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CASE STUDY 8.1??Dormancy in wheat grains: nature and practical application

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Ancestral wild wheats, the progenitors of modern bread and pasta wheats, were endemic to the eastern Mediterranean and possessed a number of mechanisms, including grain dormancy, which were requisite to their survival in that environment. Grain which ripened before the long, hot summer remained dormant, avoiding germination in response to chance rain, until the return of cooler, more rainy periods later in the year. Wheat is now cultivated worldwide in diverse environments, many of which have a high risk of rain and cooler weather during the harvest period. Unfortunately, during domestication and genetic improvement many of the mechanisms which reduced untimely germination have been inadvertently discarded or found to be incompatible with the requirements of large-scale commercial farming. Indeed, the relationship of grain dormancy to consistent grain quality has not always been taken advantage of by breeders.

In the absence of protective mechanisms, rain falling on ripe wheat crops may induce preharvest germination of grain (Figure 1), rendering it unsuitable for commercial pro-cessing. Sprouted grain in Australia has resulted in losses to growers of hundreds of millions of dollars. Breeders are there-fore looking to reintroduce factors such as dormancy into new wheat cultivars to provide ‘insurance’ against preharvest rain. After ?rst searching for dormancy characters in older cultivars held in the world wheat collections, the next hurdle is to transfer dormancy to elite cultivars which already possess all the other required agronomic, quality and disease-resistance characters.

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Figure 1 Lack of dormancy can lead to preharvest sprouting in wheat. Ripe spikes were subjected to a wetting treatment – an overhead spray for 2h – then maintained at high humidity and 20^{o}C for 5 d. The spike on the left is from a susceptible non-dormant cultivar which sprouted readilty compared with three other more dormant, sprouting resistant cultivars.

(Photograph courtesy D.J Mares)

There is a well-known association between red seed coat and dormancy, but white-grained genotypes with signi?cant levels of dormancy have also been identi?ed (Mares 1987). To date, the dormancy from red wheats has not been successfully transferred, in its entirety, into a white-grained background. Red-grained wheat cultivars dominate world production except in Australia where only white-grained genotypes are cultivated. Dormancy in both grain types is a transient character which develops during desiccation of the maturing grain, then decays with time after ripeness. Dormancy appears to be deepest if the grain has ripened in a cool environment but can be eroded by rain in the 20 day period leading up to harvest ripeness (Mares 1993). To rank genotypes for potential depth of dormancy, all lines need to be grown in the same environment and tested at the same stage of maturity using standard wetting treatments or germination tests.

Dormancy in wheat grains is dependent on the presence of an intact seed coat. Damage to this structure through invasion by fungal pathogens, disruption during swelling and shrinkage caused by wetting/drying cycles or through physical abrasion during threshing results in a loss of dormancy. Segregation patterns obtained in inheritance studies are consistent with control by two independent, recessive factors and indicate that dormancy is only recovered when both factors are present simultaneously. With simple Mendelian segregation, dormancy would have been expected in the F_2 generation. However, dormant segregants were not revealed until the F_3, one generation later than expected. From this, we can infer that at least one of the factors is probably expressed in the seed coat which lags one generation behind the embryo.

References

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