Environmental and Morphological Effects on Pre-harvest Sprouting of Wheat

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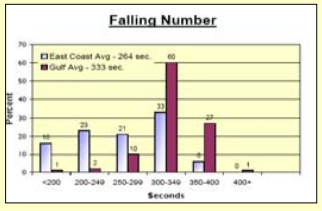
Introduction

- Falling number tests are conducted by creating a slurry of ground wheat flour and water. This paste is placed in a machine that measures the time necessary for a plunger to move through the mixture to the bottom of a test tube. The quicker the plunger falls, the lower the viscosity of the mixture and the lower the falling number. Low falling number is a result of alpha-amylase activity within the grain.
- A particularly wet harvest season in 2006 drew attention to the topic of pre-harvest sprouting (PHS) in the mid-Atlantic region. According to the U.S. Wheat Associates Report "Relatively high damaged kernel values and low falling numbers in the East reflect the difficult harvest conditions there".
- Low falling number scores reflect increased alpha-amylase activity which indicates sprouting and poor flour quality. In general, numbers below 300 seconds are considered poor quality.
- In 2006 the falling number average for east coast wheat was 260 seconds which is a 25% decrease from the five year average of 347 seconds.

Falling Number Values for the 2006 Soft Red Winter Wheat Crop (U.S. Wheat Crop Report)



Objectives

1. Increase wheat quality via avoidance of pre-harvest sprouting (PHS); adding value for producers and providing higher quality products for milling operations.
   a) Quantify inherent post-harvest dormancy of current wheat varieties and lines.
   b) Evaluate the effect of simulated rainfall intensity and duration and number of wetting/drying cycles on PHS of current wheat varieties and lines.
   c) Evaluate the effects of temperature, moisture, and morphological characteristics, collectively, on pre-harvest sprouting of current wheat varieties and lines.
2. Increase awareness and knowledge of wheat PHS.
   a) Educate producers and consultants about the process of pre-harvest sprouting and results from these studies.
   b) Deliver information from this project as curriculum in state and regional CCA schools, and Extension Agent in-service training.
   c) Publish update articles and an extension fact sheet on wheat pre-harvest sprouting, including differences among cultivars for maturity, seed dormancy, and PHS.

Materials and Methods

In-lab germination test:

- 80 lines from the Virginia Tech state wheat variety test were tested along with four white wheat varieties.
- 25 seeds from each line (four replications) were placed, crease down, in individual Petri-dishes in adequate water for germination in an incubator.
- Treatments of 10°, 20° and 30°C for 15 days were applied to measure differential innate dormancy of soft red winter (SRW) wheat lines. At 10°C all lines should break dormancy; at 20°C we expect varying levels of dormancy; and at 30°C only those with very little to no dormancy will germinate.
- A weighted Germination Index (GI) score was assigned to each line.

Materials and Methods (Cont.)

Greenhouse Rainfall Simulation:

- Heads collected from field plots were placed upright under misters in the greenhouse so that effects of wetting and spike morphology on PHS could be measured.
- The test included three replications and four treatments each representing a wetting/ drying cycle. The frequency and amount of simulated rainfall, and temperatures mimicked those observed from long-term weather observations.
- Falling number values for each treatment will be determined by the USDA Soft Winter Wheat Quality Laboratory (SWWQL), Wooster, OH.

Mister Setup for Greenhouse Experiment

Example Layout for the Greenhouse Experiment

Field Study:

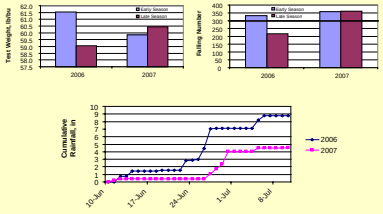
- Plots from one existing wheat trial at Warsaw, VA were not machine harvested. Plots were divided into quadrants for replications.
- Spikes were harvested from each plot at physiological maturity, harvest maturity, and approximately every five days for 15 days (i.e., 5, 10, and 15 days post harvest maturity) to measure environmental effects experienced during delayed harvest on PHS.
- Falling number tests will be conducted on harvested samples to measure the amount of sprouting damage.
- Morphological characteristics such as length of awns, angle of head, and glume tenacity were measured.
- Temperature, rainfall and relative humidity measurements were collected from the weather station at the Warsaw AREC.

