WONDER OF SPROUTING : CEREAL GRAIN

*Posted By **Zaure G. Aytasheva**, April 20, 2016*
Edit Post *Delete Post*

Reported by G.A. Shalakhmetova, Z.A. Alikulov*, , B.E. Shimshikov, Z.A. Aytasheva

Department of Molecular Biology and Genetics, al-Farabi Kazakh National University, Almaty

***L.N. Gumilyov Eurasian National University, Astana**

Pre-harvest germination (PHS) is the widespread phenomenon resulting in inferiority of grain, to decrease in its consumer qualities and respectively the prices. Areas to be most susceptible to PHS are located in Central and Northern Kazakhstan, the Ontario Province, Canada, Northern Australia, North-West of USA, UK icelands, Russian planes, and some others.

Phenomenon of pre-harvest germination depends on many factors and, first of all, genetic traits of wheat, particularly effected by abscisic acid (ABA) and gibberellic acid (GA), and specifically germination regulating seed dormancy. There are also a range of climate factors such as humidity, decreased temperatures during seed maturation, and presence of sufficient amount of molybdenum for plant growth and viability in soil [1].

In a number of climatic zones of Kazakhstan adverse weather conditions such as high air and soil humidity (rainy season) during the ripening and harvesting affect the ear formation and grain germination on the root resulted in significant deterioration of baking qualities,

a

nd in some cases complete uselessness of baking. One of the most characteristic features of sprouted grain is increased α - amylase activity. Grain germination in the ear at maturity or during seed storage induces synthesis of a specific form of α-amylase, a sp[ecial "germination enzyme" that leads to hydrolysis of starch granules, and the formation of water-soluble dextrins, what utterly spoils bread quality. Ability of sprouting in the ear depends on the genotype, which offers prospects of breeding strategies for resistance with this regard. A while back ago, investigators from Kazakh Research Institute of Agriculture, based on electrophoretic detection of "germination α-amylase isozymes" in more than 200 samples of wheat have generated new wheat cultivar Lutescens 70 resistant to the ear sprouting [2].

Detailed identification of biochemical mechanisms for plant resistance to pre-harvest germination in the long term gives opportunity to propose effective strategy for fighting with adverse stresors or pre-harvest seed germination. Molybdenum is an essential component of a molybdenum cofactor (MoCo) which is included into enzyme' Mo-containing active center, particularly in aldehyd-oxidase (AO). Germination occurs in grain in a condition of «relative dormancy», at which temperature is relatively low. Molybdenum regulates ABA biosynthesis through AO, and ABA is involved in a consecutive chain of events modulating expression of cold-responsive (COR) genes [3]. A number of studies determined the addition of physiological concentrations of ABA and further developing embryos of some grass species to lead to the prevention of premature germination via halting the expression of specific enzymes of germination. Characteristic of grain germination in the ear on a mother plant, PHS is known to

be increased due to hydrolysis caused by α-amylase.

However, in a number of studies in recent years, it was indicated that stability or a tendency to germinate in the wheat ear would be a multifactorial trait to be linked not only to uncontrolled synthesis of "germination α-amylase" in maturing grains. In the number of Australian publications the existence of caryopsis in some genotypes with late maturing α - amylase (LMA), the enzyme with high isoelectric points (IEP), has been detected. The authors have found that the LMA form of the enzyme in wheat would be the outcome of genetic defect that leads to the accumulation of highly active α - amylase with high IEP in the ripening seeds in the absence of normal conditions for germination (high humidity or other natural factors). LMA enzyme in UK is also termed "α - amylase immature grains"(AIG). The authors emphasize that the LMA or AIG (PMAA) enzymes are the consequence of genetic defect to be present in different genotypes of wheat, and this disadvantage may be spread around the world through breeding programs. Oppositely, α-amylase synthesized during caryopsis, is able to preserve own activity by maintaining temperature (around +12 ° C), what subsequently leads to low " Falling number " and adversely affects the quality of bread as final product.

In addition to the above-mentioned factors, the stability/instability of germination in the ear, there may be another factor - the hormone ABA quantity in caryopsis. ABA being an antagonist of GA, inhibits the synthesis of "germination α-amylase" and contributes the seed storage in dormancy. In our studies it was shown that PHS-steady genotypes (like Lutescens 70) contain more ABA than those unstable (Novosibirsk 67). Thus, genetic relationships and multifactorial assessment of stability to germination in the ear has been made clear. Significance of the problem is confirmed by development of national and wider genetic programs aimed at understanding this phenomenon as the search for resistant genotypes.

References:

1 .Person E. Cereal. Res.Commun. 1976. V.4. №2. P. 101-107

2. Walker-Simmons M. ABA levels and sensitivity in developing wheat embryos of sprouting resistant and susceptible cultivars . Plant Physiol. 1987. V. 84. P. 41-46.

3. Shen Q, Chen CN, Brands A, Pan SM, Tuan-Hua DH. 2001. The stress- and abscisic acid-induced barley gene HVA22: developmental regulation and homologues in diverse organisms . Plant Molecular Biology 45: 327–340