Can Agronomic Practices Reduce Fusarium Head Blight Vomitoxin Levels?

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Grain quality is a critically important component of profitable wheat production. In general, one of the major quality concerns for soft red winter wheat producers and millers is deoxynivalenol (DON), which is a vomitoxin produced by *Fusarium graminearum.* In Kentucky, the threat of *F. graminearum* infection is an annual concern.

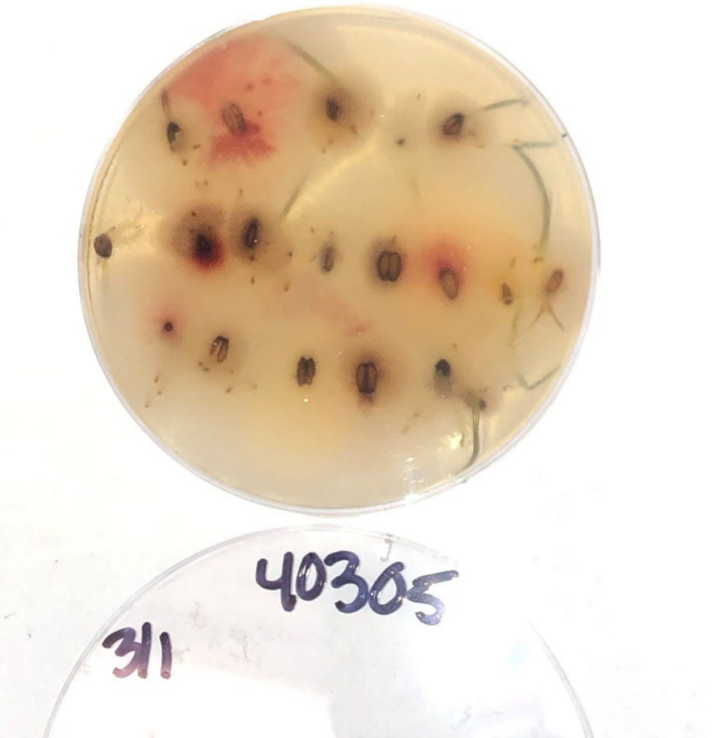
Current agronomic recommendations to reduce DON contamination in wheat grain include planting a cultivar that is moderately resistant to Fusarium head blight (FHB) along with a fungicide application at beginning flowering (Feekes 10.5.1). The goal of this project was to examine whether additional agronomic practices can reduce DON contamination in wheat grain. The agronomic practices examined included harvesting when grain moisture exceeded 15%, an in-furrow phosphorus fertilizer at planting (42 lbs P_2O_5 acre^{-1}), and an increased seeding rate (56 seeds ft^{-2}).

Research trials were established at the University of Kentucky's Research and Education Center, Princeton, KY, in the fall of 2016 to 2018. Each year, research trials were established to simulate two disease scenarios. The first was normal field conditions to mimic a producer's field, which did not include additional inoculum (ambient). The second was a mist-irrigated field that was inoculated with *F. graminearum*-infested corn kernels to promote Fusarium head blight (FHB) development to mimic conditions when FHB causes moderate to severe damage (inoculated).

All trials were planted as no-till wheat into corn stubble. Within each trial, there were eight treatments: two planting timings (October and November); two cultivars (one with moderate FHB resistance [Pembroke 2016] and one moderately susceptible to FHB [Pioneer 26R53]); two in-furrow phosphorus treatments (0 lb P_2O_5 acre^{-1} or 42 lbs P_2O_5 acre^{-1} at planting); and two seeding rates (35 pure live seed ft^{-2} or 56 pure live seed ft^{-2}). Each treatment combination was harvested at two timings: early (>15% grain moisture) and normal (13 to 15% grain moisture). Wheat harvested greater than 15% grain moisture was dried to 12.5% grain moisture with a laboratory-scale thin layer drying system (Department of Biosystems and Agricultural Engineering).

