Climatic Adaptation in a Barley Breeding Program

J. E. Grafius and V. A. Dirks

The problem of adaptation under the highly variable climatic conditions of the Great Plains is most difficult to analyze. Past experience seems to be the most reliable criterion of measurement, and past experience of the 1930's convinced many individuals that an early barley variety, to escape the mid-summer heat, drouth and grasshoppers, was a necessity. Present experience in the form of yield records for the period 1942-1951 does not support the early variety hypothesis. Perhaps better grasshopper control in recent years has removed the premium from earliness. Nevertheless one does not lightly go against the opinions of those who lived through the "thirties".

The development of a new variety takes many years, and one would like a reasonable assurance that the proposed phenotype will make the best possible use of the available rainfall. Empirical data for the years 1942-1951 indicate that in central South Dakota early varieties are frequently penalized by scanty May rainfall. The question unanswered is how much penalty will be incurred by later maturing varieties during periods less favorable for crop production? The problem is presented here in hope that the approach may prove interesting and may stimulate further consideration of the relationship between the plant and its environment.

Pertinent Information and Limiting Assumptions

Average rainfall and temperature data (4) for Huron, S. Dak., for the period of May 14 to July 13, 1928-1947, are plotted in figures 1 and 2. One has almost a feeling of hopelessness upon seeing the variability of the daily rainfall pattern. Actually each dot represents the average of 20 years; for any given year the variation may be much greater. Fortunately, the temperature curve (figure 2) is much more predictable. Also, powerful tools exist (1, 2) for resolving the difficulties presented in figure 1. Fitting of 3rd and 4th degree polynomials gave only minor, non-significant reductions in the sum of squares. Hence the 2nd degree equation was chosen.

The second degree regression line is shown in figure 3. Once this curve is drawn, the problem begins to take shape. This regression line will be the model upon which, unless stated otherwise, all subsequent statements of moisture relationships will be based.

At this point let it be emphasized that the curve used is not the true moisture curve. The true moisture curve is not known. The second degree regression curve is merely an estimate of the true rainfall curve, and as such, can be neither right nor wrong, only more or less accurate than another estimate.

From figure 3 it is obvious that a moisture deficiency will be felt in May, provided there is little moisture carry over from early spring, which is frequently the case. A moisture deficiency will also be felt in July.

Before analyzing this problem it was assumed that increasing temperature would increase evaporation loss and decrease moisture availability.