 15 = 6% to 24% NLS; 50 = 25% to 75% NLS; 87.5 = 76% to 99% NLS; 100 = 100% NLS (entire leaf dead). For each plot, the average NLS was calculated using data obtained with the 66 leaves studied.

Bindweed density and NLS data were arcsine transformed and analysis of variance was used to determine treatment effects. Data were analyzed at $P \leq 0.05$ and Systat 5.05 (SPSS Inc., Evanston, Ill.) was used. For presentation, data were back-transformed to percentages.

Results and Discussion

Spraying of bindweed-infested *C. dammeri* with *S. convolvuli* strain LA39 resulted in extensive infection of *C. arvensis*, which displayed 60% NLS as early as 20 d after inocu-

lation (Fig. 1A). The fungus had no apparent effect on the canopy of *C. dammeri*. In the control plots, necrotic spots were almost never found on leaves 20 d after inoculation, but disease severity reached 20% in these plots at 40 d (Fig. 1A). The application of benomyl did not prevent spread of the fungus from LA39-treated plots to control plots throughout the 40-d period after inoculation. Indeed, an important increase in disease severity took place in the control treatment between 20 and 40 d, and this increase was similar to that in the LA39 treatment (Fig. 1A).

In control plots, bindweed density increased from 32% to 49% during the first 20 d, but did not increase further during the next 20 d (Fig. 1B). This was expected, as bindweed reaches its highest density in August in Zürich. In plots treated with LA39, bindweed density decreased to 17% during the 40-d period after inoculation.

Plots also were monitored in Spring 1997 to assess the residual effect of mycoherbicide application on emergence of the bindweed in the next growing season. In both treatments, bindweed density amounted to $14\% \pm 4\%$ (mean $\pm$ SD) and necrotic lesions were not found on *C. arvensis*. This lack of residual effect of the mycoherbicide on bindweed development implies that LA39 needs to be applied every year for bindweed control, probably because bindweeds possess substantial reserves in their rhizomes (Barr, 1945).

A second experiment was performed in the same cemetery and at the same time, using the

same experimental design, but with plots that were half the size. Results similar to those from the first experiment were obtained regarding the effect of LA39 on infection of *C. arvensis* and bindweed density (data not shown).

In conclusion, *S. convolvuli* strain LA39 proved to be effective for bindweed control in *C. dammeri* by causing defoliation. This fungus may be useful where bindweed is the main weed to be controlled, especially in amenity areas where groundcovers and bushes provide favorable conditions for its development and where environmentally friendly control strategies are welcomed. Future research will determine if LA39 can suppress bindweeds consistently, in different years and in different climatic regions.

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