# Relationship between FHB and DON among SRWW Cultivars with Different Levels of Type II Resistance

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## ABSTRACT

Deoxynivalenol (DON) is among several mycotoxins produced by *Fusarium graminearum*, the causal agent of Fusarium head blight (FHB), in infected wheat spikes. Cultivar resistance is a recommended strategy for managing FHB and DON, with resistance to the spread of visual symptoms (Type II resistance) generally corresponding to resistance to DON accumulation (Type III resistance). However, the relationship between visual symptoms and DON is highly variable. Our goal was to evaluate the effects of cultivar on the FHB/DON functional relationship. Three experiments were conducted in two years, using three cultivars with different levels of Type II resistance (Truman, moderately resistant; Hopewell, moderately susceptible; and Cooper, susceptible). Plots were spray-inoculated with a spore suspension of *F. graminearum* at anthesis, and prior to maturity, 20 spikes were tagged in each of 11 FHB severity categories: 0, 1, 2, 3. 9, and 10 diseased spikelets per spike. At physiological maturity, tagged spikes were harvested, tested for DON, and *F. graminearum* biomass was quantified by amplifying Tri5 DNA using quantitative RT-PCR. Based on linear mixed model covariance analysis, there was a significant linear relationship between FHB and DON, with significantly difference regression slopes among the cultivars. Hopewell accumulated significantly more DON than Cooper and Truman, and based on the regression slopes, the rate of DON increase with FHB increase for Cooper was similar to that of Truman in two of the three experiments. Similarly, the rate of fungal biomass increase with increase in FHB was comparable between Cooper and Truman, but significantly higher for Hopewell.

## INTRODUCTION

*Fusarium graminearum* causes Fusarium head blight (FHB) in wheat, which leads grain contamination with mycotoxins, especially deoxynivalenol (DON). Resistance is recommended for managing FHB and DON; however, resistance to FHB does not always parallel resistance to DON. The **objectives** of this study were to: **1)** characterize the functional relationships between FHB and DON and FHB and *Fusarium graminearum* biomass as influenced by cultivar resistance and **2)** evaluate the repeatability of cultivar effect on these relationships across locations and growing seasons.

## MATERIALS AND METHODS

➢Three experiments were conducted in OARDC, Wooster (two in 2007 and one in 2008) using three SRWW cultivars with different levels of Type II resistance (Truman, moderately resistant; Hopewell, moderately susceptible; and Cooper, susceptible). A randomized complete block design was used in all experiments.

➢At anthesis, all plots were inoculated with a 1:1 mixture of ascospores and macroconidia, at concentration of 100,000 (in 2007) and 50,000 spores/ml (in 2008).

**Figure 1. Inoculated plots, showing spikes with different levels of severity**

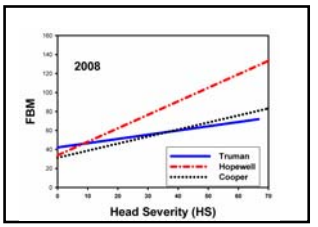


**Figure 2. Relationship between FHB head severity and fungal biomass (FBM) of three cultivars in Experiment 2008**

- Prior to physiological maturity, FHB head severity was assessed in each plot and 20 spikes were tagged in each of 11 severity categories: 0, 1, 2, 3, … 10 diseased spikelets per spike (figure 1).
- At maturity, spikes in each category were harvested separately and analyzed for DON. For samples from 2008, *Tri5* gene-derived quantitative PCR was used to quantify fungal biomass at each severity level.
- Linear mixed model covariance analysis was used to evaluate the influence of cultivar on the relationships between FHB and DON and between FHB and fungal biomass (FBM).

**Table 1. Regression coefficients from linear mixed model covariance analysis of cultivar effect on the relationship between FBM and FHB (year 2008)**

| Cultivar | Intercept (se)* | Slope (se)* |
|---|---|---|
| Truman | 42.17 (6.26) | 0.45 (0.20) |
| Hopewell | 33.83 (6.89) | 1.42 (0.17) |
| Cooper | 31.33 (4.51) | 0.74 (0.11) |

* Standard error in parenthesis. **Slopes followed by the same letter are not significantly different at the 5% level of probability based on a linear mixed model covariance analysis of the effect of cultivar on the FHB/DON relationships.

**Table 2. Regression coefficients from linear mixed model covariance analysis of cultivar effect on the relationship between DON and FHB**

| Experiment | Cultivar | Intercept (se)* | Slope (se)* |
|---|---|---|---|
| 2007(a) | Truman | 3.96 (1.81) | 0.45 (0.05) a** |
| | Hopewell | 5.30 (1.81) | 0.79 (0.04) b |
| | Cooper | 0.42 (1.81) | 0.48 (0.04) a |
| 2007(b) | Truman | 5.32 (1.73) | 0.40 (0.05) a |
| | Hopewell | 3.04 (1.73) | 0.76 (0.04) b |
| | Cooper | 2.57 (1.73) | 0.66 (0.04) b |
| 2008 | Truman | 3.51 (1.06) | 0.19 (0.03) a |
| | Hopewell | 8.40 (1.06) | 0.29 (0.03) b |
| | Cooper | 8.85 (1.06) | 0.18 (0.03) a |

## RESULTS AND DISCUSSION

➢In all experiments, there was a significant linear relationship between DON and FHB head severity **(Figure 3)**, as well as between fungal biomass and FHB for all cultivars (**Figure 2**). Independent of the cultivar, DON contamination and fungal biomass increased with increase in FHB severity, but both rates of increase varied among experiments.

