

# BIOLOGICAL TREATMENT WITH *DEBARYOMYCES HANSENI* REDUCES THE CONTENT OF DEOXYNIVALENOL AND CULMORIN IN DURUM WHEAT GRAIN

Urszula Wachowska<sup>1</sup>, Marian Wiwart<sup>1</sup>, Elżbieta Suchowilska<sup>1</sup>, Michael Sulok<sup>2</sup>, Wolfgang Kandler<sup>2</sup>,  
Rudolf Krska<sup>2</sup>, Dariusz Gontarz<sup>3</sup>

<sup>1</sup>Faculty of Agriculture and Forestry, University of Warmia and Mazury in Olsztyn,  
<sup>2</sup>Department IFA-Tulln, University of Natural Resources and Life Sciences in Vienna  
<sup>3</sup>PZZ Lubella GMW, Sp. z o.o. Sp.k. in Lublin



Durum wheat (*Triticum turgidum* ssp. *durum*) is extremely susceptible to *Fusarium* head blight (FHB), and breeding new varieties with enhanced FHB resistance is complicated because the sources of FHB resistance are rare in the primary gene pool of tetraploid wheats. Fungi of the genus *Fusarium* cause *Fusarium* head blight (FHB) and produce numerous secondary metabolites, thus decreasing the quality of durum wheat grain. Trichothecenes, including deoxynivalenol (DON), are the most commonly occurring and the most toxicologically important mycotoxins. Culmorin (CUL, a tricyclic sesquiterpene diol), which remains weakly researched, enhances the phytotoxic effects of DON on wheat seedlings. The control of FHB with the use of fungicides is difficult due to their limited effectiveness. Biocontrol agents such as yeasts, including *Debaryomyces hansenii*, applied during the growing season to suppress *F. graminearum*, could pose a viable alternative to fungicides. **The aim** of this study was to evaluate the concentration of DON and CUL in *Triticum turgidum* ssp. *durum* grain during infection with *F. graminearum* after biocontrol treatment.

## Methods

Field experiments were conducted to evaluate the applicability of a *Debaryomyces hansenii* isolate (NCBI GenBank accession number KX444668) for reducing the concentrations of DON and CUL in the grain of 5 spring cultivars of durum wheat grown at two locations in Poland (Bałcyny near Olsztyn and Niedzwica Kościelna near Lublin). *D. hansenii* cells were applied two times during the flowering stage of wheat. Flowering spikes were inoculated with an aqueous suspension of *F. graminearum* spores DON genotype (Fig. 4). The concentration of fungal cells in the suspension was  $10^4$  cells in  $1\text{ cm}^3$  of water. Unprotected plants were the control. Durum wheat spikes (Fig. 1,3) were inoculated with a spore suspension of *F. graminearum* DON genotype (Fig. 4) in a field, 24 hours after the application of the biocontrol agent (Fig. 2, 4). The analysis of the mycotoxin profile by LC-MS / MS was performed by IFA-Tulln.



Fig. 1. Fusarium head blight (FHB) symptoms.

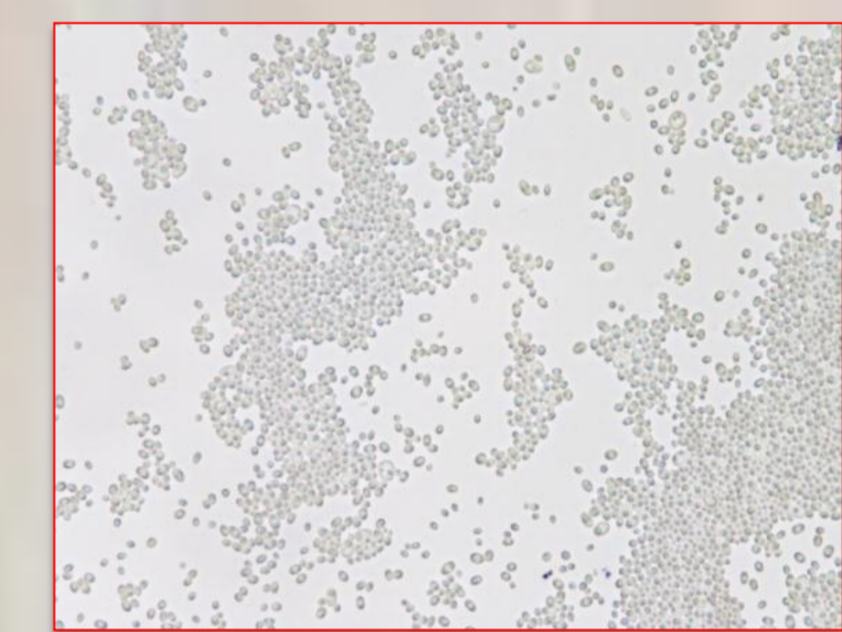


Fig. 2. *Debaryomyces hansenii* cells.

