EFFECT OF FUSARIUM INFECTION DURING WHEAT SEED DEVELOPMENT ON THE PRODUCTION OF DON AND SEED QUALITY

Jason Argyris and Dennis M. TeKrony
Department of Agronomy

OBJECTIVES:

1) Determine the time of infection of *Fusarium graminearum* during wheat seed development and its effect on the production of DON and seed quality.

2) Investigate effect of disease tolerance and susceptibility on severity of seed infection

INTRODUCTION:

Head scab caused by *Fusarium graminaerum* (Schwabe) has caused significant losses in the soft red winter wheat crop in Kentucky and in small grain crops in many regions of North America. Damage from head scab results in reductions in seed quality, emergence, and yield of wheat. In addition, losses in food-grain quality are caused by production of fungal mycotoxins, specifically vomitoxin (deoxynivalenol = DON). Relatively little information is available regarding when peak infection occurs during seed development and maturation and how these infection levels relate to the production of DON and the eventual seed germination and vigor. Considering that the seed is the delivery system for improvements in germplasm and the source for regeneration of new cultivars, it provides a vital link between research initiatives for seed improvement, and the farmer.

MATERIALS AND METHODS:

<u>Field plot establishment and environment</u>

Replicated plots of four soft red winter wheat cultivars, two susceptible (Roane, Pioneer 2552) and two tolerant (Coker 9474, Pioneer 25R18) were established following corn in a chisel plowed and disked seedbed on Spindletop Farm in Lexington, KY in October of production year1999-2000. This study was conducted as part of the uniform southern scab nursery. The corn seed inoculation procedure was modeled after the method of Paulitz (1996) and inoculum was distributed among field plots on April 24. An irrigation schedule initiated on April 28, 2000 continued throughout seed development to stimulate FHB epidemic conditions. Air and canopy temperature were recorded, as well as temperature in the developing heads of two cultivars as described in Panozzo et al., (1999). Plots were mist-irrigated twice daily until May 26. At anthesis (Feekes 10.2), spikes in each replication of each cultivar with anthers extruded in mid-spikelet were identified. At ten days after anthesis (DAA) seventy-five previously marked spikes were harvested, with harvesting continuing at four-day intervals through harvest maturity (HM, ~14 % seed moisture, fwb).

<u>Seed Development</u>

Fresh weight, dry weight and seed moisture were determined at each harvest for all varieties. In addition, seeds were also assigned a numerical rating as an indicator of disease severity and classified as normal=3, slightly shriveled or discolored=2, and white tombstone=1.

Seed Assessment
Floral structures (glumes, lemma, palea, caryopsis) of Pioneer 2552 were evaluated for infection at each harvest date. Ten consecutive spikelets from each spike were numbered, and the basal glume and floret in each of the ten spikelets was removed for evaluation. The ten fresh, complete florets were separated into glume, lemma, palea, and caryopsis, surface sterilized, plated, and evaluated for *Fusarium spp*. infection. The remaining three varieties were evaluated for seed infection only.

Seed quality

Seed from twenty-five spikes of each harvest was submitted to laboratory of L. P. Hart, Michigan State University for analysis of deoxynivalenol (DON) as described previously (Hart and Brazelton, 1983). Standard germination, accelerated aging germination, a stress vigor test, and the conductivity test for membrane integrity were conducted according to the Association of Official Seed Analysts (AOSA, 1999) guidelines.

RESULTS AND DISCUSSION:
Physiological maturity (PM, maximum seed dry weight) occurred between 40-45% seed moisture (dwb) for all varieties. Roane and P25R18 reached PM 17 and 6 days respectively before the highest *Fusarium spp*. seed infection levels (Fig. 1). Similar trends were shown for P2552 and Coker 9474, with PM at 51 and 30 DAA (data not shown). Peak infection occurred between 22-28% seed moisture in three of four varieties. The average infection by *Fusarium spp.* in floral parts from seven harvests of P2552 ranged from 25% on Jun. 8 to over 90% on Jun. 16 (Fig. 2). Seed infection followed similar trends, ranging from 20-68%, and was significantly lower than other floral structures at harvests four and five.

The cultivar, P2552 was most susceptible to infection (19-67%), but this susceptibility had little impact on measures of seed quality (Table 1). Germinability of seeds from all harvests and all varieties was generally high. Weak correlations between both laboratory quality tests (standard germination (SG) and accelerated aging vigor (AA)) and seed infection percentage were observed for all varieties. Accelerated aging germination was higher than SG, which would indicate the fungus was killed during aging at 41^{o}C. A moderate relationship was observed for Roane and P2552 when visually assigned seed infection was correlated with actual seed infection by *Fusarium spp*.(data not shown).

