Interaction of a Bioherbicide and Glyphosate for Controlling Hemp Sesbania in Glyphosate-Resistant Soybeans

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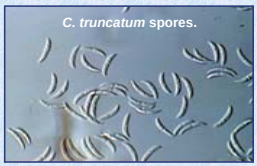
ABSTRACT

The fungus *Colletotrichum truncatum* was tested at different inoculum concentrations alone, in combination with, prior to, or following treatment with different rates of glyphosate [N-(phosphonomethyl)glycine ; Roundup Ultra™] for control of hemp sesbania (*Sesbania exaltata*) in glyphosate-resistant soybean field test plots. *C. truncatum* and glyphosate were applied in all pairwise combinations of 0.125 x 10^7, 0.25 x 10^7, 0.50 x 10^7, and 1.0 x 10^7 spores ml^{-1} and 0.15, 0.30, 0.60, and 1.2 kg ha^{-1}, respectively. Weed control and disease incidence were enhanced at the two lowest fungus (0.125 and 0.25 x 10^7 spores ml^{-1}) and herbicide rates (0.15 and 0.30 kg ha^{-1}) when fungal spores were applied after glyphosate treatment. Application of the fungus in combination with or prior to glyphosate at 0.60 kg ha^{-1} or greater resulted in reduced disease incidence and weed control regardless of inoculum concentration. At the highest glyphosate rates weeds were controlled by the herbicide alone. These results suggest the possibility to attain additive or synergistic herbicide effects on *C. truncatum* control of hemp sesbania when glyphosate is applied at low rates.

INTRODUCTION

Several reports have described various plant pathogen:herbicide interactions. The interactions of *A. cassiae* and sicklepod [*Senna obtusifolia* (L.) Irwin & Barneby] with glyphosate showed that glyphosate suppressed sicklepod defense response by lowering phytoalexin production, and thus the herbicide acted synergistically with this pathogen (Sharon *et al*., 1992). These interactions of glyphosate and *A. cassiae* on sicklepod represent the most completely understood biochemical events associated with pathogen:herbicide interactions. Numerous other examples have correlated phenylalanine ammonia-lyase (PAL) activity with pathogen challenge and plant defense (Hoagland, 1999). Compounds that inhibit PAL, in most cases, have caused increased susceptibility to disease. Furthermore, several herbicides (including glyphosate) alter the levels of PAL, phytoalexins, and phenolic compounds in plants, all of which affect plant defense against pathogens (Hoagland, 1990).

The objective of these studies was to determine if disease and control of hemp sesbania by *C. truncatum* is affected by interactions with glyphosate.



MATERIALS AND METHODS

Inoculum (spores) of *C. truncatum* were produced in petri dishes containing PDA. Agar surfaces were flooded with a *C. truncatum* spore suspension (6 x 10^6 conidia). The plates were inverted on open-mesh wire shelves and incubated at 25 C for 5 d in fluorescently lighted incubators. The conidia were rinsed from the plates with sterile, distilled water, and adjusted to the desired concentrations. Spore counts and concentrations were estimated with hemacytometers. The virulence of this pathogen 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 (0.2% v/v) (Boyette *et al*., 1994). Therefore, this formulation was used in these field trials.

Field test plots were established at the SWSRU Experimental Farm, Stoneville, MS in June of 2001 and 2002. Hemp sesbania was mechanically sown at soybean planting. Treatments consisted of: 1) glyphosate (GLY) at 0, .15, .30, .60, and 1.2 L ha^{-1} followed by, with, or prior to *C. truncatum* spores at inoculum densities of 0, .125, .50, and 1.0 x 10^7 spores ml^{-1} at a volume of 250 L ha^{-1}. All applications were made using backpack sprayers when weeds were in the second-fourth leaf stage of growth (ca. 6-8 cm tall). Test plots consisted of four, 6 m rows, with the two center rows receiving treatment. Disease development and weed mortality data were recorded at 7 day intervals over a period of 21 days. A split block experimental design was utilized, and means were separated using Fisher's LSD (P = 0.05).

Table 1. Mortality as affected by glyphosate followed by CT

GLY (L/ha)	Spores/ml x 10^7					
	0.0	.125	.250	.50	1.0	LSD_{05}
0.0	0	15	40	75	90	7
.15	25	65	85	90	93	6
.30	60	70	75	89	100	8
.60	85	94	95	100	100	4
1.2	100	100	100	100	100	0
LSD_{05}	7	6	6	5	6	

Table 2. Mortality as affected by GLY and CT simultaneously

GLY (L/ha)	Spores/ml x 10^7					
	0.0	.125	.250	.50	1.0	LSD_{05}
0.0	0	14	35	70	92	4
.15	21	22	24	25	30	8
.30	60	62	64	69	70	4
.60	88	95	96	100	100	7
1.2	100	100	100	100	100	0
LSD_{05}	6	7	8	7	5	

Table 3. Mortality as affected by CT followed by glyphosate

GLY (L/ha)	Spores/ml x 10^7					
	0.0	.125	.250	.50	1.0	LSD_{05}
0.0	0	15	28	69	93	3
.15	23	25	28	30	32	6
.30	62	60	64	70	72	5
.60	89	97	98	100	100	6
1.2	100	100	100	100	100	0
LSD_{05}	4	6	5	5	7	

Figure 1a & b. Hemp sesbania infected and killed by *C. truncatum.*

Fig. 1c. Mid-season control of hemp sesbania controlled with *C. truncatum*/glyphosate.

CONCLUSIONS

- Hemp sesbania was effectively controlled by *C. truncatum* alone only at high (1x) rates (1 x 10^7 spores/ml) and with glyphosate alone at .5x and 1x (.6 and 1.2 L ha^{-1}, respectively) (Tables 1-3).
- Bioherbicide efficacy was reduced when applied as a tank mixture (Table 2) or prior to herbicide treatment (Table 3).
- Weed control at reduced herbicide rates (.15x and .30x) was significantly improved when *C. truncatum* was subsequently to glyphosate.
- Glyphosate followed by *C. truncatum* controled hemp sesbania more efficaciously than tank mixtures of the bioherbicide and glyphosate, or when applied prior to glyphosate.
- Herbicide and bioherbicide rates may be significantly reduced with no significant reduction in weed control efficacy.
- Results suggest that it may be possible to significantly enhance the bioherbicidal potential of *Colletotrichum truncatum* using herbicides such as glyphosate as synergists.

REFERENCES

Boyette C.D. 1994. Weed Technol. 8:526-528.
Hoagland, R.E. 1990. In R.E. Hoagland, ed. Microbes and Microbial Products as Herbicides, ACS Books, Washington DC, pp. 87-113.
Hoagland, R.E. 1999. *In* F. A. Macías, J. C. G. Galindo, J. M. G. Molinillo, and H. C. Cutler, eds. Recent Advances in Allelopathy, Vol 1. Cadiz, Spain: Servicio De Publicationes Universidad De Cadiz. pp. 423-450.
Sharon, A., R. Ghirlando, and J. Gressel. 1992. Plant Physiol. 98:303-308.

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