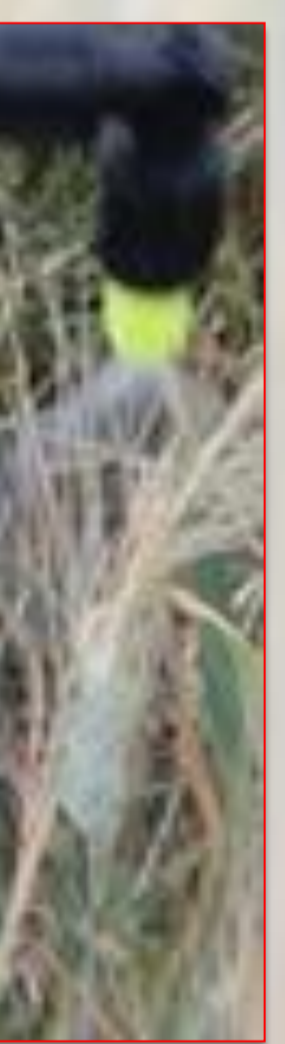


Fig. 3. Spraying wheat plants with *D. hansenii* suspension

Table 1. Characteristics of spring durum wheat cultivars

Cultivar	DON accumulation rate	Breeding	FHB resistance (9-point scale)
Duragold	medium	Slovakia	6.8
Duranegra	medium	Slovakia	6.4
Durasol	high	Germany	4
Floradur	medium	Germany	6
Tamadur	medium	Germany	6

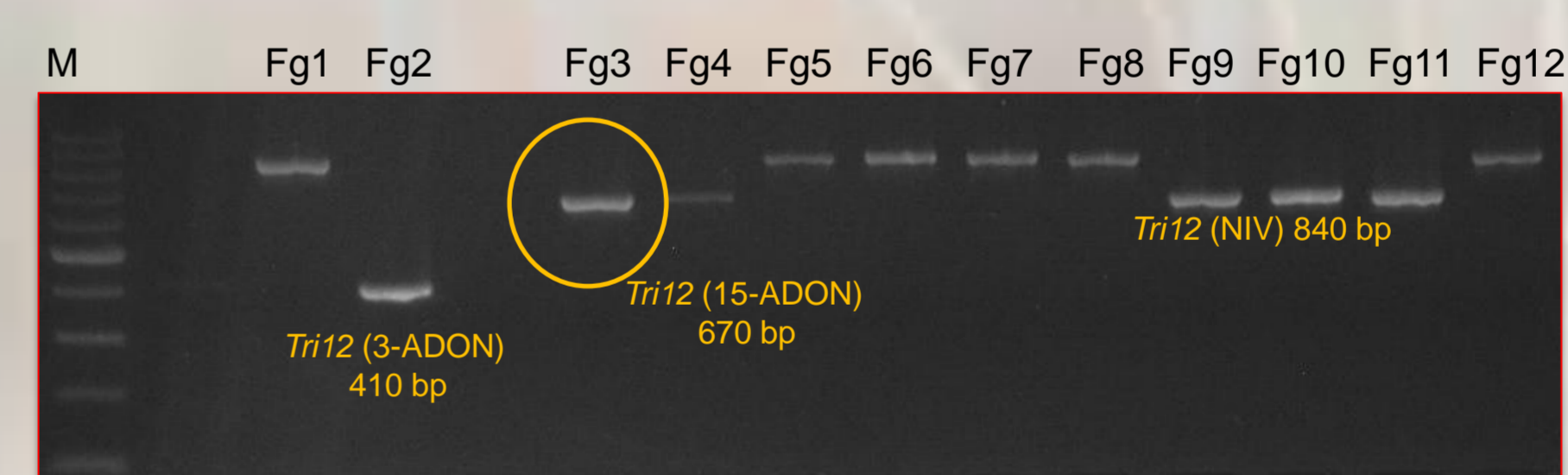


Fig. 4. Genotypes of *F. graminearum*. PCR products: M-marker 100-1000bp, lines 3,4,6-12 *F. graminearum* isolates.

