

## **Antagonism of *Trichoderma* spp. and *Gliocladium virens* against wood decay fungi**

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**K e y w o r d s :** Biocontrol, *Trichoderma*, *Gliocladium virens*, wood decay

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### **1. Introduction**

The potential of using antagonistic fungi as biocontrol agents to protect wood against decay has long been recognized. The pioneering work of R. WEINDLING (1934) revealed antagonistic activities of *Trichoderma* against other fungal species, and *Trichoderma* and *Gliocladium* species have since received much attention as biocontrol agents, particularly against soilborne pathogens. Species of *Trichoderma* and *Gliocladium* are widely distributed throughout the world, and occur in nearly all soils and in other natural habitats such as wood. In 1958, R. LINDGREN specifically advocated the study of antibiosis and competitive effects of *Trichoderma* spp. against destructive

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fungi in pulp, pulpwood, and logs. Nevertheless, such biological control still remains a relatively unexplored field.

Under laboratory conditions conducive to growth on agar, sawdust, and wood, cultures of *Trichoderma* spp. can overgrow and cause lysis of the brown-rot fungus *Lentinus lepideus* (A. BRUCE and B. KING, 1983). Furthermore, A. BRUCE and B. KING (1983) demonstrated that antagonistic effects of *Trichoderma* spp. persisted in wood after death of the antagonist and aqueous Soxhlet extraction. P. J. MORRIS et al. (1986) also found that *Trichoderma* spp. protected wood from decay by *L. lepideus* and that the protection was removed by leaching. They also found that *Trichoderma* spp. did not protect wood from attack by *Coniophora puteana*.

Mycoparasitism and saprophytism appear to be major characteristics of *Trichoderma* spp. in nature. However, a variety of secondary metabolites have been identified in vitro, particularly antibiotics. In some cases, controversy has arisen about the exact identity of a fungus studied in connection with certain antibiotics. In vitro activities of antagonistic fungi have been reviewed comprehensively by R. J. COOK and K. F. BAKER (1983).

The purpose of our work was to determine the antagonistic ability of *Gliocladium virens* and various *Trichoderma* spp. against important white- and brown-rot fungi by testing their ability to (1) inhibit growth and overgrow colonies of the decay fungi in a malt-agar medium, and (2) prevent decay and eradicate decay fungi in wood blocks, with or without added nutrients.

## 2. Methods

### 2.1 Antagonists and decay fungi

The following fungi were purchased from the American Type Culture Collection: *Gliocladium virens* (ATCC 52045), *Trichoderma harzianum* (ATCC 26799), and *T. polysporum* (ATCC 20475). *T. harzianum* (ATCC 20476) and *T. polysporum* (ATCC 20475) were isolated from Binab™ pellets (J. L. RICARD, 1970). These isolates will be referred to as T75 and T76 in this paper. *Trichoderma* species that had been isolated from wood in and out of ground contact were also included for study.

The following decay fungi were used: Brown-rot - *Postia* (= *Poria*) *placenta* (Fr.) M. Lars. et Lomb. [MAD-698], *Antrrodia* (= *Poria*) *carbonica* (overh.) Ryv. et Gilbn. [MD-141], *Lentinus lepideus* Fr. [MAD-5341], *Gloeophyllum trabeum* (Pers.: Fr.) Murr. [MAD-617], *Fibroporia vaillantii* (DC: Fr.) Parm, *Coniophora puteana* (Schum.: Fr.) Karst. [MAD-5151 and *Fomitopsis meliae* (Underw.) Gilbn. [FP-105065-Sp.]; white-rot - *Phlebia brevispora* Nakas. in Nakasone et Eslyn [HBB-7030-sp.], *Irpex lacteus* (Fr.: Fr.) Fr. [HBB-7328-sp.], *Coriolus versicolor* (L.: Fr.) Quel-[MAD-697], *Phanerochaete chrysosporium* Burds. [ME-4611], *Pycnoporus sanguineus* (L.: Fr.) Murr. [FP-103 380-S], *Ganoderma applanatum* (Pers.) Pat. [MAD-7081 and *Bjerkandera adusta* (Willd.: Fr.) Karst. [L-15359-sp.].

