Biological Control Of Crown Rot
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Overview:
Crown Rot is a cereal disease caused by a soil and stubble borne fungus which appears as reddish-pink colonies. Stubble retention has increased the prevalence of Crown Rot as the fungus carries over on the stubble.
This paper describes laboratory and field experiments which test the efficacy of spores of a harmless fungus, *Trichoderma* sp. in controlling the fungus, F. *graminearum* which causes Crown Rot. An alternative to stubble burning is spraying the stubble with spores of the biocontrol fungus. In the laboratory the *Trichoderma* sp. was found to be highly successful in controlling the Crown Rot causing fungus in moist soils. A conventional boom spray was used to test the *Trichoderma* sp. in the field. The *Trichoderma* sp. colonised the wheat stubble however no significant yield difference was recorded. The disease was not sufficiently present at one site and a separate disease affected the other; further trials will be undertaken.

Introduction

Crown rot, caused by the soil- and stubble-borne fungus *Fusarium graminearum* Group 1, is a serious disease of wheat, barley and other cereals. It is especially important in central and northern New South Wales and southern Queensland, where yield losses are estimated to cost farmers $5-10 million a year. There are some tolerant cultivars of wheat such as Sunco and Sunlin but the control is incomplete. Under severe disease pressure, grain yields are depressed even in these tolerant cultivars.

In recent years, the practice of stubble retention has increased the amount of disease because of the carryover of the fungus in the wheat stubble. The disease is also becoming more common in the other states. Stubble burning has been effective in reducing the inoculum of the pathogen but is not a sustainable agricultural practice. Therefore, other methods of inoculum reduction and disease control are desirable. This study investigated the possibility of reducing the inoculum of *F. graminearum* in wheat stubble by spraying the stubble with spores of a harmless fungus, *Trichoderma* species, in order to control the disease.

Laboratory Studies

Effect of a *Trichoderma* sp. on the survival of *F. graminearum* in soil

This experiment investigated the effect of applying spores of a *Trichoderma* sp. to wheat straw infested with *F. graminearum* and following the survival of the pathogen for 6 months in a sandy loam soil (pH 6.5) under dry, moist and wet conditions at 15 C and 25 C. Sterilised wheat straw pieces were inoculated with agar plugs- of *F. graminearum* and incubated at 25 C for 3 weeks. The *Trichoderma* sp. inoculum was prepared in the same way and ground to obtain the spores of the fungus.

The pathogen-infested straws were sprayed either with a spore suspension of the *Trichoderma* sp. or with distilled water

(controls). Ten straws per replicate were buried in 50g of soil in a petri plate. Distilled water was added to the soil to achieve the required moisture potential as determined by the moisture characteristic of the soil. The plates were sealed and incubated either at 15 C or at 25 C. The straws were sampled every 2 months. At each sampling, 30 straws (3 replicates of 10 straws) per treatment were sampled and after 7 days' incubation at 25 C, the number of straws yielding the characteristic reddish-pink colonies of *F. graminearum* was recorded and the percentage survival of the pathogen determined for each of the treatments.

After 6 months of incubation in the dry soil at 15 C and 25 C, 100% of the straws yielded the pathogen on the agar plates; that is the F. graminearum survived. In the moist soil, however, there was significant reduction in the survival of the pathogen in the presence of the *Trichoderma* at both temperatures and in the absence of the *Trichoderma* sp. at 25 C (Figure 1). After 6 months at 25 C, the pathogen had been eliminated in the moist soil. The *Trichoderma* sp. was less effective in the wet soil (Figure 2). **Figure 1.** Effect of *Trichoderma* sp. on survival of *Fusarium graminearum* in moist soil at 15 and 25°C.

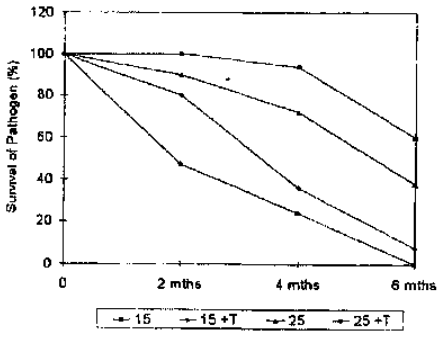
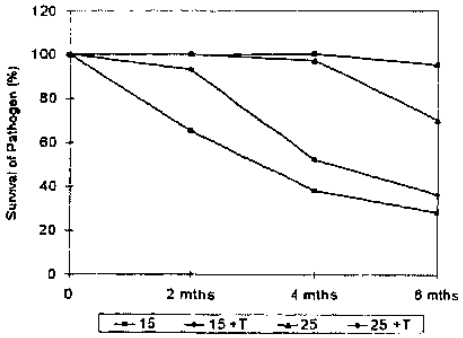


Figure 2. Effect of *Trichoderma* sp. on survival of *Fnsarhim graminearum* in wet soil at 15 and 25°C.



