IMPACT OF INFECTION WITH TRICHODERMA AGGRESSIVUM F. EUROPAEUM ISOLATES ON THE YIELDING OF SOME WILD STRAINS OF AGARICUS BITORQUIS FROM DIFFERENT REGIONS OF POLAND


Abstract

Effect of infections with fungi from the Trichoderma genus on yielding of several strains of Agaricus bitorquis mushrooms deriving from natural sites of different regions of Poland was studied. One cultivated (control) and six wild strains of A. bitorquis were used in the experiments. Substrates were inoculated with two different T. aggressivum f. europaeum (Th2) isolates. Inoculation of substrate with T. aggressivum f. europaeum isolates caused a decrease of A. bitorquis yield.

Key words: Agaricus bitorquis, wild strains, Trichoderma, yield

Introduction

The most severe diseases in mushroom cultivation are the so called green moulds caused by fungi from the Trichoderma genus (Mamon et al. 2000), resulting in huge yield losses in mushroom plantations. In Europe the most aggressive form is a strain designated as Th2, i.e. Trichoderma aggressivum f. europaeum. This strain is a biotype of a non-aggressive form of T. harzianum (Williams et al. 2003) but it differs quite considerably from it, primarily by the speed of mycelium growth (Samuels et al. 2002, Sobieralski et al. 2009 b). According to Harman and Kubicek (1998), the speed of Th2 biotype in vitro growth at 27°C reached 1.1 mm per hour and sporulation took place already four days after inoculation of medium. In the

This study was supported by the Polish Ministry of Science and Higher Education for the years 2007–2010 as research project No. 310 058 32/2762.
The cultivation of *A. bitorquis* growers apply higher temperatures than in the cultivation of *A. bisporus* (Hasselbach and Mutsers 1971) which, when combined with higher thermal requirements of *T. aggressivum* f. *europaeum*, can pose a serious problem.

The aim of the performed experiments was to evaluate the influence of substrate inoculation with *Trichoderma* spp. on yielding of several strains of *A. bitorquis* mushrooms deriving from natural sites from different regions of Poland.

### Material and methods

Mushroom strains used in the trial derived from the collection of cultivated and medicinal mushrooms of the Department of Vegetable Crops of the Poznań University of Life Sciences (PULS). Table 1 shows sites from which individual objects of cultivated mushrooms used in the experiments were harvested.

Six wild strains of mushrooms used in the experiments derived from the following sites: Ab/1/3, Ab/2/12, Ab/3/17, Ab/4/19, Ab/5/23 and Ab/6/71, with a production strain K26 of Somycel company used for control.

The experimental substrates were inoculated independently with two different *T. aggressivum* f. *europaeum* isolates: T.K 111 and T.43M/7 deriving from fungi collection of the Department of Vegetable Crops of the PULS. The isolates were obtained from substrate of mushroom growing farms: T.K 111 from Wolsztyn, and T.43M/7 from Łosice.

Mother mycelium of the experimental strains and isolates was prepared in the biological laboratory of the Department of Vegetable Crops of the PULS and later reproduced in a Mushroom Farm in Łobez near Jarocin. The material used to inoculate substrates was grain mycelium prepared in accordance with the formula recommended by Lemke (1971). Experiments were conducted in plastic containers

<table>
<thead>
<tr>
<th>Month of harvest</th>
<th>Locality</th>
<th>Site</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIII</td>
<td>RDLP Szczecinek, Kożienice Forest District, Pionki Commune</td>
<td>Meadow</td>
<td>Ab/1/3</td>
</tr>
<tr>
<td>VIII–IX</td>
<td>RDLP Radom, Zwoleń Forest District, Zwoleń Commune</td>
<td>Meadow</td>
<td>Ab/2/12</td>
</tr>
<tr>
<td>V–VII</td>
<td>Śródkowomazowiecka Lowland, ul. Rybickiego, Skierkiewice</td>
<td>At the fence of hospital</td>
<td>Ab/3/17</td>
</tr>
<tr>
<td>V–VII</td>
<td>RDLP Szczecinek, Czarne Człuchowskie Forest District</td>
<td>Meadows and forest edge</td>
<td>Ab/4/19</td>
</tr>
<tr>
<td>V–VII</td>
<td>RDLP Toruń, Miradz Forest District, Kurzebiela</td>
<td>Meadows and forest paths</td>
<td>Ab/5/23</td>
</tr>
<tr>
<td>V–VII</td>
<td>Research Institute of Vegetable Crops, ul. Rybickiego 15/17, Skierkiewice</td>
<td>Experimental field</td>
<td>Ab/6/71</td>
</tr>
</tbody>
</table>

