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Pre-harvest Sprouting and Mold seen in 2008 barley crop

By Karen Hertsgaard and Paul Schwarz

According to USDA-NASS, the 2008 barley harvest is now almost 92 percent complete nationwide. In early September, the IBMS published an article examining protein and plump quality issues for the 2008 crop. Several other quality factors have also recently appeared in the 2008 crop, which are pre-harvest sprouting (PHS) and mold. Both can render a barley crop unacceptable for malting and can cause problems for maltsters and brewers. The IBMS will examine these topics to explain the difficulties these quality factors can cause maltsters and brewers and to increase understanding of the issues faced in the production of quality beer for consumers.

IBMS scientists and collaborators are continually researching methods to identify PHS damage and to ultimately produce varieties resistant to PHS. One of these researchers is Dr. Richard Horsley, barley breeder at North Dakota State University (NDSU). He states:

PHS or pre-germination, referred to as germination of kernels on the plant before harvest, typically occurs when rainy or wet weather conditions delay harvest in the field. Plants with low seed dormancy are generally more susceptible to PHS. These phenomena of PHS and dormancy have been extensively studied worldwide in several cereal crops, including barley, bread wheat, and durum wheat. Barley with PHS is an ever-present concern in the malting barley industry because it can lead to reduced grain yield, grain quality, and malting quality. Thus, PHS imposes serious technological and economic impacts on growers, maltsters, and brewers. Low dormancy combined with the wet, cool summer weather conditions has led to serious PHS problems in the upper Midwest US in recent years. The occurrence of barley PHS in 2002 in Minnesota and North Dakota was the most serious since the regional barley crop quality survey was initiated in 1977.

An intact barley plant having kernels with rootlets or even leaves growing out it may be obviously sprouted. A more difficult problem to spot may be partially sprouted barley (i.e. incipient sprouting). Another term used in the malting industry to describe germinating barley with just the tips of rootlets (radicle) emerging from the kernel is "chitted". Barley with incipient sprouting, or chitting, may initially re-germinate; however, the percent germination may drop to unacceptable levels (<95%) during storage. The allowable amount of sprouted kernels is determined by the buyer; however, research done outside of NDSU has shown that the amount of sprouted kernels should not exceed 2-3% in malting barley to avoid large losses in germination during storage. Other problems due to PHS that can arise during the malting process include non-uniform germination, increased water sensitivity, and higher mold growth. Use of malt made from barley with PHS may result in low wort (the liquid used to make beer) yields during brewing. Grain not acceptable for malting due to PHS usually is used for animal feed.

Techniques to identify PHS damage

Dr. Horsley goes on to explain some of his research, which includes techniques to identify PHS damage and identification of PHS resistant varieties.



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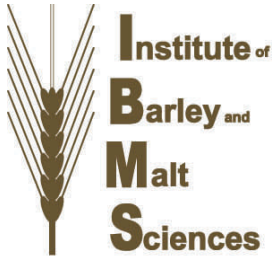
Dormancy is usually determined by a germination test of manually threshed kernels, while several techniques are available for determining the extent of PHS. To determine the range of damage due to PHS, one of two types of general methods is used. One is a visual score of grain germination; the other is an enzyme-related measurement, including direct and indirect measurement of the enzyme α -amylase, which is produced during germination. In the US, visual examination for sprouted grain is the official method approved by the USDA-Grain Inspection, Packers, and Stockyards Administration (GIPSA). A limitation of this method is that it is subjective and cannot detect the extent of sprout damage in some instances. Another test for sprout damage is called "the pearling test" and it is widely used in the US by the malting industry. This test relies on visual examination of the kernels following pearling to remove a portion of the husk.

