Redvine and Trumpetcreeper Controlled by Interaction of the Bioherbicide *Myrothecium verrucaria* and Glyphosate

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ABSTRACT

Aqueous and emulsified formulations of the bioherbicidal fungus *Myrothecium verrucaria* (Alb. & Schwein.) Ditmar:Fr. were tested alone, in combination with, prior to, and following treatment with glyphosate [*N*-(phosphonomethyl)glycine] for controlling natural infestations of redvine [*Brunnichia ovata* (Walt.) Shinners] and trumpetcreeper [*Campsis radicans* (L.) Seem. ex Bureau] in field tests at Stoneville, MS in 2000 and 2001. Maximum redvine and trumpetcreeper mortalities (86% and 78%, respectively) occurred nine DAT when emulsified fungal treatments were tank mixed with glyphosate. Similar levels of control (83% and 75%) occurred with tank mixes of glyphosate and aqueous fungal formulations. Infected weeds of each species exhibited similar disease symptomatology within 24 h following treatment. Disease symptomatology was characterized by necrotic flecking on leaves that coalesced into large lesions. Symptoms progressed from infected cotyledons and leaves to produce stem lesions within 72 h. Soybeans planted in treated plots emerged normally with no reductions occurring in plant height or biomass. No visual disease or herbicide damage occurred to soybeans. These results suggest that it may be possible to use combinations of glyphosate and *M. verrucaria* to improve the control of redvine and trumpetcreeper.

INTRODUCTION

Redvine and trumpetcreeper are native perennial, deciduous, woody dicot, shrubby vines capable of growing several meters in length (Elmore, 1984). They are found in cultivated fields, wastelands, fence rows, yards, riverbanks, swamps, and forests, and are distributed extensively in the Mississippi Delta region. These weeds are among the ten most troublesome weeds in the row crops of the Mississippi delta. These weeds reduce crop yield and quality and interfere with cultivation and harvest operations.

Redvine and trumpetcreeper are difficult to control because of their extensive deep root system (Chachalis and Reddy, 2000, 2001; Elmore 1984). Many herbicides that show promise kill only the foliage with little or no translocation to rootstock (Chachalis and Reddy 2000; Shaw and Mack 1991). Regrowth from underground rootstocks occur because of insufficient translocation of glyphosate to rootstocks (Reddy 2000; Reddy and Chachalis, 2000b). Glyphosate is a widely used, nonselective broad-spectrum postemergence herbicide with some activity on redvine (Chachalis and Reddy, 2000; Reddy and Chachalis, 2000a; Chachalis *et al*., 2001;). Glyphosate at 1 to 2x use rates provide 60 to 90% control of these weeds but plants reestablish in within 4 to 6 weeks after treatment. Destruction of foliage is only temporary and new sprouts arise from the underground rootstock.

It became clear with our studies that control of these weeds with glyphosate alone, even at rates two-to-four times the rates recommended in non-GMO soybeans, is temporary at best, and alone cannot control these weeds satisfactorily. Strategies based on synergistic interactions of glyphosate and plant pathogens could result in improved, more effective management of these weeds and warrants investigation.

The fungus *Myrothecium verrucaria* (Alb. & Schwein.) Ditmar:Fr., originally isolated from sicklepod (*Senna obtusifolia* L.) exhibited excellent biocontrol potential for several weed species, including the legumes sicklepod and hemp sesbania [*Sesbania exaltata* (Raf.) Rydb. ex A.W. Hill], when formulated with the surfactant Silwet L-77 (a silicone-polyether copolymer spray adjuvant, OSi Specialties, Inc., Charlotte, NC) (Walker and Tilley, 1997). This fungus also effectively controlled kudzu in the absence of a dew treatment over a wide range of physical and environmental conditions and under field conditions (Boyette, *et al*., 2001), and a U.S. Patent was issued for use of this pathogen as a bioherbicide for kudzu control (Boyette, *et al*., 2002). Redvine and trumpetcreeper were not examined as potential hosts in any of these reports and have not been previously reported as hosts of *M. verrucaria* in the literature. Preliminary experiments revealed that both redvine and trumpetcreeper were modestly susceptible to *M. verrucaria*, but not at levels that would provide acceptable weed control. Previous research has shown that it is possible to significantly improve the performance of several bioherbicides through chemical synergism, especially with glyphosate (Boyette and Hoagland, 2000; Hoagland, 2000). The objectives of this present study were to determine the effects of *M. verrucaria* / glyphosate aqueous and emulsified formulations and application timings on mortality and dry weight reductions of redvine and trumpetcreeper and effects on soybean planted in treated plots.

