The Effect of Mildew and Scald Infection on Yield and Quality of Barley

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POWDERY mildew, Erysiphe graminis hordei Marchal, and Rhynchosporium scald, Rhynchosporium secalis (Oud.) Davis, rank with barley stripe as being the most destructive diseases of barley in California. While not as spectacular as barley stripe or such diseases as stem rust and bunt of wheat, their widespread distribution and annual occurrence make them a potential threat to barley production year in and year out. The addition of mildew and scald resistance to the variety Atlas was a distinct advancement toward stabilizing barley production in California. The resultant variety, Atlas 46, has proved a useful tool in measuring the effect of mildew and scald on yield and quality, the importance of which has never been fully appreciated.

Several investigators have established linear relationships between the incidence of certain diseases, which either kill the plants or replace their fruiting bodies, and reduction in yield (4, 7, 13, 14). Losses due to foliar diseases have been more difficult to measure. Dusting a portion of the crop to control or minimize disease development has been used frequently and fairly successfully (3, 8, 9, 10, 11, 12). Complete control of the diseases, however, is difficult to obtain; the plants, moreover, are subjected to unnatural conditions. Yarrow (16) found that dusting clover with sulfur increased the respiration of both healthy and mildew-infected leaflets. The development of essentially isogenic varieties which differ only in their disease reaction seems to be the most logical approach in measuring the effect of disease development on yield and quality.

Two methods are available for obtaining such varieties, namely, backcrossing or the continuous selection in successive generations of plants homozygous for the desired character. Of these, backcrossing appears to be the more meritorious. The resultant varieties, in addition to being available for commercial production, will have the same range of adaptation as the recurrent parents. Consequently, the fullest expression of the given character may be expected.

Varieties developed in this manner, while not completely isogenic, attain a high degree of homozygosity for the genic complement of the recurrent parent. On a theoretical basis, if progeny from a cross between two parents differing by 100 independent gene pairs are backcrossed seven times, 45.6% of the resulting plants would be homozygous for all genes of the recurrent parent, except those closely associated with those transferred.

Atlas 46, a composite of 385 F₃ lines between a mildew-resistant composite (Atlas) and a scald-resistant composite (Turk) differs from Atlas in being resistant to the mildew and scald occurring in California. During the course of conducting varietal yield trials, an opportunity arose to compare the performance of varieties under various levels of mildew and scald infections. Their comparative yields, together with determinations on such factors as kernel weight, kernels per spike, and spikelet sterility, are directly associated with yield and quality in this paper. In keeping with the past performance of backcross-derived varieties (15), the probability that the two varieties should be identical under disease-free conditions. Consequently, measurable effects occurring in the presence of mildew or scald are attributable directly to the effect of infection.

Materials and Methods

Yield, kernel number per spike, and kernel size were determined for Atlas and Atlas 46 grown in paired plots at several locations in 1947, 1948, and 1949. The numbers of nodes and sterile basal nodes per spike were determined on a limited number of paired plots grown in 1947. The replicated five times, were grown at each location and varied from year to year but were widely distributed throughout the state, giving a good cross section of the barley-producing areas. This study was part of a large-scale varietal trial conducted in co-operation with the California Agricultural Experiment Service.

The center row of each plot was harvested for yield determinations. With the exception of kernel weight, all other determinations were based on 10 spikes, hand-threshed from each plot. After counts for kernel number, basal nodes were made in 1947 and 1949, the kernels were hand-threshed and the kernels weighed. The sample size was approximately 400 kernels. In 1947 kernels were obtained on 200 kernels taken at random from each plot for yield determinations.

No attempt was made to control or initiate infection in any of the nurseries. The large number of plots and their widespread dispersion was relied upon to obtain groupings desired; namely, disease-free, severely infected, and severe scald — mildew free. Late planting, necessitated by insufficient fall rains, favored mildew development but reduced the incidence of scald. Scald was prevalent only in 1948 to warrant a study. Mildew infection was widespread during the growing season in all locations, providing useful data on its effect upon yield.