## 2.2 Tests for fungistatic effectiveness of antagonists

Dual culture of antagonists and fungus on malt-agar. The method used was similar to that of M. S. CAVALCANTE and R. A. EATON (1981). Mycelial plugs of *G. virens* or *Trichoderma* spp. were placed on opposite edges of Petri plates containing 2% malt extract in agar. After 2 days, the center of the plate was inoculated with one of seven Basidiomycete fungi. Plates without antagonist fungi were used as controls. The plate cultures were incubated at 27 °C and 70% relative humidity. Three replications were used for each experiment. When the Basidiomycete fungus in control plates had grown over the surface, the presence of an inhibition zone between the Basidiomycete fungal growth and the antagonist was noted. The ability of the antagonists to kill the Basidiomycete fungi was evaluated after 5 weeks' incubation by aseptically transferring plugs from test plates to a modified Taylor's (1971) medium, as described in T. L. HIGHLEY and W. E. ESLYN (1982), to determine viability of Basidiomycetes.

Pretreatment of wood with antagonists over a soil medium. Southern pine test blocks (2.5 cm × 2.5 cm × 1 cm) were mass treated with antagonistic fungi using a modified soil-block technique. Soil (1,200 g oven-dry) was placed in an aluminum pan measuring 23 cm × 32 cm × 6 cm. Deionized water was added to bring the moisture content of the soil up to 40%, and 24 sweetgum feeders (2.5 cm × 2.5 cm × 0.2 cm) were placed on the soil surface. The pan was covered with foil and autoclaved for 30 minutes at 121°C. After cooling, the sterile pans were each inoculated with plugs of an antagonist from malt-agar plates by placing a plug at each end of each feeder. Where both T75 and T76 were used, a plug of each was placed at the ends of each feeder. Seven days after pans were inoculated, 24 sterile pine blocks were placed into each pan on top of the feeders, and the pans were incubated for 28 days at 27°C and 70% relative humidity.

Pretreatment of wood with *Trichoderma* over basal medium with glucose and  $\text{NH}_4\text{NO}_3$ . Test blocks of southern pine and Douglas-fir were pretreated with *Trichoderma* strains T75 and T76 over a basal salts (T. L. HIGHLEY, 1973b) agar medium containing various concentrations of glucose and  $\text{NH}_4\text{NO}_3$ . Twenty-five ml of the agar medium was placed into 8-oz French square bottles; each bottle was inoculated with the antagonist and incubated for 1 week at 27°C and 70% humidity. Sterile pine or Douglas-fir blocks were placed on glass triangles resting on the mycelium-covered agar and the bottles were incubated for another 3 weeks, as described above, before placement into decay chambers.

Soil-block and agar-block tests of pretreated wood. The blocks pretreated with antagonists were evaluated for decay resistance using the standard American Society for Testing and Materials (ASTM) soil-block test (1971) or an agar method (T. L. HIGHLEY, 1973a). For the agar method (which simulates exposure to low-decay hazard), 8-oz French square bottles containing 25 ml of 1.5% agar in water were used as decay chambers. Wood blocks were placed into bottles upon preinoculated 2.54-cm squares of filter paper laid over glass triangles resting on the agar medium. Bottles for agar-block and soil-block tests were incubated at 27°C and 70% relative humidity in the dark. Percentage of weight loss, which is the measure of decay, was calculated from the weights of decayed blocks after equilibration at 70% relative humidity and 27°C. Original weights had been recorded after similar equilibrations. Three replications were used for each treatment.

### 2.3 Residual fungistatic effect by *Gliocladium virens*

Southern pine blocks were pretreated with *G. virens* as described above. Following pretreatment, one set of blocks was heated at 100°C for 1 hour to kill the antagonist. Half of these blocks were hot-water extracted in an autoclave for 2 hours at 100°C, followed by cold-water extraction for 24 hours. All of the blocks were exposed to decay fungi in soil-block tests as previously described. Three replications were used for each treatment.