## Results

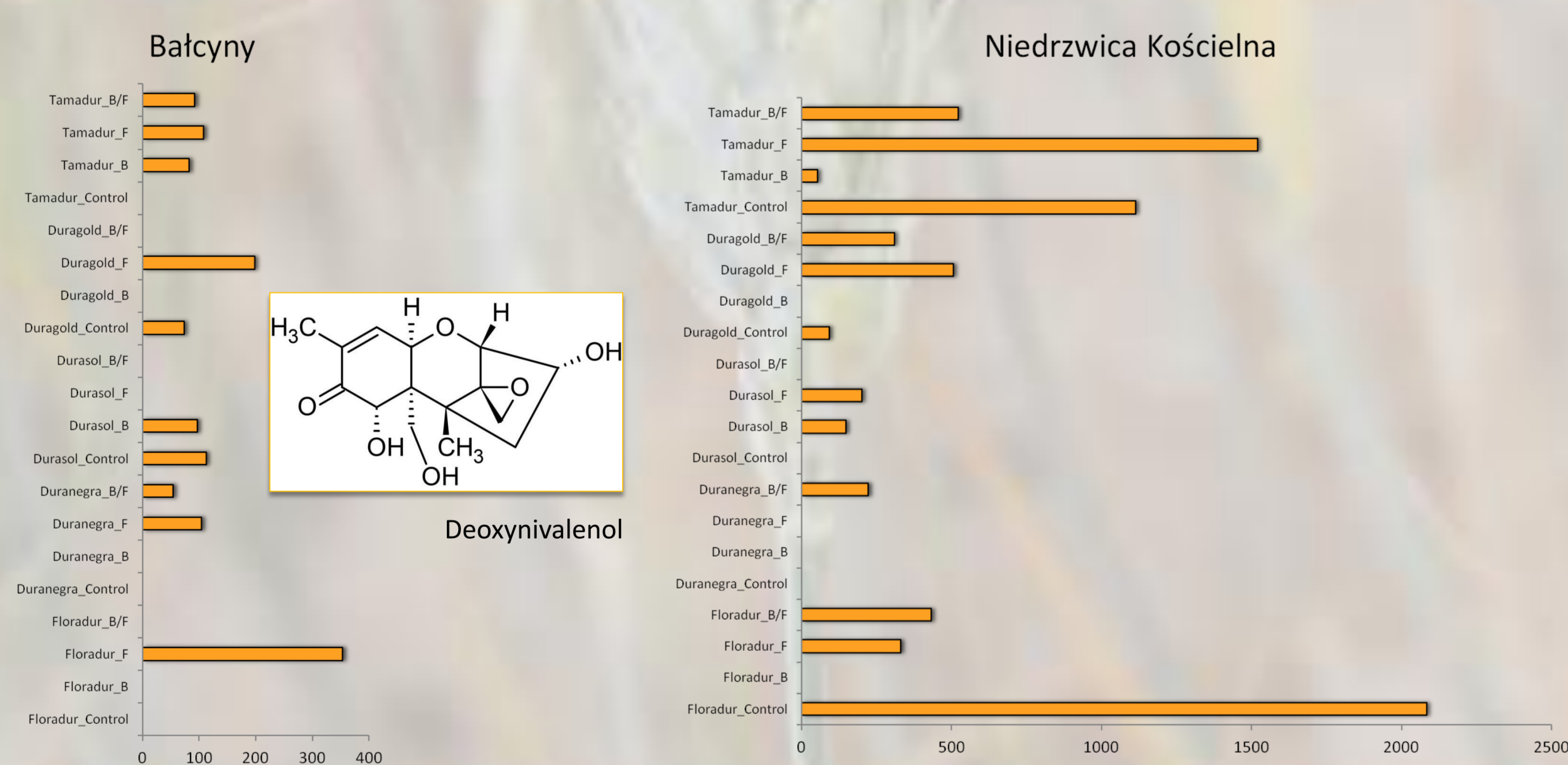


Fig. 5. Concentration DON ( $\mu\text{g}/\text{kg}$ ) in durum wheat grains of biological treatment (B) and inoculated *F. graminearum* (F).

