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Project Title: Development of an Accelerated Phenotyping Platform for Measuring FDK in Large Breeding Populations

PROJECT 2 ABSTRACT

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The goal of this project is to evaluate wheat breeding lines for *Fusarium*-damaged kernels (FDK) using imaging and compositional approaches to identify a platform that is more accurate and higher throughput than the current method of sieving, visual inspection, and manual counting. To meet this goal, the following objectives are proposed:

1) collect scabby grain samples from regional scab nurseries,
2) develop baseline FDK data using existing protocols (*i.e.* sieve and manual counting),
3) image grain samples from each plot to establish image-based FKD predictions,
4) send subset of grain samples across FDK spectrum to WSU for single kernel characterization,
5) analyze whole grain samples for FDK using near-infrared spectroscopy, and
6) perform comparative data analysis to determine accuracy and repeatability of each approach.

The percentage of FDK within a representative genotype sample has shown to be reliable measure of resistance to FHB, typically more so than field (incidence, severity, and index) ratings. The strong correlation observed between FDK and DON is why breeders use FDK as a primary phenotype for determining level of resistance among breeding lines. Why not just use DON for determining resistance? Currently, the measurement of DON, while a very important and useful trait to collect, is very time-consuming because of the time required to ship, process, and analyze DON levels using laboratory protocols. However, the current method of measuring FDK involves manually counting the number of both tombstone (*i.e.* shriveled) and healthy kernels in a grain sample. This current method for FDK analysis is also time-consuming as well as labor-intensive. This is a major bottleneck in screening for FHB resistance that needs to be addressed to decrease the amount of time to process samples before sending off for DON testing, and more importantly, receiving quality FHB data for making informed breeding decisions in the next generation (crossing and selections). This study will evaluate additional methods for phenotyping FDK to compare their accuracy and throughput with the current adopted method of manual counting. These methods include digital image analysis, NIR spectroscopy, and the Single Kernel Characterization System (SKCS).

To advance the research priorities for variety development with host plant resistance, grain samples of replicated entries in the 2018-2019 Uniform Southern Scab Nursery and 2018-2019 Uniform Southern Soft Red Winter Wheat Nursery will be collected from three inoculated field nurseries (Florence, SC; Kinston, NC; Warsaw, VA) to evaluate FDK using image-based and compositional approaches. In addition, an overall FHB index field rating as well as an individual incidence (type I resistance) and severity (type II resistance) ratings will be measured to determine the correlation between phenotypes. Each grain sample will also be sent to the UMN DON testing laboratory for DON level data. Grain samples will be measured for FDK using manual tombstone and healthy kernel counts, digital imaging software, NIR spectroscopy, and the SKCS. The different methods will be measured for repeatability, accuracy in respect to the manual counting method, and throughput in respect to the average time of analysis per sample. Breeders will have this information to be able to incorporate a more accurate and higher throughput FDK phenotyping platform to increase breeding efficiency for improving FHB resistance in commercial wheat cultivars.