MATERIALS AND METHODS

***Inoculum Production and bioherbicide formulation*. Inoculum (conidia) of *M. verrucaria* (MV) were produced in petri dishes containing Difco potato dextrose agar (PDA). Agar surfaces were flooded with 3 ml of a *M. verrucaria* conidia suspension containing 2 x 10^6 conidia / ml. The PDA plates were inverted on open-mesh wire shelves and incubated at 25C° for 5 days in fluorescently lighted incubators. The resulting conidia were rinsed from the plates with sterile, distilled water, and were adjusted to the desired concentrations by adding distilled water. Spore counts and concentrations were estimated with hemacytometers. Previous research had shown that the virulence of this pathogen as well as several other bioherbicidal fungi was significantly improved when formulated as an emulsion by mixing aqueous spore suspensions with unrefined corn oil (30% v/v)and Silwet L-77™ surfactant (SW) (a silicone-polyether copolymer spray adjuvant (0.2% v/v). Therefore, this formulation was selected for use in the field trials. Unrefined corn oil was used to form emulsions (EM) in treatment receiving an emulsified formulation.**

***Field Operations*. Field test plots were established in a field that was heavily infested with naturally-occurring redvine and trumpetcreeper populations near Stoneville, MS in June 2000 and 2001. Treatments consisted of: (1) Glyphosate (GLY) [RounUp Ultra®] at 2 pt/A; (2) MV+SW (inoculum density of 2 x 10^7 conidia/ml at a volume of 250 L/ha); (3)MV+EM; (4) MV+SW+GLY; (5) MV+SW fb GLY; (6) GLY fb MV+SW; (7)MV+EM+GLY (8) MV+EM fb GLY; (9) SW only; (10) EM only and (11) Untreated (UNT). All applications were made using pressurized backpack sprayers when weeds were in the second-fourth leaf stage of growth (ca. 6-8 cm in height). Test plots were 2x2 m^2. Disease development and weed mortality data were recorded at 3 day intervals over a period of 9 days. At 9 DAT, soybeans (DP 5915RR) were planted in the treated areas, and after 9 more days, soybean germination was calculated in each of the treated plots by comparing the number of germinated (fully emerged) soybeans against untreated control plots. Soybean heights were evaluated in a like manner. Data were pooled over the two year testing period. A completely randomized block experimental design was utilized, and means were separated using Fisher's Least Significant Difference at P = 0.05.**

Figure 1. *M. Verrucaria* on PDA and conidia

	Redvine Control (%)	Trumpetcreeper Control (%)	Redvine Dry Wt. Red. (%)	Trumpetcreeper Dry Wt. Red. (%)
Treatment				
1. GLY	61	59	67	63
2. MV+SW	10	9	14	11
3. MV+EM	57	53	64	61
4. MV+SW+GLY	83	75	88	81
5. MV+SW fb GLY	81	72	86	75
6. GLY fb MV+SW	80	70	84	74
7. MV+EM+GLY	86	78	91	86
8. MV+EM fb GLY	82	71	86	75
9. SW	0	0	0	0
10. EM	0	0	0	4
11. UNT	0	0	0	0
LSD_{05}	7.1	6.6	6.9	6.0

Table 1. Effects of Glyphosate and *M. verrucaria* Interaction of Control of Redvine and Trumpetcreeper in Naturally-Infested Field Test Plots

Figure 2. Trumpetcreeper (top); redvine (bottom)

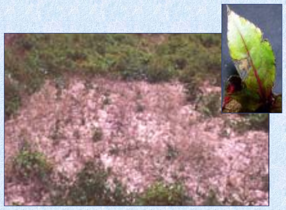

Figure 3. Redvine and trumpetcreeper controlled by MV+EM+GLY; lesion coalescence on redvine leaf (inset)

RESULTS AND DISCUSSION

Redvine and trumpetcreeper were controlled at 86% and 78%, respectively, nine DAT when emulsified fungal treatments were tank mixed with glyphosate (Table 1). Similar levels of control (83% and 75%) occurred with tank mixes of glyphosate and aqueous fungal formulations. Dry weight reductions of plants followed a similar trend (Table 1). Infected redvine and trumpetcreeper exhibited disease symptomatology within 24 h following treatment, which was characterized by necrotic flecking on leaves that coalesced into large lesions (Figure 3). Symptoms progressed from infected cotyledons and leaves to produce stem lesions within 72 h. Soybeans planted in treated plots emerged normally with no reductions occurring in plant height or biomass. No visual disease or herbicide damage occurred to soybeans (data not shown).

Unlike results from previous reports from greenhouse experiments (Boyette et al., 2001), there were no significant differences in either weed control or dry weight reductions when glyphosate was applied after fungal treatments (Table 1). It is possible that variations in glyphosate formulations (e.g., surfactants) may have interacted negatively with the bioherbicide. Future research will include studies to evaluate the effects of different proprietary glyphosate formulations as well as other commonly used chemical pesticides on the biocontrol efficacy of *M. verrucaria*.

CONCLUSIONS

1. **Neither glyphosate alone nor *M. verrucaria* alone (either in aqueous or oil emulsions) effectively controlled redvine or trumpetcreeper.**
2. **There is a synergistic or additive effect upon weed control and dry weight reductions when M. verrucaria and glyphosate are tank-mixed or applied sequentially.**
3. **Neither weed control nor dry weight reductions of either weed species was affected by timings of application.**
4. **Soybeans that were planted in treated plots were not adversely affected by any of the treatments.**

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