### 2.4 Eradication of decay fungi by *Gliocladium virens*

Southern pine blocks were exposed to decay fungi in soil-block tests for 2 weeks. The blocks were then transferred to another set of soil-block bottles inoculated with *G. virens*. Three replications were used for each decay fungus.

## 3. Results

In the dual culture study, *G. virens* and the *Trichoderma* spp. completely inhibited growth of the seven decay fungi tested. In each case, the antagonists continued to grow until the entire plate was covered. Inhibition zones were not observed. *G. virens* killed all eight decay fungi, but the *Trichoderma* spp. varied in their ability to cause death of the decay fungi (Tab. 1). *G. virens* and *Trichoderma* isolates F-3 and the combination of T75 and T76 were tested for their ability to kill seven additional decay fungi (Tab. 2). *G. virens* killed all but *Fomitopsis meliae*. The *Trichoderma* spp. did not kill *F. meliae* or *Bjerkandia adustus*.

Pretreatment of southern pine blocks with *G. virens* over a soil medium greatly reduced brown-rot decay but was much less effective against the white-rot fungi (Tab. 3). The *Trichoderma* spp. varied in their capacity to prevent decay. In general, they greatly reduced decay by the brown-rot fungi except for *Gloeophyllum trabeum*, which was controlled to some extent only by the combined action of T75 and T76. *Trichoderma* spp. in most cases were ineffective against the white-rot fungi.

T75 and T76 (combined) were evaluated further in agar-block and soil-block tests using southern pine and Douglas-fir wood (Tab. 4 through 7). *Antrodia carbonica* and *Lentinus lepideus* were controlled effectively in both agar and soil tests, regardless of the nutrients present. *Gloeophyllum trabeum* was controlled in the agar-block tests but not in the soil-block tests.

We did not observe a residual fungistatic effect of *G. virens* in wood (Tab. 8). *G. virens* was effective only against *A. carbonica* in arresting decay in wood blocks (Tab. 9).

Table 1 Ability of *Gliocladium virens* and *Trichoderma* spp. to kill seven wood decay fungi on malt agar<sup>1</sup>.

Antagonist	Brown-rot					White-rot				
	Antrodia carbonica	Postia placenta	Lentinus lepideus	Gloeophyllum trabeum	Phlebia brevispora	Irpex lacteus	Coriolus versicolor			
<i>Gliocladium virens</i>	+	+	+	+	+	+	+			
<i>Trichoderma</i> spp.	-	-	-	-	-	-	-			
<i>T. harzianum</i> ATCC 26799	-	-	-	-	-	-	-			
<i>T. harzianum</i> ATCC 20476	-	-	-	-	-	-	-			
<i>T. polysporum</i> ATCC 20475	-	-	-	-	-	-	-			
<i>T. harzianum</i> and <i>T. polysporum</i> combined (ATCC 20476 and ATCC 20475)	+	+	+	+	+	+	+			
Unknown <i>Trichoderma</i> wood isolates:										
F-3	+	+	+	+	+	+	+			
LF-1	+	+	+	+	+	+	+			
P24-C	+	+	+	+	+	+	+			
P71-H	+	+	+	+	+	+	+			
F49-E	+	+	+	+	+	+	+			
12-11a	-	-	-	-	-	-	-			
10-16c	+	+	+	+	+	+	+			
9-12a	+	-	+	+	-	+	+			
10-11	+	+	+	+	+	+	+			
657	+	+	+	+	-	-	+			
F113F	+	+	+	+	-	-	+			

<sup>1</sup> + = no growth of basidiomycete (3 replications) from agar plug and assumed dead; - = basidiomycete able to grow from agar plug.

Table 2: Ability of selected antagonists to kill six additional decay fungi on malt agar<sup>1</sup>.

