Some Factors Influencing the Injury to Winter Wheat Heads by Low Temperatures

J. E. LIVINGSTON AND J. C. SWINBANK

INJURY to winter wheat heads in Nebraska by a late spring frost in 1946 was reported by Livingston and Swinbank (1). This same type of injury occurred again in the spring of 1947, although the damage was less severe. In general, the fields managed in such a way that they headed early for the locality, or planted to an early maturing variety, were the fields most severely injured. The most damage occurred at the stage when the head emerges from the boot. The stage of development appeared to be more important in determining the amount of injury than the variety of grain. A question arises, therefore, as to whether or not the early maturing varieties such as Pawnee and Wichita might actually head too early for Nebraska conditions. Earliness is a desirable character from the standpoint of escaping damage from stem rust and hot weather. However, if Pawnee and other early varieties head while there is still danger from injury by late spring frosts, then it would seem that these and still earlier varieties would be subject to such frequent damage that they would be undesirable because they would be less dependable. In view of these considerations and in order to determine some of the factors affecting frost susceptibility, a series of experiments was planned to study the following factors in relation to frost injury of wheat heads: (1) stage of development; (2) relationship between temperature and length of exposure; (3) soil fertility; (4) free moisture on heads; (5) varietal tolerances to frost injury.

Material and Methods

Winter wheat varieties were planted in the greenhouse on October 31, in 8-inch crocks containing a compost of two parts of manure, one part of sand, and two parts of soil. The crocks were left in the greenhouse at 22°C for 20 days following planting and then placed out-of-doors for 45 days. Upon being returned to the greenhouse the plants were thinned to 10 plants per crock. Artificial illumination was provided from 5:00 p.m. until 11:00 p.m. each day. Spring varieties were handled in the same manner except that they were not placed out-of-doors. Pawnee hard red winter wheat was used in tests relative to the stage of head development and the relationship between temperatures and length of exposure. Thatcher spring wheat in tests regarding the effect of soil fertility, Thatcher and Reliance to study the effect of free moisture on the heads, and seven hard red winter and two spring varieties for the evaluation of varietal

Twenty-four hours prior to being subjected to freezing temperatures and for 15 hours following treatment, the wheat heads were recorded every 5 minutes using a Northrup electrical recorder. There was approximately a variation above and below the temperatures listed.

The system used in the classification of the heads to the developmental stages at the time of freezing was as follows:

Stage 0 — fertilized embryos approximately enlarged.
Stage 1 — fertilized embryos beginning to terminate enlargement.
Stage 2 — immediately after pollination.
Stage 3 — pollination in progress.
Stage 4 — pollen nearly mature, 2 to 3 inches exposed.
Stage 5 — head fully emerged with a short stalk, peduncle exposed.
Stage 6 — head fully emerged but peduncle exposed.
Stage 7 — head one-half exposed.
Stage 8 — boot open so that the head is slightly visible.
Stage 9 — head still completely enclosed in the boot.
Stage 10 — head just starting to expand the boot.

The data were not analyzed statistically since the experiments were designed to show trends rather than establish definite values which, according to the results presented in this paper, would vary under different environmental conditions.

Results

The influence of temperature, length of exposure and stage of maturity on the frost susceptibility of Pawnee winter wheat heads is shown by the data presented in Tables 1 and 2. Since the differences between any two successive stages were small, from the standpoint of development and reaction to the cold treatment, the 11 stages were combined into five groups for the presentation of the data and for the reasonably close correlation between the percentage of heads with sterile florets (Table 1) and the percentage of sterile florets (Table 2). A high percentage of the heads were completely sterile in the greenhouse tests than in the field. Otherwise, the results were similar.

All heads produced in the greenhouse were subjected to the cold treatment or not, had sterile florets. In gathering the data presented...