Effect of *Trichoderma* isolates on the survival of *F. graminearum* in two soil types

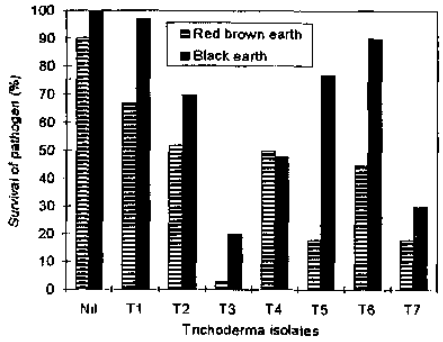
As crown rot is severe in the alkaline black earth soils of northern NSW and Queensland, this experiment compared the effectiveness of different isolates of *Trichoderma* species in reducing *F. graminearum* in wheat straw buried in an acid red brown earth (pH 5.2) and an alkaline black earth (pH 7.6). Seven *Trichoderma* isolates (Tl - T7) that had been shown to be highly antagonistic to the pathogen on agar were used.

Wheat straws colonised with the pathogen were sprayed with distilled water (controls) or with spore suspensions of the 7 *Trichoderma* species as before. Each replicate consisted of 10 straws buried in 50g of each soil type in a petri plate. The soils were moistened and incubated at 30°C. At monthly intervals, 3 replicate plates of each treatment were sampled, the percentage survival of the pathogen was determined after incubating for 7 days at 25 C.

The 7 *Trichoderma* isolates differed considerably in their efficacy in reducing the survival of *F. graminearum* in wheat straw in moist soil at 30 C (Figure 3). Isolates T3 and T7 were significantly better than the others in both soil types. In general, there was greater reduction of *F. graminearum* in the red brown earth compared to the black earth. Nevertheless, isolates T3 and T7 reduced the

pathogen's survival in the black earth from 100% (nil) to 20-30% after 3 months.

Figure 3. Effect of different isolates of *Trichoderma* spp.
on the survival of *F. gramineaum* in 2 soil types after 3 months.



Field Experiments

Spore suspensions of the *Trichoderma* sp. were sprayed on infested wheat stubble using a conventional boom at the end of March on two properties (Spring Ridge and Gilgandra) so that the fungus would have about 2 months to reduce the inoculum of the pathogen before sowing wheat. During the growing season, wheat stubble was recovered and plated on agar to see if the *Trichoderma* and pathogen were present. Yield results were obtained at the end of the season.

Sampling at the mid-tillering stage showed little crown rot infection in the wheat plants at both properties. However, the stubble recovered from the soil showed moderate (30-50%) to high (>75%) colonisation of *Trichoderma* at Gilgandra and Spring Ridge respectively. Grain yields, however, were not significantly different between the sprayed and unsprayed treatments (results not shown). The reasons for this are: (1) Little disease had developed at Gilgandra as assessed by the presence of whiteheads at grain fill and (2) At Spring Ridge, the extremely wet conditions from grain fill onwards meant that the plants were not sufficiently moisture-stressed to produce whiteheads and the presence of severe "head scab" may have also confounded the yield results.

Conclusions

In laboratory experiments, a *Trichoderma* sp. reduced the survival of the crown rot pathogen significantly when applied to wheat straw infested with the pathogen and buried for a period of 6 months in moist or wet soil at a temperature of 15 C or 25 C. The biocontrol fungus was more effective in reducing the survival of the crown rot pathogen in moist than in wet soil at both temperatures. The wet soil conditions appeared to be less favourable for the activity of the *Trichoderma* sp. After 6 months in moist soil at 25 C, the pathogen was completely eliminated from the buried straws in the presence of the *Trichoderma* sp. while about 40% of the straws still harboured the pathogen in its absence.

Screening 7 antagonistic *Trichoderma* isolates for their efficacy in reducing the survival of the pathogen in a red brown earth and a black earth showed that the isolates T3 and T7 were more effective than the other isolates in both soil types. In general, *Trichoderma* species are favoured by acid soil conditions but some fungal isolates have now been identified which are effective in alkaline black soils.

In field trials, the application of *Trichoderma* spores onto wheat stubble in autumn resulted in moderate to high levels of colonisation of straw pieces (50-75%) sampled from the soil in winter. However, no significant yield differences were obtained because the disease was not sufficiently severe at one site to show up any differences and the presence of severe "head scab" at the other site may have confounded the results. Further field trials are planned.

The laboratory results suggest that the inoculum load of the crown rot pathogen, which is normally stubble-borne, may be significantly reduced in the soil within 3-6

months of application of the biocontrol fungus to the stubble. This strategy has a greater likelihood of success in the summer-dominant rainfall wheat areas of northern NSW and southern Queensland where warm, moist soil conditions can be expected between harvest and the sowing of the new wheat crop than in the southern wheat areas where summer drought usually prevails. The reduced inoculum potential should result in less crown rot and permit wheat cultivars, especially tolerant cultivars like Sunco, to reach their yield potential instead of suffering large yield losses as has been experienced in recent years when subjected to severe disease pressure.

Acknowledgements

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