➢However, Hopewell consistently had higher DON accumulation rate (regression slope) than Cooper and Truman. In two of the three experiments, Cooper had DON accumulation rates similar to Truman (**Table 2**).

➢Truman and Cooper had similar rates of fungal biomass increase, which were significantly lower than Hopewell (**Table 1**).

➢At various levels of severity, the differences in DON accumulation among the three cultivars were not always statistically significant. DON differences between Truman and Cooper were smaller than differences between Hopewell and Truman, but Cooper generally accumulated more DON than Truman for a similar level of FHB (**Table 2(b)**).

➢Fungal biomass did not always parallel DON content across cultivars at different levels of disease. At FHB severity levels between 1 and 14%, Hopewell and Cooper consistently had significantly higher DON content than Truman, however, at the same levels of disease, FBM was not significantly different among the cultivars (**Table 2(a)**).

➢Above 25% severity, Hopewell had significantly higher fungal biomass and accumulated significantly more DON than both Cooper and Truman (**Table 2(a)**).

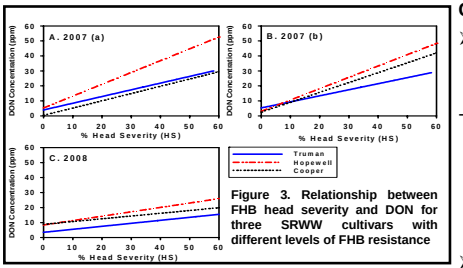


**Figure 3. Relationship between FHB head severity and DON for three SRWW cultivars with different levels of FHB resistance**

**Table 2. Mean DON concentration/fungal biomass at different levels of head severity among SRWW cultivars with different levels of FHB resistance**

**a. Mean DON concentration and corresponding fungal biomass comparison at each FHB head severity from Experiment 2008**

| Exp 2008 | Cultivar | HS (%)* 1 | 5 | 14 | 25 | 35 | 50 |
|---|---|---|---|---|---|---|---|
| DON vs.FHB | Truman | 3.7 a | 4.5 a | 6.2 a | 8.4 a | 10.3 a | 13.2 a |
| | Hopewell | 8.7 b | 9.9 b | 12.5 b | 15.7 b | 18.6 b | 23.0 b |
| | Cooper | 9.0 b | 9.8 b | 11.4 b | 13.5 c | 15.3 c | 18.1 c |
| FBM vs.FHB | Truman | 42.3 a | 44.2 a | 48.4 a | 50.0 a | 58.3 a | 65.3 a |
| | Hopewell | 35.4 a | 41.0 a | 53.8 a | 69.3 b | 83.5 b | 104.7b |
| | Cooper | 32.0 a | 35.0 a | 41.7 a | 53.6 a | 57.3 a | 68.4 a |

**b. Mean DON concentration at each FHB head severity from all three experiment**

| Exp | Cultivar | HS (%)* 1 | 5 | 14 | 25 | 35 | 50 |
|---|---|---|---|---|---|---|---|
| 2007(a) | Truman | 4.4ab | 6.2ab | 10.2a | 15.2a | 19.6a | 26.3a |
| | Hopewell | 6.1a | 9.2a | 16.3b | 15.0b | 32.9b | 44.7b |
| | Cooper | 0.9b | 2.8b | 7.2a | 12.5a | 17.4a | 24.6a |
| 2007(b) | Truman | 5.7a | 7.3a | 11.0a | 15.4a | 19.4a | 25.5a |
| | Hopewell | 3.8a | 6.8a | 13.6a | 21.9b | 29.5b | 40.8b |
| | Cooper | 3.2a | 5.9a | 11.8a | 19.0c | 25.6c | 35.5c |
| 2008 | Truman | 3.7a | 4.5a | 6.2a | 8.4a | 10.3a | 13.2a |
| | Hopewell | 8.7b | 9.9b | 12.5b | 15.7b | 18.6b | 23.0b |
| | Cooper | 9.0b | 9.8b | 11.4b | 13.5c | 15.3c | 18.1c |

* Severity levels were chosen base on a visual severity scale for Fusarium head blight (not shown here). Means followed by the same letter are not significantly different at the 5% level of probability based on a linear mixed model covariance analysis of the effect of cultivar on the FHB/DON and FHB/FBM relationships.

## CONCLUSIONS

➢ Our results showed that Type III resistance (DON accumulation) did not always parallel Type II resistance.

-The moderate susceptible Hopewell consistently accumulated significantly more DON than susceptible Cooper.

- Moderate resistant Truman has similar DON accumulation rate to susceptible Cooper in two of three experiments.

➢ For a given level of disease and fungal biomass the moderately resistant cultivar, Truman, accumulated significantly less DON that the susceptible cultivars.

➢ Further studies are being conducted to determine what causes Truman to accumulate less DON that Hopewell, even when the level of infection (FBM) is comparable between the two.

## REFERENCE

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## ACKNOWLEDGEMENT

*"This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 59-0790-4-112. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture."*