Individual head and whole plant canopy temperature data taken from Jun. 9 to Jun. 26 (Fig. 3) show similar minimum and maximum temperatures during cooler, rainy conditions. However, in warmer and drier conditions, temperature differences in the head exceeded those in the canopy by 3-4^{o}C. Temperature and irrigation provided a favorable environment for infection, but no significant disease pressure was observed in any variety until early to mid June (Fig.4). Significantly higher levels of seed infection were observed in P2552 for the final 3 harvests, while Roane and P25R18, exhibited intermediate seed infection levels.

The retention of high seed quality in our study with significant seed infection late in the field season suggests many of the infections were late and mostly superficial, leaving a somewhat depleted seed, but a viable embryo. The absence of significant disease pressure at flowering and throughout early development can be attributed to late placement of inoculum and delayed ascospore maturation, resulting in minimal infection at anthesis. This study will be repeated for the 2000-2001 production year using the same experimental procedures. Inoculum will be placed in field plots earlier to stimulate more severe disease conditions in early reproductive development.

REFERENCES:

1. Association of Official Seed Analysts. 1999. Rules for Testing Seeds. Assoc. Off. Seed Anal., Lincoln, NE.
2. Hart, L. P. and W. E. Braselton. 1983. Distribution of vomitoxin in dry milled fractions of wheat infected with *Gibberella zeae*. J. Agric. Food Chem. 31: 657-659.
3. Panozzo, J.F., H.A. Eagles, R.J. Cawood, and M. Wooten. 1999. Wheat spike temperatures in relation to varying environmental conditions. Aust. J. Agric. Res. 50:997-1005.
4. Paulitz, T.C. 1996. Diurnal release of ascospores by Gibberella zeae in inoculated wheat plots. Plant Dis. 80:674-678.

TABLE 1. SEED DEVELOPMENT AND QUALITY DEVELOPMENT AND QUALITY CHARACTERISTICS FOR PIONEER 2552

Pioneer 2552						
Date	Visual seed FHB rating score	Dry wt. (g/sd)	Seed moist. (%)	Fusarium (%) 100 sd	SG (%) 100 sd	AA (%) 100 sd
8-Jun	2.6	0.641	47.5	20	91	91
12-Jun	2.7	0.790	43.1	19	91	94
16-Jun	2.3	0.779	37.9	32	88	97
21-Jun	2.1	0.834	25.2	64	88	93
26-Jun	2.4	0.859	17.6	67	83	95
30-Jun	2.6	0.786	17.1	43	84	97
5-Jul	2.5	0.772	35.8	57	91	95

FIGURE 2. INFECTION OF FLORAL COMPONENTS OVER 7 HARVESTS

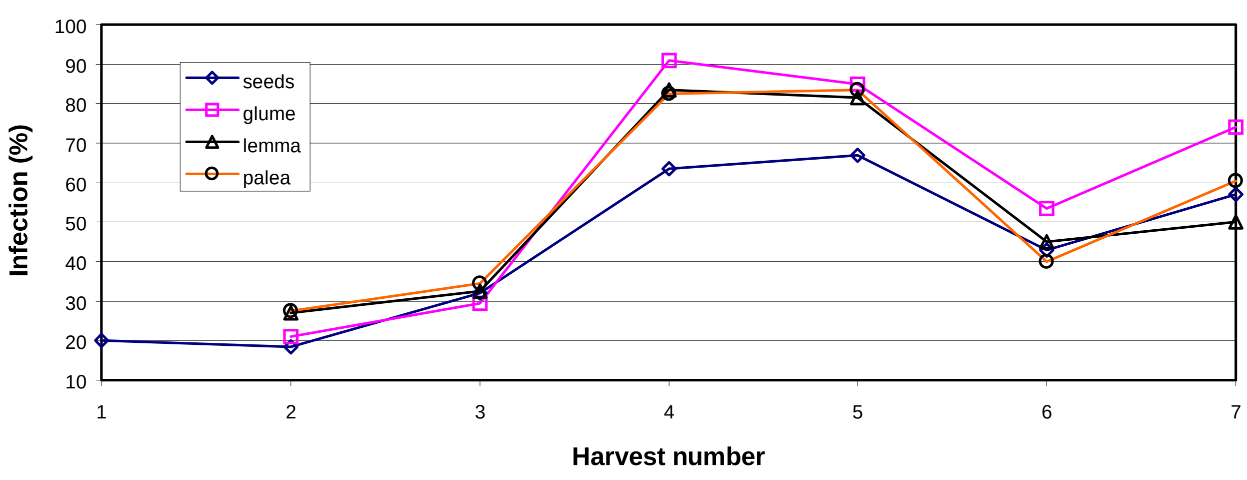
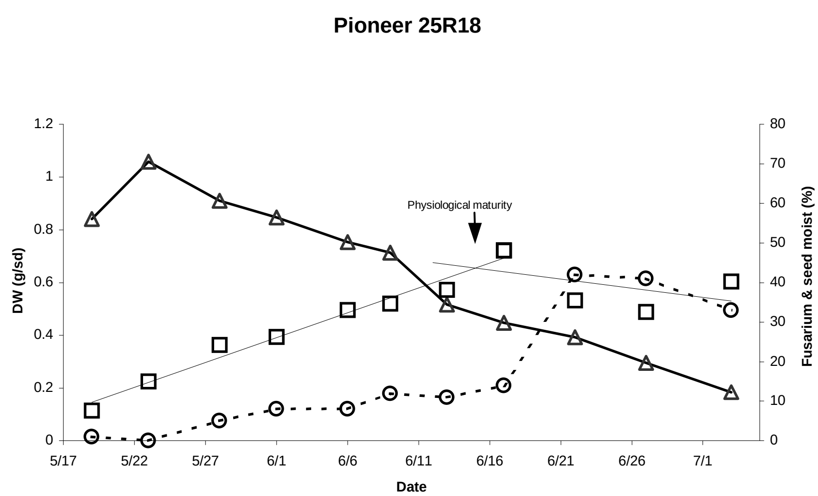