A widely used group of methods used by malting barley procurers is to determine PHS based on the measurement of the enzyme α -amylase. In sound, or unsprouted barley, the enzyme α -amylase is not found because it is produced during germination. The two most commonly used methods for detecting the presence of α -amylase are measurement of falling number (FN) on the falling number apparatus and stirring number (SN) on the rapid visco-analyzer (RVA). Both methods indirectly measure α -amylase activity by evaluation of starch pasting properties. The FN method is more widely used in the wheat industry and the SN method is more widely used in the malting barley industry in US. Both the FN and SN methods have been approved by American Society of Brewing Chemists (ASBC) as standard methods for assessment of barley PHS damage.

Scott Heisel of the American Malting Barley Association (AMBA) explains how methods for detecting PHS were standardized recently:

Because PHS was especially severe and widespread in 2002, it became quite obvious that standardization of methods would be helpful. At the time the industry measured PHS using a pearling method, while the Federal Grain Inspection Service (FGIS) measured "Sprout Damage" (FGIS official term) by a visual method without pearling. The FGIS method generally underestimated sprouting compared to the industry method. This created a problem with crop insurance. Producers with coverage for "sprout damage" had barley that was rejected by the industry (using a pearling method) but Insurers only recognized the FGIS method as official, and in many cases, producers could not collect because the official method underestimated sprouting.

Because of these problems, AMBA began to organize collaboratives with industry, FGIS & NDSU late in 2002 and early 2003. These were organized to satisfy the new testing method requirements of both FGIS and ASBC. FGIS accepted the method called "Injured by Sprout" in Dec. 2003. ASBC accepted the method "Sprout Damage by Pearling Method" at the Annual ASBC Meeting in 2004. The final outcome for growers was that FGIS method "Injured by Sprout" was recognized by crop insurance (Risk Management Agency) officially beginning with the 2008 crop at levels above 1.0%.



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Identification of varieties resistant to PHS

Dr. Rongshuang Lin, a former PhD student on Dr. Horsley's barley breeding/genetics project, developed a screening test to identify barley varieties that may be susceptible to PHS as part of her dissertation research. This test involves the harvesting of barley spikes at harvest maturity, placing them in the freezer so they do not begin the process of losing dormancy, hand threshing the heads and germinating the seeds in Petri dishes. Using this technique Drs. Horsley and Lin were able to determine that varieties such as Robust or Tradition with moderate dormancy and resistance to PHS may have germination ranging between 20-35%. Non-dormant varieties such as Stander and Legacy that are susceptible to PHS may have germination ranging between 60-90%. Dr. Horsley's project continues using this test to determine potential susceptibility to PHS of experimental barley lines in the NDSU barley breeding program to screen dormancy levels in breeding lines from seven barley breeding programs in the US. This work is being funded by the USDA-CSREES Barley Cooperative Agricultural Project (CAP).

Mold also seen

Another problem seen by some producers in certain areas this year is mold in the harvested crop. Brewers have long avoided barley that is visibly moldy because of problems that can be encountered in malting brewing. According to Alan Slater of Busch Agricultural Resources, LLC in West Fargo, ND:

There are many different types of mold that can occur in the field. Many of the samples are grey/black in appearance. This is also caused by the wet conditions right when the crop was physically ripe. Mold will impact the malting process by increasing the variability of growth and overall making it very difficult for the maltster to control results. Many times the mold will increase, or grow, during the malting process, almost suffocating the kernels.

Off-flavors in the beer can also be caused by molds.

A specific problem with one group of molds is the rather dramatic effect of beer gushing. This is where a large volume of the beer literally spurts from the bottle upon opening and is caused by surface active protein produced by the mold which destabilizes the gas bubbles in beer. Gushing is known to be caused by various species of mold including Fusarium which is also known to produce the toxin deoxynivalenol (DON or Vomitoxin). Although molds can cause specific problems for maltsters and brewers, it must be remembered that all grain carries a population of microorganisms including yeasts, bacteria and molds. Some can cause the problems in malting and brewing stated above and some are relatively innocuous or even beneficial. More scientific research is needed in this area, to better define the relationship of visible "mold" and actual problems.