FLUID DRILLING: A POTENTIAL DELIVERY SYSTEM FOR FUNGAL BIOLOGICAL CONTROL AGENTS WITH SMALL-SEEDED VEGETABLES

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Research involving biological control of soilborne plant pathogens has received much attention during the past ten years. Most current research utilizes the genus *Trichoderma* (form-class Deuteromycetes), which is a common soil-inhabiting saprophyte.

In 1972, Wells et al. (1) found *Trichoderma harzianum.* Rifai present in sclerotia of *Sclerotium rolfsii* Sacc., and used this isolate to reduce damage of *S. rolfsii* in tomatoes under greenhouse and field conditions. Others isolated strains of *T. harzianum* from soil which were antagonistic to *S. rolfsii* and *Rhizoctonia solani* Kuhn (2,3,4,5).

Although *Trichoderma harzianum* is a potential biological control agent under experimental conditions, there are problems associated with its commercial use. A variety of carriers have been developed for delivering the biocontrol agent to the soil (1,5,6), but all are commercially impractical because of the excessively large amounts of carrier required for application. However, recent findings by Harman et al. (7,8) indicated that using *T. hamatum* (Bon.) Bain as a seed treatment may eliminate this problem. They also found that *T. hamatum* was a superior antagonist compared to *T. harzianum* for control of disease caused by *Pythium* spp. and *R. solani.*

Another area of investigation is the application of fluid drilling or gel seeding technology to biological control problems. This technique involves the addition of germinated seeds to a gel carrier and subsequent sowing into the soil. The major advantage of sowing germinated seed compared to dry seed is earlier and more uniform emergence (9). The gel protects the exposed radicle from mechanical damage and also provides the growing seedling with an initial water source. Unfortunately, the gel tends to attract microorganisms, including soilborne pathogens which may result in an increased incidence of disease. Conway et al. have used fungicides as adjuvants to the gel matrix to decrease damping-off disease caused by *R. solani* in chili peppers (10). Fluid drilling offers an ideal system for delivery of a biocontrol agent such as *Trichoderma* for control of soilborne disease problems.

Trichoderma isolates which were antagonistic to *R. solani* were identified according to Dennis and Webster (11). Typical reactions involved the coiling of *Trichoderma* hyphae around the *R. solani* mycelium.

Initial studies indicated that there are no significant increases or decreases in the viable populations of the fungus in gel over a period of 14 days (Conway, unpublished data). Therefore, preliminary field studies were conducted to determine survivability of fluid-drilled *Trichoderma* in the soil. Experimental plots were located in four field sites in two locations in the state, Bixby and Stillwater. At each field site, eight treatments were evaluated using a randomized complete block design with four replicates. Along with germinated hot chili pepper seed, two different species, *T. hamatum* and *T. harzianum,* were incorporated into the gel at two rates, 1×10^5 conidia/ml and 1×10^7 conidia/ml. Additional treatments consisted of growing the *Trichoderma* on oats and incorporating the oats into the soil at time of planting, a fungicide gel treatment, and a gel control with no *Trichoderma* spp. added. Soil samples were taken from the planting rows at a depth of 10 cm., three to four weeks after planting. *Trichoderma* counts were made from soil dilution plating on *Trichoderma*-selective medium (12). Duncan's multiple range test at the 5% level of significance was used to compare treatments. Significantly higher numbers of *Trichoderma* propagules were detected in soil samples taken from treatments which utilized *Trichoderma* on oats and *Trichoderma* incorporated into the gel at 1×10^7 conidia/ml (Table 1). An exception to this was the results from the *T. hamatum* treatments at Stillwater, where there was no significant difference among treatments. Other gel seeding studies measuring *Trichoderma* survivability in soil (Conway, unpublished observations) have shown similar variations. These differences could be due to the resident populations of microorganisms antagonistic to *Trichoderma* or to varying soil environment.

These preliminary studies have shown some promise that *Trichoderma* can be incorporated into a fluid drilling system, and remain viable in the gel if planting is delayed. Additionally, high populations of *Trichoderma* can be maintained through the period in which seedlings are most susceptible to damping-off.

Environmental chamber and additional field studies are in progress to further evaluate the incorporation of *Trichoderma* into a fluid drilling system, for reduction of damping-off losses due to soilborne pathogens.

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TABLE 1. *Enumeration of* Trichoderma *propagules from planting row soil 3-4 weeks after incorporation with germinated hot chili pepper seeds.*

Treatment	Average number of *Trichoderma* propagules ($\times 10^2$) per gram of dry soil			
	Location			
	Bixby 1	Bixby 2	Bixby 3	Stillwater
T. harzianum				
Gel (1×10^5 conidia/m*l*)	7.6 A	3.5 A	8.3 A	5.9 A
Gel (1×10^7 conidia/m*l*)	19.4 AB	47.5 B	50.8 B	30.6 B
Oats	31.4 BC	—	—	54.8 C
T. hamatum				
Gel (1×10^5 conidia/m*l*)	4.7 A	4.6 A	8.9 A	6.4 A
Gel (1×10^7 conidia/m*l*)	15.0 AB	46.5 B	—	9.4 A
Oats	40.4 C	—	—	7.8 A
Fungicide	7.8 A	3.0 A	9.6 A	5.7 A
Control	8.2 A	3.3 A	8.8 A	4.4 A

Values in the same column followed by the same letter are not significantly different according to Duncan's multiple range test, $P = 0.05$.