Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda

Research Application Summary

Relationship between grain yield and Fusarium head blight in soft red winter wheat as influenced by cultivar resistance

Salgado, J.D.[1], Wallhead, M.W.[1], Madden, L.V.[1] & Pierce A. P.[1]
[1]Department of Plant Pathology, The Ohio State University, OARDC Wooster, OH 44691
Corresponding author: paul.661@osu.edu

Abstract

Fusarium Head Blight (FHB) is a serious disease in all wheat-growing areas in the world. FHB affects wheat by reducing yield and grain quality. Our objective is to characterize the relationship between FHB and grain yield. Three soft red winter wheat cultivars with different levels of FHB resistance (Truman, Hopewell and Cooper, moderately resistant moderately susceptible, and susceptible to FHB, respectively) were evaluated. Based on regression slopes, yield reduction per unit increase in FHB index varied among cultivars, being highest for moderately susceptible Hopewell, intermediate for moderately resistant Truman and lowest for susceptible Cooper.

Key words: Cultivar resistance, Fusarium Head Blight, grain yield reduction

Résumé

Fusariose (FHB) est une maladie grave dans toutes les régions productrices de blé dans le monde. FHB s'attaque au blé, en réduisant le rendement et la qualité du grain. Notre objectif est de caractériser la relation entre la fusariose et le rendement en grain. Trois cultivars de blé tendre rouge d'hiver, avec différents niveaux de résistance à la fusariose (Truman, Hopewell et Cooper, moyennement résistant, modérément sensible, et sensibles à la fusariose, respectivement) ont été évalués. En se basant su les pentes de régression, la réduction des rendements par unité augmente en indice de fusariose qui varie selon les cultivars, étant le plus élevé pour les moyennement sensibles Hopewell, intermédiaires pour une résistance modérée Truman et le plus bas pour les sensibles Cooper.

Mots clés: Résistance des cultivars, la fusariose, la réduction de rendement en grains

Background

Fusarium Head Blight (FHB) or Scab of Wheat (*Triticum aestivum* L.), is predominantly caused by *Fusarium graminearum* Schwabe (teleomorph: *Gibberella zeae*) in North America (Bai and Shaner, 1994; Parry *et al*., 1995; McMullen *et al*., 1997; Paul *et al*., 2005). Under disease favourable

weather conditions, FHB can significantly reduce wheat yield. FHB infection can cause extensive damage in a short period of time (Snijders, 1990; McMullen *et al.*, 1994; Paul *et al.*, 2005; Paul *et al.*, 2006). Infected wheat spikes have poor grain filling, which reduces kernel size and weight, thus lowering grain quality. In addition, infected grain can also accumulate deoxynivalenol (DON), a mycotoxin produced by this pathogen. DON accumulation represents a health threat to human and livestock, therefore mycotoxin-contaminated grain is either rejected or priced down in commerce (Snijders, 1990; Bai and Shaner, 1994; McMullen *et al.*, 1997; Stack and McMullen, 1998).

The relationship between yield and FHB is highly variable and may be affected by several factors. For instance, based on random coefficient mixed model analysis, Madden and Paul (2009) reported that wheat class affected the intercept but not the slope of this relationship. However, it is unclear how yield loss due to FHB is influenced by cultivar susceptibility. This relationship may also vary among cultivars with different levels of resistance/tolerance to FHB and different yield potential, and may be influenced by the presence and amount of other diseases such as Stagonospora leaf and glume blotch.

Study Description

Hypothesis. There are functional relationships between FHB and different components of wheat yield. These relationships will vary among cultivars with different levels of resistance to FHB and will be influenced by the presence and amount of foliar diseases.

Experimental overview. Field experiments were conducted during 2009 and 2010 wheat growing seasons at the Ohio Agricultural Research and Development Center (OARDC) in USA to characterize relationships among FHB, grain yield, and test weight in cultivars with different levels of resistance to FHB. Field plots of three soft red winter wheat cultivars with different levels of FHB resistance (Truman, Hopewell and Cooper, moderately resistant moderately susceptible, and susceptible to FHB, respectively) were inoculated with *G. zeae/ F. graminearum*. Plots were spray-inoculated at anthesis (Feekes 10.5.1) with spore concentrations ranging from 0 to 150,000 spores/mL. FHB intensity was estimated at soft dough (Feekes 11.2) and yield determined following harvest.

Results and Conclusion

Averaged across inoculum concentrations, mean FHB index and grain yield ranged from 1.49 to 24.64% and 5,552 to 6,311 kg/ha for Cooper; 3.76 to 42.06% and 3,975 to 5,298 kg/ha for Hopewell; and 0.67 to 9.61% and 5,473 to 5,907 Kg/ha for Truman (Figs. 1 and 2). Based on regression slopes, yield reduction per unit increase in index varied among cultivars, being highest for moderately susceptible Hopewell (MS), intermediate for moderately resistant Truman (MR) and lowest for susceptible Cooper (S), with estimated losses of 27.77, 23.91 and 20.26 kg/ha per unit increase of disease index, respectively, for the three cultivars (Fig. 2. I, II, and III). The estimated rate of test weight reduction per unit increase in FHB index also varied among cultivars, being 0.26, 0.19 and 0.15 lb/bu for Hopewell (MS), Cooper (S) and Truman (MR) (Fig. 2. V, IV and VI) respectively. These results indicate that the functional relationships between FHB index and grain yield and FHB index and test weight vary among cultivars with different levels of resistance to FHB.