Wood decay fungus	Antagonist		
	Gliocladium virens	Trichoderma (T75 and T76)	Trichoderma F-3
<b>Brown-rot</b>			
<i>Coniophora puteana</i>	+	+	+
<i>Fomitopsis meliae</i>	-	-	-
<b>White-rot</b>			
<i>Ganoderma applanatum</i>	+	+	+
<i>Phanerochaete chysosporium</i>	+	+	+
<i>Pycnoporus sanguineus</i>	+	+	+
<i>Bjerkandera adusta</i>	+	-	-

<sup>1</sup> + = no growth of basidiomycete (3 replications) from agar plug and assumed dead; - = basidiomycete able to grow from agar plug.

#### 4. Discussion

Biological protection of wood requires broad-spectrum antagonism toward wood decay fungi. Pure culture studies (A. BRUCE, 1983; A. BRUCE and B. KING, 1983) have shown that a variety of nondecay fungi, including *Scytalidium* and *Trichoderma*, can cause the death of the brown-rot fungus *Lentinus lepideus* in agar culture. In our study, dual-culture experiments on malt-agar showed that *G. virens* and *Trichoderma* spp. were able to overgrow all species of wood decay fungi tested and, in most instances, kill them. However, the ability of these antagonists to inhibit and kill decay fungi in malt-agar cultures was not correlated with their ability to prevent wood decay in soil-blocks tests. White-rot fungi, for example, were particularly difficult to control in wood-block tests even though they were killed by the antagonists in dual culture. Thus, to a great extent cultural conditions probably determine whether or not antagonistic properties are expressed. Under proper cultural conditions, more broad-spectrum antagonism toward wood decay fungi might be achieved in wood.

We found that T75 and T76 could not control decay by *Gloeophyllum trabeum* in soil-block tests; but in agar-block tests, which simulate low-decay hazard conditions, decay was controlled. Evidently, the antagonists were better able to compete against *G. trabeum* under low-decay conditions.

Table 3: Weight loss<sup>1</sup> of southern pine blocks pretreated with *Gliocladium virens* or *Trichoderma* spp.

Antagonist pretreatment	Percent weight loss produced by wood-rotting basidiomycetes									
	White-rot					Brown-rot				
	Phanerochaete chrysosporium	Coriolus versicolor	Phlebia brevispora	Irpex lacteus	Antrodia carbonica	Lentinus lepideus	Postia placenta	Gloeophyllum trabeum		
<i>Gliocladium virens</i> (ATCC 5045)	11.6	11.4	19.7	30.9	0	0	1.3	1.8		
<i>Trichoderma</i> spp. T. harzianum (ATCC 26799) T. harzianum + T. polysporum (T75 + T76)	9.2 11.6	26.1 25.6	21.7 23.9	21.7 23.5	1.2 0	42.0 0	41.6 0	61.1 14.4		
unknown <i>Trichoderma</i> wood isolates:										
F-3	12.8	26.7	24.8	4.6	0	0	1.3	63.3		
LF-1	2.2	27.5	20.2	21.5	1.2	1.3	9.7	64.6		
P24-C	11.0	6.5	14.9	4.6	0	0	0	49.7		
P71-H	5.9	4.0	6.4	17.7	0	0	0	44.9		
F49-E	11.9	0	10.7	0	0	0	0	39.7		
None (control)	11.5	25.6	23.7	23.7	30.5	42.7	55.2	61.7		

<sup>1</sup> Percent weight loss produced in 10 weeks (average of 3 replications).

Table 4: Effect of glucose and  $\text{NH}_4\text{NO}_3$  in the basal medium on antagonism of Trichoderma strains ATCC 20475 and 20476 against brown-rot fungi in southern pine in agar-block test<sup>1</sup>.

Nutrient	Concentration of nutrients (%)					
$\text{NH}_4\text{NO}_3$	0	0	0.2	0.2	1	1
Glucose	0	1	1	10	1	0

  

Fungi	Weight loss (%)						Controls (without antagonist)
<i>Antrodia carbonica</i>	0	0	0	0.1	0	0	24.9
<i>Postia placenta</i>	0	0	3.1	0.1	0.2	0	11.7
<i>Lentinus lepideus</i>	0	0.1	0	0	0.2	0	15.0
<i>Gloeophyllum trabeum</i>	0.1	0	0.1	0	0	0.1	16.1

<sup>1</sup> Average of three replications.