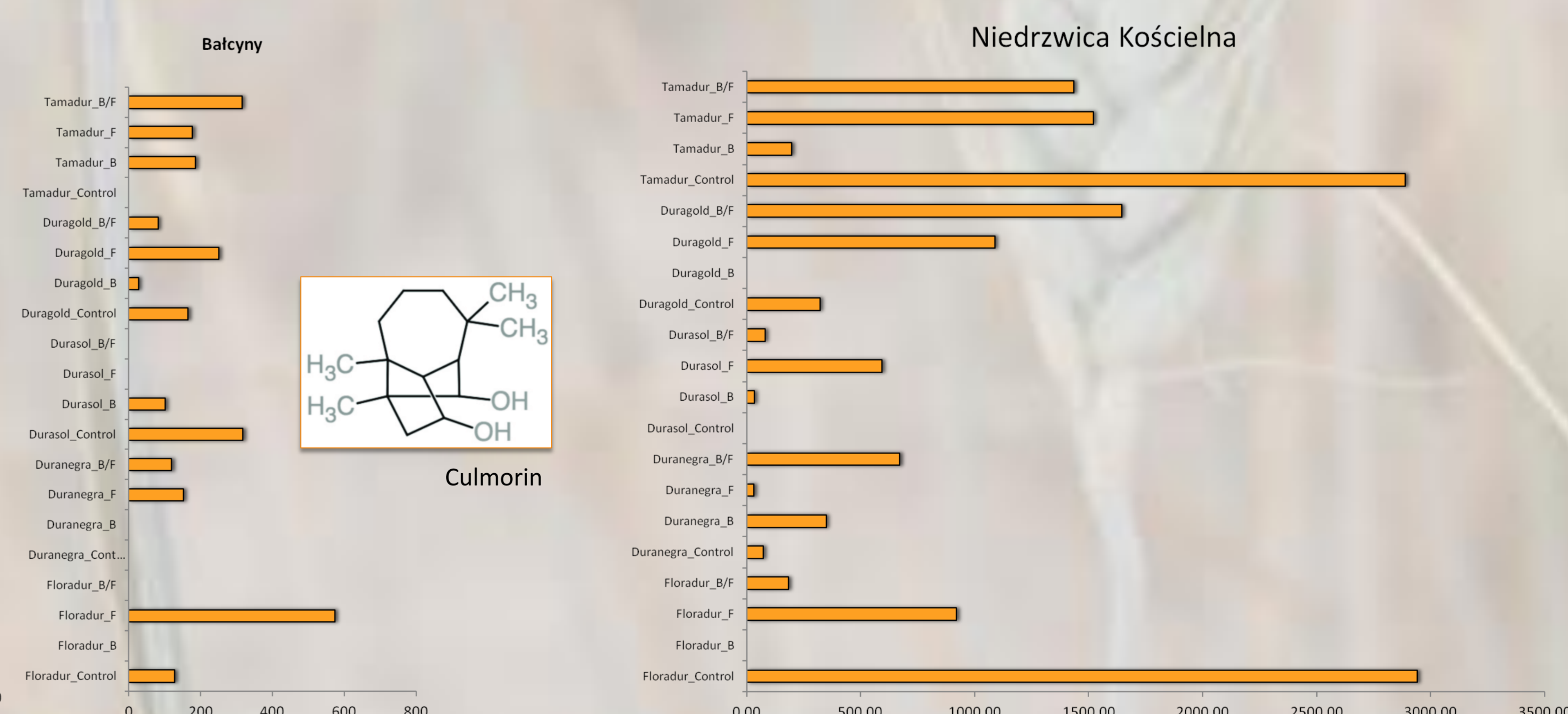


Fig.6. Concentration DON ( $\mu\text{g}/\text{kg}$ ) in durum wheat grains of biological treatment (B) and inoculated *F. graminearum* (F).

- DON and DON-3-glucoside (D3G) were detected in 26 out of the 40 examined samples. The DON content of grain was particularly high in the control samples of cv. Floradur and Tamadur in Niedzwica Kościelna (2081 and 1113  $\mu\text{g}/\text{kg}$ , respectively). In most cases, the inoculation of wheat spikes with *F. graminearum* increased the DON content of grain up to 1519  $\mu\text{g}/\text{kg}$ .
- Biological treatment involving a cell suspension of *D. hansenii* isolate decreased DON concentrations in grain, compared with control samples and grain samples from spikes inoculated with *F. graminearum* (Fig.5).
- The CUL content of grain was usually higher than DON content. A clear positive correlation was found between CUL and DON concentrations.
- CUL, 15-hydroxyculmorin and 5-hydroxyculmorin were detected in 35 grain samples, and their content was high (up to 2887.87  $\mu\text{g}/\text{kg}$ ) in cv. Tamadur and Duragol in Niedzwica Kościelna. At this location, the biological treatment exerted a particularly high inhibitory effect on CUL production by *Fusarium* spp. (Fig.6).