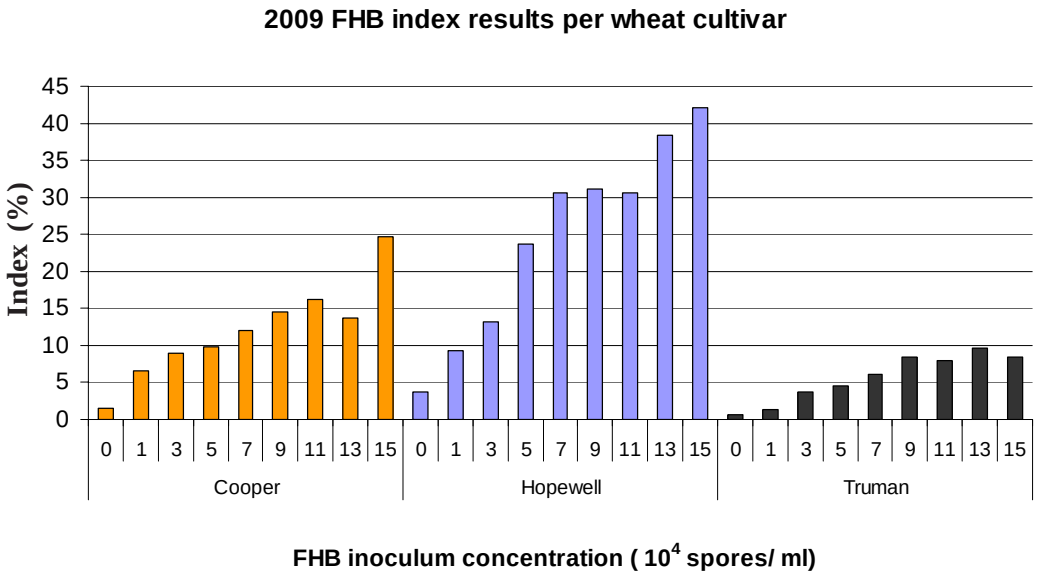

Figure 1. Mean disease index for cultivars Cooper (S) Hopewell (MS) and Truman (MR) for different inoculum concentrations (x 10,000) of *G. zeae/ F. graminearum*.

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 author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Figure 2. Grain yield (I, II, III) and test weight (IV, V, VI) response to FHB index (IND) for SRWW cultivars with different levels of resistance to FHB - Cooper (susceptible), Hopewell (moderately susceptible) and Truman (moderately resistant).

References

Bai, G. and Shaner, G. 1994. Scab of wheat: Prospects for control. *Plant Disease*78:760-766.

Littell, R.C., Milliken, G.A., Stroup, W.W., Wolfinger, R.D. and Schabenberger, O. 2006. SAS System for Mixed Models. SAS Institute, Cary, NC.

Madden, L.V. and Paul, P.A. 2009. Assessing heterogeneity in the relationship between wheat yield and Fusarium head blight intensity using random-coefficient mixed models. *Phytopathology* 99: (*accepted with minor revision*).

McMullen, M., Jones, R., and Gallenburg, D. 1997. Scab of wheat and barley: A re-emerging disease of devastating impact. *Plant Disease* 81:1340-1348.

Parry, D.W., Jenkinson, P. and McLeod, L. 1995. Fusarium ear blight (scab) in small grain cereals-a review. *Plant Pathology* 44:207-238.

Paul, P.A., Lipps, P.E. and Madden, L.V. 2005. Relationship between visual estimates of Fusarium head blight intensity and deoxynivalenol accumulation in harvested grain: A meta-analysis. *Phytopathology* 95:1225-1236.

Paul, P. A., Lipps, P.E. and Madden, L.V. 2006. Meta-analysis of regression coefficients for the relationship between Fusarium head blight and deoxynivalenol content of wheat. *Phytopathology* 96:951-961.

Paul, P.A., Lipps, P.E., Hershman, D.E., McMullen, M.P., Draper, M.A. and Madden, L.V. 2008. Efficacy of triazole-based fungicides for Fusarium head blight and deoxynivalenol control in wheat: A multivariate meta-analysis. *Phytopathology* 98:999-1011.

Snijders, C.H.A. 1990. Genetic variation for resistance to Fusarium head blight in bread wheat. *Euphytica* 50:171-179.

Stack, R.W. and McMullen, M.P. 1998. A visual scale to estimate severity of Fusarium head blight in wheat. NDSU Extension Service: Small Grains Publications. Online Publication/PP-1095.