Long-term effectiveness of the biological control treatment after death of the antagonists can be achieved if the antagonist deposits a fungistatic material in the wood. A. BRUCE and B. KING (1983) demonstrated that the antagonistic effects of *Trichoderma* and *Scytalidium* persisted in wood after death of the antagonist and aqueous Soxhlet extraction. However, P. I. MORRIS et al. (1986) found that 24-hour Soxhlet leaching completely removed the protection conferred on wood blocks by *Scytalidium* sp. and *Trichoderma* spp. They did not test for residual fungistatic effect without extraction. In our study, we examined only *G. virens* for residual fungistatic effect against decay fungi; no fungistatic effect occurred, regardless of whether or not blocks were leached. It is possible that *G. virens* deposited a heat-labile fungistatic material in wood, and this material was destroyed when the wood was heat-treated to kill the antagonist. In studying the fungistatic effect of residue of *Scytalidium* and *Trichoderma* spp., A. BRUCE and B. KING (1983) used ethylene oxide to kill the antagonists. The effect of high temperature on residual toxicity deserves further attention.

Only *G. virens* was examined for its ability to arrest already established decay fungi in wood, and except for *A. carbonica*, it was ineffective in stopping progress of decay. This contrasts with the results of agar interactions between *G. virens* and decay fungi where *G. virens* quickly overgrew and killed the decay fungi. This apparent anomaly between agar and wood studies is probably due to the relative lack of nutrients in wood.

Table 5: Effect of glucose and  $\text{NH}_4\text{NO}_3$  on antagonism of *Trichoderma* strains ATCC 20475 and 20476 against brown-rot fungi in southern pine in agar-block test<sup>1</sup>.

Nutrient	Concentration of nutrients (%)					
	0	0	0.2	0.2	1	1
$\text{NH}_4\text{NO}_3$	0	0	0.2	0.2	1	1
Glucose	0	1	1	10	1	0

  

Fungi	Weight loss (g)						Controls (without antagonist)
	0.1	0.2	0	0	0.4	0.3	
<i>Antrodia carbonica</i>	0.1	0.2	0	0	0.4	0.3	24.9
<i>Postia placenta</i>	0.1	0.1	0.2	0	0.2	0.5	62.2
<i>Lentinus lepideus</i>	0	0.2	0	0	0.3	0.2	40.9
<i>Gloeophyllum trabeum</i>	36.2	35.3	36.7	45.7	33.5	48.8	59.6

<sup>1</sup> Average of three replications.Table 6: Effect of glucose and  $\text{NH}_4\text{NO}_3$  on antagonism of *Trichoderma* strains ATCC 20475 and 20476 against brown-rot fungi in Douglas-fir in agar-block test<sup>1</sup>.

Nutrient	Concentration of nutrients (%)					
	0	0	0.2	0.2	1	1
$\text{NH}_4\text{NO}_3$	0	0	0.2	0.2	1	1
Glucose	0	1	1	10	1	0

  

Fungi	Weight loss (%)						Controls (without antagonist)
	1.4	1.4	1.5	1.3	1.5	1.4	
<i>Antrodia carbonica</i>	1.4	1.4	1.5	1.3	1.5	1.4	6.0
<i>Postia placenta</i>	1.6	1.9	7.7	1.9	1.5	1.5	11.4
<i>Lentinus lepideus</i>	1.3	1.3	1.8	1.2	1.8	1.6	13.3
<i>Gloeophyllum trabeum</i>	1.5	1.8	1.9	1.3	1.8	1.5	7.6

<sup>1</sup> Average of three replications.

Our work suggests that *Gliocladium* and *Trichoderma* have potential as natural agents for biological control of wood decay. *A. carbonica* and *Lentinus lepideus* are the main decay fungi in Douglas-fir and pine timber, respectively. In our study, decay of Douglas-fir and pine by both of these fungi was controlled by the combined action of T75 and T76. However,

Table 7: Effect of glucose and  $\text{NH}_4\text{NO}_3$  on antagonism of *Trichoderma* strains ATCC 20475 and 20478 against brown-rot fungi in Douglas-fir in agar-block test<sup>1</sup>.

