

WHEAT CAP

Mark Sorrells and Jamie Sherman, April 2007

FACTS: Pre-harvest Sprouting

What is Wheat Cap?



Coordinated Agricultural Project for Wheat is a multi-state, multi-institution project, funded by USDA/CSREES, dedicated to the genetic improvement of US wheat through research, education, and extension.

The Problem

Pre-harvest sprouting (PHS) is the premature germination of wheat seeds so that the embryo starts growing while still on the head in the field (Fig. 1). This occurs when wet conditions delay harvest. The distribution and severity of PHS varies from year to year depending on the weather, but tends to be more of a problem in the Eastern U.S. Wheat genes interact with the environment to predispose a variety to PHS. White varieties are more likely to exhibit PHS than red under similar environmental conditions. However, some PHS resistant white varieties have been identified. One group of genes that reduces PHS does so by extending the duration of seed dormancy.

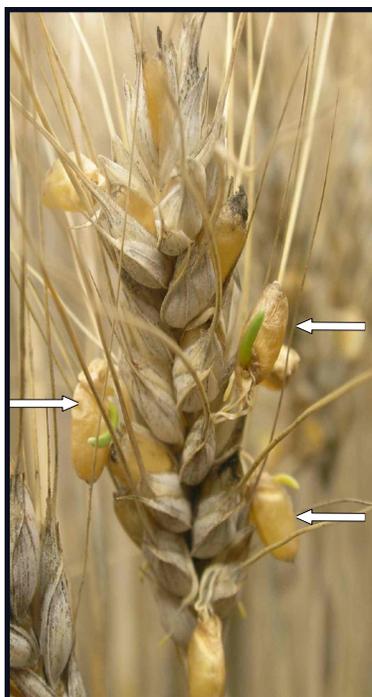


Figure 1: Seeds germinating on head (arrows)

PHS has a high economic cost for both growers and end-users. As the seed germinates starch and protein are degraded, reducing the quality of the seed. Flour from the degraded seed will produce products that are porous, sticky, off-color and generally poor quality. If the grain has over four percent damaged kernels then it is unacceptable for human food products and severely sprouted grain is often used for animal feed, reducing the price by 20% to 50%. Although agricultural practices can help, the most effective way to reduce PHS is to breed varieties with increased seed dormancy.

Breeding Problems

Dormancy is controlled by more than one gene with each gene adding to the amount of dormancy. In Fig. 2 heads to the left, labeled 0 or 1, have more dormancy and so more PHS resistance. Moving to the right, individuals carry fewer and fewer PHS resistance genes or genes that are less effective against PHS. Identifying the best combination of genes to provide the appropriate amount of PHS resistance is difficult. Since resistance to PHS involves an interaction between genes and the environment, the most accurate test of PHS resistance is using intact spikes harvested in the field at the same stage of ripening. It is impossible to do more than one such selection per year which slows breeding. Marker assisted selection can help alleviate these difficulties by allowing multiple cycles of selection each year.

Marker Assisted Selection

The molecular technique that uses markers to track genes is called marker assisted selection (MAS). In MAS, markers are used as flags to help breeders select the best gene combinations. Wheat CAP member Mark Sorrells and his group have associated molecular markers with genes that provide resistance to PHS. Markers allow breeders to choose the gene combinations that are consistently the most effective for reducing damage from PHS, especially for white wheat. When used in combination with genes for red kernel color, resistance to pre-harvest sprouting is increased in red wheat as well.



Fig 2: PHS resistance decreasing from left to right

Photo by Kent Loeffler, PlantPath., Cornell U.

What is the Wheat CAP Doing?

The Wheat CAP has established marker assisted selection in 25 public wheat breeding programs. We will continue to use MAS to improve wheat disease resistance, yield and quality.