The Effect of Moisture and Temperature During Storage
Test Reaction of Zea mays Seed Stored in Air,
Carbon Dioxide, or Nitrogen

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CONSIDERABLE interest has developed in the "cold test" reaction or germination test as a criterion of the influence of various heritable and environmental factors on the ability of Zea mays seed to germinate after exposure for a brief period of time to conditions unfavorable to germination. Seeds are generally exposed to soil borne pathogens under conditions favorable to the pathogens and not favorable for germination of the seed. Later, when conditions more favorable for germination are restored, seeds whose embryos have not been invaded and injured by pathogens may germinate and produce normal seedlings. The tests in general usage are assumed to simulate cold, wet weather or, in some instances, flooding conditions taking place in the field after the seed is planted.

Standard or normal germination or field tests under generally favorable conditions have been used to evaluate the effects of different storage factors on germination of corn seed. These tests are probably adequate for the conditions defined. However, under certain conditions, the cold test may provide means for making a more critical evaluation of some of the factors which contribute to longevity of the seed.

REVIEW OF LITERATURE

There is evidence that old seed or seed improperly stored for a period of time, even though its total viability under favorable conditions may be high, will produce poor field stands under conditions which favor soil borne pathogens but inhibit germination of the seed. Rush and Neal (8) indicate that age of seed influences cold test germination. Livingston (5) and Rush and Neal (8) have presented evidence that early harvested seed which is artificially dried was lower in cold test germination than seed harvested later at a more mature stage.

Welton (11) reported that seed germinated well for 4 years and then began to decline in germination up to 12 years after which there was no further germination. A loss in vigor in the seedlings accompanied the decline in germination. Robertson, et al. (6) reported that seed of about 10% moisture stored in a dry unheated room germinated 32% after 21 years and that there had been a gradual decline in viability from the beginning of the experiment. A dry climate was considered as contributing much to the longevity of farm seeds. Dungan and Koehler (1) reported seed at about 10.5% moisture and initially infected with ear rot pathogens germinated 11 to 32% after 10 years storage in a tin box. Haferkamp (2) et al., reported six varieties of corn seed stored in miscellaneous containers at Pullman, Wash., where mean annual rainfall is only 11.4 inches, germinated from 0 to 70% strong seedlings after 32 years of storage.

Sayre (9) tested seed after storage by planting in the field at normal corn planting time. In one experiment, seed was stored at "room temperature". Seed at 18% moisture was dead in 1 year, whereas seed at 14% moisture had decreased in germination after 13 years of storage. In another experiment, seed at 11.0% moisture held at 72.0°F. and 28°F., or better after 6 years storage. Seed at 14.6% moisture held at 28°F. germinated 80% while seed at 18.2°F. and 28°F. was only 13% viable after 6 years. Seed at 11.2% moisture was sealed in air, carbon dioxide, or nitrogen and stored at 86°F. 37°F. and 0°F. and tested for 13 years. Storage in carbon dioxide was found to be no better in air and storage in oxygen was found to be far greater than that of gases. Seed stored in air or nitrogen and held at 0°F. and 37°F. was still viable after 13 years, while seed stored at 86°F. was lower in viability after 3 years and completely dead after 13 years of storage. In another experiment, seed at 11.2% moisture held at 72.0°F. and 28°F., or better after 6 years storage. Seed at 14.6% moisture held at 28°F. germinated 80% while seed at 18.2°F. and 28°F. was only 13% viable after 6 years. Seed at 11.2% moisture was sealed in air, carbon dioxide, or nitrogen and held at 86°F. 37°F. and 0°F. and tested for 13 years. Storage in carbon dioxide was found to be no better in air and storage in oxygen was found to be far greater than that of gases. Seed stored in air or nitrogen and held at 0°F. and 37°F. was still viable after 13 years, while seed stored at 86°F. was lower in viability after 3 years and completely dead after 13 years of storage.

Dungan and Koehler (1) found that careful storage of seed of Station Yellow Dent corn yielded progressively less as the age of the seed increased and the yield was 3.5% for seed 4 to 10 years old. The yield reductions were 2.8 and 2.2% for 1- and 2-year old seed but 3- and 4-year old seed yielded 5.6% respectively, less than 1-year old seed. Commercially produced hybrid corn seed, 2-year old seed was found to yield 5.5% and 8.7% progressively less than 1-year old seed. Yellow Dent seed up to 7 years old yielded progressively less than 1-year old seed under perfect stands. Old seed produced plants lacking the vigor of seed 3 years old yielded 4.8% less than 1-year old seed. Perfect stands and 7.8% less with no adjustment of temperature and moisture on cold test germination. Seed was stored in carbon dioxide, air, or nitrogen gas and discussed.

The original experiment included samples of seven moisture levels treated with three different non-fungicide treated samples was also included. Data for one fungicide treatment of four different fungicides for two hybrids are presented in this paper. These data are considered representative of those obtained in a study which comprised a total of 84 lots made up of 12 combinations of varieties, moisture contents and temperature conditions. (With the various closure and storage conditions used, a total of 7,000 inbred line and tester combinations were included in the over-all program.)

MATERIALS AND METHODS

In order to obtain the representative data, a commercially produced seed of two hybrids grown on the experimental farm was used. The seed of one hybrid had been classified as "strong" and the other "weak" on the basis of cold test reaction of non-fungicide treated samples. Seed was harvested in 1943 and the seed was 9 months old before the storage experiment was started in 1948.

The seed of each hybrid was divided into lots adjusted to a different nominal moisture level by drying or by adding water in small increments and stored at different temperatures.