Nutrient	Concentration of nutrients (%)					
	$\text{NH}_4\text{NO}_3$	0	0	0.2	0.2	1
Glucose	0	1	1	10	1	0

  

Fungi	Weight loss (%)						Controls (without antagonist)
	<i>Antrodia carbonica</i>	1.8	1.6	1.9	1.8	1.7	
<i>Postia placenta</i>	1.8	1.9	11.2	1.6	14.1	8.3	58.7
<i>Lentinus lepideus</i>	1.7	3.0	2.2	2.1	2.1	1.7	26.1
<i>Gloeophyllum trabeum</i>	25.5	30.7	45.5	26.5	29.8	36.7	23.1

<sup>1</sup> Average of three replications.

Table 8: Residual fungistatic effect by *Gliocladium virens* in southern pine blocks.

Wood decay fungi	Weight loss produced by decay fungi in blocks pretreated with			
	Live antagonist	Killed antagonist <sup>1</sup>	Killed antagonist plus extraction <sup>2</sup>	Controls (without antagonist)
Percent weight loss in blocks <sup>3</sup>				
White-rot				
<i>Coriolus versicolor</i>	11.4	21.3	29.4	18.1
<i>Phlebia brevispora</i>	19.7	20.0	15.1	15.4
<i>Irpex lacteus</i>	30.9	37.4	36.9	32.3
Brown-rot				
<i>Postia placenta</i>	1.3	67.8	64.4	64.6
<i>Lentinus lepideus</i>	0	46.4	47.5	39.2
<i>Antrodia carbonica</i>	0	25.1	24.8	29.2
<i>Fibroporia vaillantii</i>	43.0	25.4	27.8	20.2
<i>Gloeophyllum trabeum</i>	1.8	63.5	59.0	59.0

<sup>1</sup> Blocks exposed to *Gliocladium virens* for 4 weeks, followed by heat treatment to kill *G. virens*.

<sup>2</sup> Water extraction following heat treatment.

<sup>3</sup> Weight loss produced in 10 weeks (average of 3 replicates).

T a b l e 9: Ability of *Gliocladium virens* to arrest decay fungi in southern pine blocks.

Wood decay fungi	Weight loss by decay fungi prior to exposure to		Weight loss produced by decay fungi after 10 weeks' exposure to	
	G. virens <sup>1</sup>		G. virens	Controls (without G. virens)
<b>White-rot</b>				
<i>Coriolus versicolor</i>	2.0		10.6	31.1
<i>Phlebia brevispora</i>	0.6		30.4	16.6
<i>Irpex lacteus</i>	1.0		42.1	14.0
<b>Brown-rot</b>				
<i>Postia placenta</i>	10.0		29.7	56.4
<i>Lentinus lepideus</i>	5.5		42.3	40.7
<i>Antrodia carbonica</i>	0.6		1.9	31.1
<i>Fibroporia vaillantii</i>	3.5	44.4	24.7	
<i>Gloeophyllum trabeum</i>	19.4	59.0	67.5	

<sup>1</sup> Weight loss produced by the decay fungi prior to exposure to *Gliocladium virens* was subtracted from the final weight loss obtained.

broad-spectrum control against decay fungi in wood has not been achieved. Mechanistic studies on the interaction of antagonistic and decay fungi may solve this problem. The social and political pressures that have arisen from ecological concerns associated with wood preservatives have enhanced the need for alternative protection mechanisms. Effective biological Control clearly has a place in wood protection and may reduce, if not eliminate, the use of toxic chemicals for control of wood decay.