The wheat head in the center has not yet reached physiological maturity. Physiological maturity was defined as the loss of color in the head and first few mm of stem.

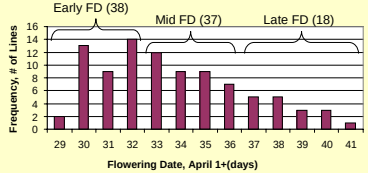
Results

Samples for Germination Index (left), Example of Sprouted Seed (right)

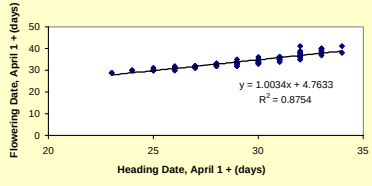
2006 Versus 2007 Weather Impacts on SRW Test Weight and Falling Number



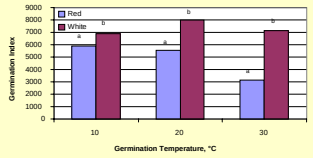
Distribution of Lines by Flowering Dates and Number Per Maturity Group



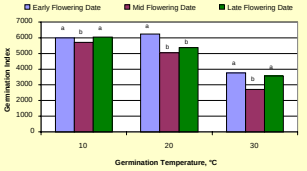
Relationship of Flowering Date and Heading Date, 2007



Germination Index for Red Versus White Seeded Lines



Germination Index by Flowering Date Group



Germination Index by Flowering Date for Released Lines

Early Flowering Date (April 1 + 29-32 days)

Brand	Line	Germination Index	
		----- 30 °C -----	----- 10 °C -----
Southern States	520	5312 +	6354
USG	3592	4419	5940
Pioneer	26R31	3438	5586
Agripro	MAGNOLIA	2664	5064
USG	3209	2129	6191
Coker	9511	2006	5778
Renwood	3260	1415	6117
Pioneer	26R24	1343	5922
Coker	9553	524 -	5090
LSD (0.05)		1191	519
Mean		3471	6019

Late Flowering Date (April 1 + 37-41 days)

Brand	Line	Germination Index	
		----- 30 °C -----	----- 10 °C -----
Vigoro	9713	6174 +	6729 +
Southern States	8309	5408 +	6442
Pioneer	26R15	4899 +	6825
Coker	9436	3177	5891
LSD (0.05)		1215	478
Mean		3593	6028

Mid Flowering Date (April 1 + 33-36 days)

Brand	Line	Germination Index	
		----- 30 °C -----	----- 10 °C -----
Vigoro	TRIBUTE	3753 +	6354 +
Southern States	8404	3690 +	6354 +
Vigoro	9510	3519	6113
Agripro	BRANSON	3342	4479
Coker	9184	2782	6756
Vigoro	DOMINION	2545	6118
USG	3706	2472	6258
Southern States	560	2430	5356
Pioneer	26R12	2418	5181
USG	3342	2403	5280
Agripro	PANOLA	2398	4414
Southern States	MPV57	1811	4960
Southern States	8302	1524 -	5481
AGS	2050	1297 -	4995
VCIA	SISSON	1164 -	5655
USG	3665	1056 -	4194 -
VCIA	MCCORMICK	702 -	4817 -
LSD (0.05)		930	481
Mean		2712	5707

A plus or minus sign indicates a performance significantly above or below the test average.

Conclusions

- There were significant differences in GI among the 10, 20, and 30°C treatments.
- A high GI at the 30°C treatment demonstrates an extremely low level of innate dormancy.
- A low GI in the 10°C treatment demonstrates that a line has an extremely high level of innate dormancy.
- SRW lines expressed highly variable rates of innate dormancy .
- White seeded lines, excluding Cayuga, expressed low levels of innate dormancy in relation to red seeded lines. Cayuga carries the QTL linked to the flanking markers *Xbarc055* and *Xbcd143* identified to be associated with PHS resistance.
- GI varied by maturity group but the trend was inconsistent.
- A total of nineteen lines with low, moderate, and high levels of innate dormancy were selected for greenhouse simulation studies.