Figure 1. Changes in dry weight, seed moisture and Fusarium spp. infection during seed development in two wheat varieties



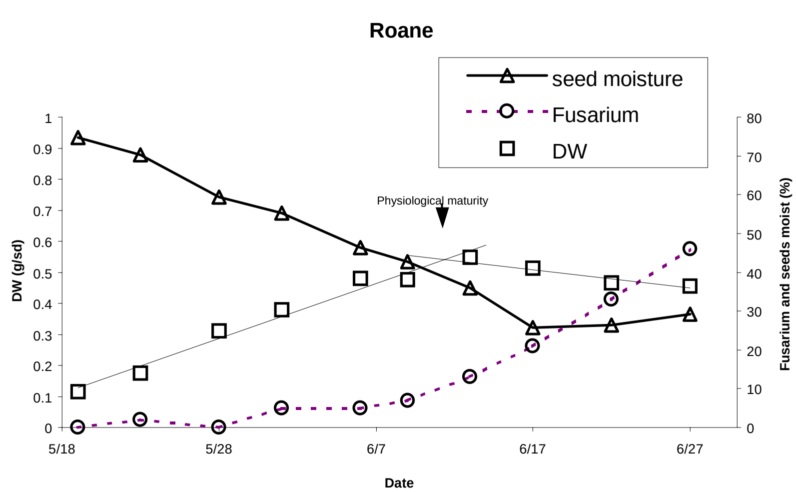


Figure 3.. Head and canopy temperature comparison in Coker 9474

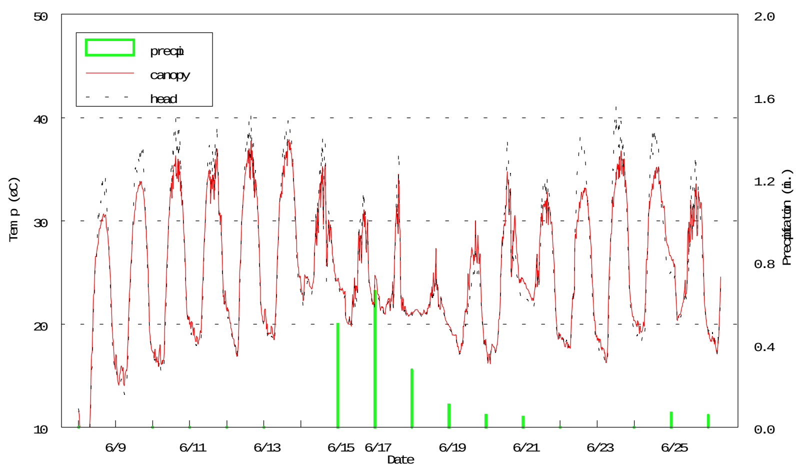


Figure 4. Relationship of temperature and precipitation to *Fusarium spp*. s seed infection in four wheat varieties during seed maturation