## 5. Summary

We tested the ability of *Trichoderma* spp. and *Gliocladium virens* to (1) inhibit growth and overgrow colonies of white-rot and brown-rot decay fungi in a malt-agar medium, and (2) prevent decay and arrest decay fungi in wood blocks. *G. virens* and the *Trichoderma* spp. overgrew the decay fungi cultured on the malt-agar medium and in most cases killed them. In soil-block tests, pretreatment of southern pine blocks with *G. virens* prevented brown-rot decay but was ineffective against the white-rot fungi. Similarly, *Trichoderma* spp. generally prevented or reduced decay by the brown-rot fungi, except for *G. trabeum*, but also were generally ineffective against the white-rot fungi. Various concentrations of  $\text{NH}_4\text{NO}_3$  and glucose in a basal medium did not affect antagonism of *Trichoderma* spp. in wood blocks. *G. virens* did

not confer residual fungistasis to wood blocks. In soil-block tests of wood blocks, *G. virens* arrested the growth of *Antrodia carbonica* but not other decay fungi. Our work suggests that *Gliocladium* and *Trichoderma* have potential as natural agents for biological control of wood decay.

### **Zusammenfassung**

#### **Antagonismus von *Trichoderma* spp. und *Gliocladium virens* gegenholzerstörende Pilze**

Es wurde die Fähigkeit von *Trichoderma* spp. und *Gliocladium virens* geprüft, (1) das Wachstum von Weiß- und Braunfäulepilzen in einem Malz-Agar-Medium zu hemmen und ihre Kolonien zu überwachsen und (2) Pilzbefall in Holzklötzchen zu verhindern oder zu stoppen. *G. virens* und *Trichoderma* spp. überwachsen die holzerstörenden Pilze in der Malz-Agar-Kultur und töteten sie in den meisten Fällen. In Erde-Klötzchen-Versuchen verhinderte eine Vorbehandlung von Kiefernklötzchen mit *G. virens* einen Befall durch Braunfäulepilze, erwies sich jedoch als unwirksam gegen Weißfäulepilze. *Trichoderma* spp. verhinderten oder verminderten im allgemeinen ebenfalls Braunfäulebefall, ausgenommen bei *G. trabeum*; sie waren jedoch generell unwirksam gegen Weißfäulepilze. Verschiedene Konzentrationen von  $\text{NH}_4\text{NO}_3$  und Glucose in einem Basalmedium beeinflussten den Antagonismus von *Trichoderma* spp. in Holzklötzchen nicht. *G. virens* wirkte auf die Holzklötzchen nicht fungistatisch. In Erde-Klötzchen-Versuchen stoppte *G. virens* das Wachstum von *Antrodia carbonica* aber nicht die anderen holzerstörenden Pilze. Die Ergebnisse deuten darauf hin, daß *Gliocladium* und *Trichoderma* zur biologischen Bekämpfung von Holzerstörung in Betracht kommen.

### **Résumé**

#### **Antagonisme de *Trichoderma* spp. et *Gliocladium virens* contre des champignons lignicoles**

Nous avons testé la capacité de *Trichoderma* spp. et de *Gliocladium virens* de (1) ralentir la croissance de champignons de pourriture blanche et brune en milieu malt-agar et de recouvrir leurs colonies et (2) d'empêcher ou d'arrêter le développement des champignons de pourriture dans des blochets. *G. virens* et les *Trichoderma* spp. ont recouvert les champignons cultivés sur du malt-agar et ont tué la plupart d'entre eux. Dans des essais avec des blochets enfouis dans la terre un traitement préalable des blochets de pin avec le *G. virens* a empêché une attaque par les champignons bruns, mais fut inefficace contre les champignons de pourriture blanche. *Trichoderma* spp. ont empêché ou réduit en général l'attaque des champignons de pourriture brune, sauf le *G. trabeum*; mais en général ils furent inefficace contre les champignons de pourriture blanche. Différentes concentrations de  $\text{NH}_4\text{NO}_3$  et de glucose dans un milieu de base n'ont pas influencé l'antagonisme de *Trichoderma* spp. *G. virens* n'a pas eu un effet fongistatique sur des blochets. Dans des essais de blochets enfouis dans le sol, *G. virens* a eu un effet fongistatique sur *Antrodia carbonica*, mais pas sur les autres champignons. Les résultats ont montré que le *Gliocladium* et les *Trichoderma* pourraient être utilisés pour le contrôle biologique de la détérioration du bois.

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