RDLP – Regional Directorate of State Forests.
boxes measuring $38 \times 39 \times 13$ cm containing 6 kg substrate each. Detailed description of the method used to conduct the experiment can be found in a paper by Sobieralski et al. (2009a). Incubation of the substrate was carried out at 27°C and cultivation at 24–25°C. Mushrooms were harvested for the period of six weeks.

The trial was established as a completely randomised design in four replications and two cultivation cycles. Two independent trials were performed in identical design for each $T.\text{aggressivum} f.\text{europaeum}$ isolate.

The results were subjected to analysis of variance for two-factor experiments at the level of significance of $\alpha = 0.05$ (Newman-Keuls test).

Results and discussion

Specific conditions found in the cultivation hall during the cultivation of mushrooms, namely high temperature and humidity as well as the presence of organic matter, favour the development of aggressive forms of $\text{Trichoderma}$ spp. (Grogan 2005). This is particularly important in the case of $A.\text{bitorquis}$ mushroom cultivation characterised by higher requirements regarding incubation temperature and yielding in comparison with $A.\text{bisporus}$ (Guler et al. 2006).

The performed experiments corroborated the claim by Williams et al. (2003) about particular aggressiveness of the $T.\text{aggressivum} f.\text{europaeum}$ strain with respect to mushroom mycelium. Investigations carried out by the authors showed significant yield reductions of the replications in which the substrate was inoculated with $T.\text{aggressivum} f.\text{europaeum}$ T.K 111 and T.43M/7 isolates.

Yields obtained from control plots ranged from 3.9 to 9.3 kg/m² (Figs. 1 and 2). In both experiments the cultivated K26 strain gave the best yields: 9.3 and 8.5 kg/m², respectively. These yields were lower than those usually obtained from commercial cultivations (Sobieralski and Siwulski 2006). However, experiments
carried out by the authors earlier, confirmed that the results obtained in experiments performed using relatively small volumes of the cultivation substrate were fully reliable (Sobieralski and Siwulski 2002 a, 2002 b, Sobieralski et al. 2009 a). They were also corroborated by Abosriwil and Clancy (2004) who conducted experiments on fungicide effectiveness against various species of the *Trichoderma* genus in mushroom cultivation on substrate in plastic bags of 1 and 5 dm³ volume.

Analysing yielding of the cultivated strain and the wild strains of mushroom infected with *T. aggressivum f. europaeum* isolates, it can be stated that the T.43M/7 isolate caused significantly higher yield loss of both mushroom strain groups than the T.K 111 isolate. The cultivated strain K26 infected by T.43M/7 isolate showed a considerably lower yield (2.0 kg from 1 m²) than that recorded after inoculation of the substrate with T.K 111 isolate (3.6 kg from 1 m²). The response of mushroom wild strains deriving from natural environment to the substrate inoculation with the examined *T. aggressivum f. europaeum* isolates varied. The Ab/2/12 strain which responded very strongly to the infection with isolate T.K 111 (yield decline of 3.4 kg/m² in relation to control) showed a certain amount of tolerance to the infection with T.43M/7 (yield decline of 1.2 kg/m² in relation to control). A reverse response was observed in the case of the Ab/6/71 strain which exhibited certain tolerance to infection with T.K 111 isolate (yield decline of 2.2 kg/m² in relation to control), while in the substrate inoculated with T.43M/7 isolate, it showed a considerable loss of yield (yield decline of 4.7 kg/m² in comparison with control). In the case of the substrate inoculated with T.K 111 isolate, the best yields were recorded for the cultivated strain of K26 (8.5 kg/m²) and the worst for Ab/2/12 wild strain (4.7 kg/m²). Yields of the remaining wild strains ranged from 7.3 to 5 kg/m².

