Effects of genotype and environment on the sprouting propensity and other grain characters of wheat (*Triticum aestivum* L.).

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SUMMARY

Six wheat cultivars exhibiting a range in susceptability to sprouting damage were subjected to three artificially controlled environments. Nine characters thought to be involved with sprouting damage were examined. The characters of interest were: dehydration rate (harvest ripeness), grain weight, the red-grained pigment (phlobaphene) and one of its precursors (flavan-3-ol), germination, embryo maturity, embryo dormancy, basal alpha amylase and alpha amylase response to germinible conditions.

Results indicated that lack of germination following standard International Seed Testing procedures (Anon., 1966, 1976) may not be appropriate as an indication of dormancy in all environmental conditions. Lack of germination may be due to embryo immaturity or to embryo dormancy. At cooler temperatures, embryo maturity was delayed well past harvest ripeness, and at this point true dormancy appeared to have been lost. Examination of the synchrony between embryo in maturity and impedence to germination was considered important when examining dormancy. The difference between these two characters appeared to be the most reliable estimate of actual dormancy. Other traits investigated had poor synchrony with true dormancy. Different environments markedly affected the synchrony of embryo immaturity, dormancy and harvest ripeness. The role of anoxia, hormonal balance and other catabolic enzymes involved in early germination were reviewed, and it was suggested that these factors may prove useful in future research

into the sprouting damage problem.

Chapter one : INTRODUCTION

Sprouting damage may occur when wet weather initiates germination processes in unharvested grain, with subsequent deterioration in breadmaking quality. It is a potential hazard to wheat growing regions throughout the world, e.g. Europe (Olered, 1967; Belderok, 1968), Australia (Moss, et al., 1972) and New Zealand (Sanders, 1974; McEwan, 1976a).

Seed dormancy is usually accepted as being related in some way to resistance to sprouting damage (e.g. Belderok, 1968a); that is, dormancy may be associated with lack of catabolic processes in the endosperm (Ching, 1972; Leshem, 1973; Villiers, 1972). Several enzymes initiated during the germination process are involved in the degradation of the starch and protein of the endosperm. These enzymes include alpha-amylase, which break the branch chain amylopectin starch molecules to dextrins and amylases, and beta-amylase which degrade these smaller compounds to low molecular weight dextrins and maltose (Kent-Jones and Amos, 1967; Pyler, 1969). Beta-amylase is present in the sound grain but its activity is restricted, as there are relatively few exo-groups at which this enzyme is capable of hydrolysing (Kent-Jones and Amos, 1967; Pyler, 1969). Alpha-amylase appears a major factor in starch dextrinisation, and levels of this enzyme relate to the degree of sprout damage (Johansson, 1976; Olered, 1967; Moss et al., 1972). Other enzymes may also be involved in early germination, such as proteolytic enzymes (Gordon, 1975; Kruger, 1976). In sprout damaged wheat, the increased level of starch dextrinisation results in an inferior loaf (Olered, 1967; Pyler, 1967; Moss et al., 1972). The loaf is reduced in volume, has a grey and sticky crumb, and a dark crust colour (Olered, 1967; Kent-Jones and Amos, 1968; Pyler, 1969; McDermott, 1971). Sprout damaged grain may also have a lighter bushel or test weight (Ghaderi and Everson, 1971; Fouler and de la Roche, 1975), and lowered milling yield (Belderok, 1968; McEwan, 1959).

Breeding for sprout resistance involves recognition of usable genetic parameters. The relationship between grain colour and pre-harvest sprouting tendency is well documented (e.g. Gfeller and Svejda, 1960; Kimber, 1971) : white grained wheats being susceptible to sprouting, while the red grained wheats exhibit varying degrees of dormancy. However, not all wheats have a sufficiently long enough dormant period to offer reliable crop protection. Other parameters may include : (1) reducing the sensitivity of the aleurone cells to gibberellic acid, (2) selectively inactivating alpha-amylase response to germinible conditions, and (3) identification of the role of specific proteolytic enzymes involved in early germination (Bhatt, et al., 1976; Gale, 1976; Kruger and Preston, 1976). Recent field studies (Gordon, 1975) suggested that enzymes other than amylases may have marked influences on wheat endosperm degradation during early germination.

The present investigation investigates suggestions of earlier work (Gordon, 1975) but taken over a wider genotypic sample and number of environments with particular reference to the magnitude of the genotype environmental interaction. The characters of interest were the red grain pigment (phlobaphene) and one of its precursors (flavan-3-ol), germination, embryo maturity and dormancy, basal alpha-amylase and alpha-amylase response to environmental conditions conducive towards germination, grain weight, and harvest ripeness. Six cultivars were stratified random samples that offered contrasting susceptibilities to pre-harvest sprouting. The strata were : white-grained and red-grained cultivars. Their response in characters relevant to sprouting damage were followed in three climatically controlled laboratories.