Freezing Injury of Inbred and Hybrid Maize Seed

E. C. Rossman

When premature killing frosts occur in the autumn of the year, there is considerable anxiety over the effects on the corn crop and on the quality of seed corn. The most recent premature frost in Iowa and most of the Corn Belt occurred in the autumn of 1945. Late spring planting, cool temperatures during the early growing season, and an early frost in the fall were factors contributing to frost damage. Average test weight of the Iowa corn crop in 1945 was 49.6 pounds per bushel compared with the 10-year mean (1938-1947) of 55.2 pounds. Translated into bushels of corn, this reduction of 5.6 pounds per bushel in test weight meant a loss of some 40 to 50 million bushels of corn in Iowa.

Germination and quality of a large portion of the hybrid seed corn crop in 1945 were reduced as a result of early frosts. The total number of bushels of hybrid seed corn certified for sale in Iowa in 1945 was 443,506 compared with 881,116 bushels in 1944 and 765,541 bushels in 1946 (8). Fortunately, there was a considerable carry-over of 1944 seed which alleviated the short seed-corn supply for 1946 planting.

Kisselbach and Ratcliff (5) conducted an extensive study of freezing injury to open-pollinated seed corn from 1913 to 1920. Since relatively little information on the effects of freezing temperatures on hybrid seed corn was available, a series of experiments was conducted at Ames, Iowa in 1946 and 1947. Effects of temperature, moisture content of the seed, length of freezing period, variety of seed, rate of freezing and thawing, repeated freezing and thawing, and rate of drying on freezing damage were investigated and have been reported elsewhere (10). Relative tolerance of the seed of a group of inbred lines to freezing temperature, and the effect of genetic constitution of the seed on freezing tolerance were investigated also and are reported here.

Materials and Methods

Twenty-five inbred lines of corn were tested for tolerance of the seed to freezing temperatures in 1946 and 16 of the same inbreds were tested again in 1947. The effect of the seed on freezing tolerance was studied with all possible single cross combinations (plus reciprocals) among four inbred lines that differed in freezing tolerance.

Two plantings of the inbreds were made in the nursery approximately 2 weeks apart to provide moisture content of the seed in the fall. Hand pollinations were made to provide the selfed seed and the single cross two, four inbreds were very diverse in that 1946, ideal corn-growing seasons were very diverse in that 1947 was very dry, with unusually hot conditions during May and June, with unusually hot conditions during July, August, and September. Some of the seed to freezing temperature appeared to be in unfrozen conditions.

Ears were snapped with husks attached and contained approximately 50, 40, or 30% moisture by preliminary moisture tests. Ten to 15 ears of each freezing treatment at each moisture level were placed in Botany Department low temperature rooms. Each ear was to identify it throughout the procedure of freezing, sampling, drying, and shelling. Ears for unfrozen control were harvested at the same time as the samples for each treatment. Treatments were conducted in laboratory freezing chambers with uniform temperature and humidity intended to simulate typical freezes as closely as possible in the field. The ears were placed in a 35°F cold room for approximately 6 to 8 hours. Temperature readings with a potentiometer and thermocouples indicated that the temperature under the husks was approximately 5°F to 7°F after 6 to 8 hours at 35°F.

Seventy-five to 150 ears were placed on racks in a freezing chamber, which had a temperature of 35°F to 37°F after 6 to 8 hours at 35°F. Air temperature within the chamber dropped from 35°F to 20°F in approximately 1½ hours. All freezing treatments were conducted at a rate of change of temperature of approximately 3°F to 4°F per hour. A recording chart kept a constant record of temperature and duration of each treatment. Relative humidity was 94 to 98%.

Ears were removed from the freezing chamber and allowed to thaw for 6 to 8 hours. Unfrozen check ears of the same variety at each moisture level were kept in the same cold room during the time of freezing and thawing.

After thawing, each ear was sampled for moisture content. Two rows of kernels were removed for a sample; these were dried in an electric oven at 98°C, and the moisture content of each ear was calculated on a wet basis. With repeated freezing the ears were placed in a seed-corn drier approximately 95°F. Unfrozen check ears were sampled and dried with the frozen ears.

Since all the varieties did not reach the same extent of freezing injury, it was necessary to select those varieties that showed the most promise of coming through the freezing treatment with the least injury. This was done by a stepwise procedure which involved the selection of the most promising varieties.