Percentage yield losses of the examined mushroom cultivated and wild strains infected by different *T. aggressivum f. europaeum* isolates give a better illustration of the above-discussed relationships (Table 2). The highest yield loss, both in the case of infection with T.K 111 and T.43M/7 isolates, was registered in the mushroom wild strain Ab/5/23 (84.0 and 82.1%, respectively). The smallest losses of yield
were recorded in the case of Ab/6/71 strain (35.0%) when it was infected with T.K 111 isolate and Ab/2/12 strain (23.1%) following its infection with T.43M/7 isolate.

The results of investigations show unfavourable influence of the substrate inoculation with \textit{T. aggressivum} f. \textit{europaeum} isolates on yielding of both the cultivated strain of mushrooms and strains obtained from natural environment. A similar effect was observed by the authors in earlier experiments carried out on \textit{A. bisporus} strain (Sobieralski et al. 2009 a).

\begin{table}[h]
\begin{center}
\begin{tabular}{|l|l|}
\hline
Strain + \textit{T. aggressivum} f. \textit{europaeum} isolate & Percentage yield losses \\
\hline
K26 + T.K 111 & 57.6 \\
Ab/1/3 + T.K 111 & 60.6 \\
Ab/2/12 + T.K 111 & 72.3 \\
Ab/3/17 + T.K 111 & 50.0 \\
Ab/4/19 + T.K 111 & 71.2 \\
Ab/5/23 + T.K 111 & 84.0 \\
Ab/6/71 + T.K 111 & 35.0 \\
K26 + T.43M/7 & 78.5 \\
Ab/1/3 + T.43M/7 & 76.4 \\
Ab/2/12 + T.43M/7 & 23.1 \\
Ab/3/17 + T.43M/7 & 80.3 \\
Ab/4/19+ T.43M/7 & 52.1 \\
Ab/5/23 + T.43M/7 & 82.1 \\
Ab/6/71 + T.43M/7 & 70.1 \\
\hline
\end{tabular}
\end{center}
\end{table}

were recorded in the case of Ab/6/71 strain (35.0%) when it was infected with T.K 111 isolate and Ab/2/12 strain (23.1%) following its infection with T.43M/7 isolate.

The results of investigations show unfavourable influence of the substrate inoculation with \textit{T. aggressivum} f. \textit{europaeum} isolates on yielding of both the cultivated strain of mushrooms and strains obtained from natural environment. A similar effect was observed by the authors in earlier experiments carried out on \textit{A. bisporus} strain (Sobieralski et al. 2009 a).

\section*{Streszczenie}

\textbf{WPŁYW INFEKCJI IZOLATAMI TRICHODERMA AGGRESSIVUM F. EUROPAEUM NA PLONOWANIE DZIKICH SZCZEPÓW PIECZARKI SZLACHETNEJ (AGARICUS BITORQUIS) POCHODZĄCYCH Z RÓŻNYCH REGIONÓW POLSKI}

Określono wpływ infekcji grzybami rodzaju \textit{Trichoderma} na plonowanie kilku szczepów pieczarki szlachetnej (\textit{Agaricus bitorquis}) pochodzących ze stanowisk naturalnych w różnych rejonach Polski. Przebadano następujące szczepy pieczarki: Ab/1/3, Ab/2/12, Ab/3/17, Ab/4/19, Ab/5/23 oraz Ab/6/71. Jako kontroli użyto odmiany uprawnej K26 firmy Somycel. Podłoża produkcyjne inokulowano dwoma różnymi izolatami \textit{T. aggressivum} f. \textit{europaeum}: T.K 111 oraz T.43M/7. Uprawę pro-
wadzono w plastikowych skrzynkach w komorze klimatycznej. Wystąpiło znaczne zmniejszenie plonu szczepów pieczarki po inokulacji podłoży badanymi izolatami T. aggressivum f. europaeum. Reakcja badanych szczepów na porażenie była zróżnicowana. Największe zmniejszenie plonu, niezależnie od zastosowanego izolatu T. aggressivum f. europaeum, wystąpiło u szczepu pieczarki Ab/5/23, a najmniejsze – przy zakażeniu przez T.K 111 u szczepu Ab/6/71 (35,0%), natomiast przy zakażeniu przez T.43M/7 – u szczepu Ab/2/12 (23,1%).

**Literature**


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Accepted for publication: 5.10.2010