Fusarium head blight (FHB) nursery used to promote FHB disease development. Photo Credit: Katherine Rod

To determine whether in-furrow phosphorus fertilizer or seeding rate improved wheat grain quality DON was quantified. In addition, to understand whether these agronomic practices impacted FHB development FHB index, Fusarium damaged kernels (FDK), and percent of kernels infected (PKI) with *F. graminearum* were determined. The FHB index was determined as: (FHB incidence x FHB severity) ÷ 100 where FHB incidence was the percent of spikes with visible FHB in one linear meter of row and FHB severity was the percent of spikelets per spike with visible FHB symptoms. Fusarium damaged kernels was estimated by visually inspecting about 0.5 lb of grain for percentage of kernels that appeared damaged due to FHB. To determine PKI, 20 healthy looking seeds were surface disinfested and plated onto media that selectively promotes *F. graminearum* growth. After five days percentage of *F. graminearum*-infected seeds were measured; infected seed appeared pink.



Healthy looking wheat kernels germinating in a petri dish containing selective growth media for *Fusarium graminearum*. The kernels with pink fungal growth, are infected with *F. graminearum*. Photo credit: Curtis Bradley

Although there is research indicating that in-furrow phosphorus applications at planting can reduce DON in regions where available soil phosphorus is limited, in Kentucky where available soil phosphorus is typically not limiting, in-furrow phosphorus at planting did not impact DON, FHB index, FDK, or PKI (Table 1). There have also been observations that increasing the seeding rate can result in a greater percentage of wheat spikes flowering at the same time, thus decreasing the window that the entire wheat crop is susceptible to FHB, which can reduce DON. However, an increased seeding rate (56 pure live seed ft^{-2}) did not reduce DON, FHB index, FDK, or PKI (Table 1). The only agronomic practice that consistently impacted DON, FDK, and PKI was harvest timing. Both FDK and PKI were reduced when wheat was harvested at greater than 15% grain moisture (Table 1). Interestingly, DON was greatest when harvested at grain moistures greater than 15% (Table 1). This may have been due to harvest occurring earlier in the season when infected kernels were still large and heavy enough that they were not blown out of the combine, which resulted in more kernels with increased DON levels.

Table 1. Deoxynivalenol, Fusarium head blight index, Fusarium damaged kernels and the percent of healthy wheat kernels infected with *Fusarium graminearum* when three different agronomic practices are implemented.

Agronomic Practice	DON† (ppm)	FHB Index (%)	FDK (%)	PKI (%)
<u>P_2O_5 in-furrow at planting</u>				
0 lbs per acre	2.1	3.8	10.8	33
42 lbs per acre	2.0	3.9	10.4	33
Pr > F	0.5009	0.9500	0.5073	0.5410
<u>Seeding Rate</u>				
35 pure live seed ft^{-2}	2.4	5.6	12.4	24
56 pure live seed ft^{-2}	2.3	5.5	11.9	24
Pr > F	0.0765	0.2294	0.1019	0.3945
<u>Harvest</u>				
13 to 15% grain moisture	1.7	-	11.4	33
>15% grain moisture	2.4	-	9.9	32
Pr > F	<0.0001	-	0.0034	0.0010

† DON (deoxynivalenol); FHB (Fusarium head blight) Index = (FHB incidence x FHB severity) ÷ 100 where FHB incidence was the percent of spikes with visible FHB in one linear meter of row and FHB severity was the percent of spikelets per spike with visible FHB symptoms; FDK (Fusarium damaged kernels) = percent of kernels damaged by FHB; PKI (percent of healthy kernels infected with *F. graminearum*).

Despite that DON was not reduced when in-furrow phosphorus was applied at planting or with an increased seeding rate and that neither offset the cost of additional inputs (Table 2), there was a 40% chance that in-furrow phosphorus would increase yield and result in increased net returns. In addition, there was a 35% chance that an increased seeding rate would increase yield and result in increased net returns. These findings strongly suggest that additional research is needed to understand whether modifying agronomic practices can ultimately increase the probability of increased net returns, particularly when conditions are less-than-ideal at or immediately following planting.

Table 2. Yields and economic returns for applying phosphorous (P_2O_5) and an increased seeding rate for winter wheat in Kentucky as compared to UK's recommended rates (Base).

	Seeding Rate (Plants /ft^2)	P_2O_5 Rate (lbs/ac)	Wheat Yields (bu/ac)	Additional Cost ($/ac)	Additional Revenue ($/ac)	Net Returns ($/ac)
Base	35	0	74.1	--	--	--
Base + P2O5	35	42	75.3	$23.75	$6.60	-$17.15
High Seed	56	0	75.7	$22.60	$8.45	-$14.15
High Seed + P2O5	56	42	77.5	$47.60	$16.45	-$31.15