4-1-1967

SEED Quality Tests and Their Relation To Seed Performance

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SEED QUALITY TESTS AND THEIR RELATION TO SEED PERFORMANCE

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One of the jobs of quality control is to minimize the amount of deterioration that occurs during seed production. This requires constant checking with sensitive tests that can detect small amounts of deterioration.

Many kinds of tests have been developed for measuring seed deterioration. Some of these are based on observations made during germination and seedling growth: seedling growth rate, cold test performance, emergence through a layer of crushed brick, respiration rate of germinated seedlings, speed of germination, and germination after subjecting the seeds to stress conditions. Other tests are based on detailed examinations of the seeds: determination of enzyme activity, the tetrazolium test, and measurement of electrical conductivity. Brief descriptions of some of the tests now in the forefront are as follows:

<u>The cold test</u> (Figure 1) for corn determines how well seeds withstand seed rotting organisms under cold, wet soil conditions. It is the only vigor test now in routine use in this country. Seeds are planted in a mixture of sand and unsterilized soil, held at 50° F for 7 days, then transferred to warm temperatures to germinate. This test reflects the amount of mechanical damage in corn seed and the effectiveness of fungicide applications.

<u>Length of primary root</u> (Figure 2) of seedlings germinated in upright rolled towels is a measure of seedling growth rate. A variation of this method is to grow the seedling in soil for a time before taking dry or fresh weights of the seedlings. Speed of germination is essentially a measure of these same characteristics.

<u>GADA</u> (glutamic acid decarboxylase activity) (Figure 3) is one of several tests of enzyme activity. Glutamic acid solution is added to finely ground seeds. The amount of carbon dioxide evolved from this mixture in 30 minutes is an index of the enzyme activity present in the seeds. Seeds with the highest rate of carbon dioxide evolution are the most vigorous.

<u>The tetrazolium test</u> is also based on enzyme activity. Vigor ratings are obtained by close observation of staining patterns and the

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physical condition of the embryo. Tests which measure the activity of enzymes are among the quickest vigor tests to make.

Changes in permeability (Figure 4) of certain kinds of seeds indicate decreasing vigor. Permeability can be measured by soaking seeds in distilled water and then measuring the electrical resistance of the water. Low resistance means that the seeds have deteriorated, allowing materials to leach from the seeds into the water.

Survival of seeds under accelerated aging conditions is an index of longevity in commercial storage. Seeds are placed in an atmosphere of 100% humidity for 4 or 5 days. A germination test is then made to determine survival.

Respiration rate of germinative seedlings can be used as an index of vigor. Seeds are germinated and the amount of carbon dioxide given off by the seedlings is measured. The more carbon dioxide evolved, the greater the vigor of the seedlings.

The brick gravel method is one of the older vigor tests used in European countries. Germinating seeds are covered with a layer of crushed brick and the ability of seedlings to penetrate this restrictive layer is a general measure of seed vigor.

Microscopic examination for mechanical damage is a simple and effective test. Fast green or other stains may be used to make the cracks more visible.

These and numerous other tests are fully described in the literature. With this arsenal of tests available, the job now is to determine which are most suitable for use in quality control programs.

What Are The Best Quality Control Tests?

Several criteria need to be considered in selecting the tests to incorporate in a quality control program. These include (a) cost, (b) time involved, (c) personnel available, and (d) the particular aspect of quality to be tested.

Most of the tests that have been proposed do a reasonably good job of detecting differences in quality between seed lots. Most of these tests have been aimed at predicting difficulties in establishing stands under adverse field conditions and considerable experimental evidence is available on this point. We do not know if these tests can be used to measure losses in yield potential and storability of seed lots.

In order to predict potential performances, we must have more than arbitrary tests for "vigor". We must first of all know what levels of deterioration impair various aspects of performance. We must find out in what ways seeds deteriorate physiologically and then relate the condition of the seed to specific performance. The most useful vigor tests will be those that prove to be most closely related to crop performance.

Effect Of Seed Deterioration On Performance

During the past several years, we have attempted to obtain information on the effect of seed deterioration on three aspects of crop production: stand establishment, yield, and storability. Our objectives are to (a) determine the levels of deterioration that seriously affect performance, (b) associate plant responses and storability with the physiological condition of the seed, and (c) determine the feasibility of adapting this information in quality control work.

So far we have concentrated on corn, oats, and soybeans. We frequently use artificially aged seed to obtain suitable research material. Although the lots we used in these studies exhibited various degrees of deterioration, most had a high germination percentage and would be considered of marketable quality.

Stand Establishment

Field emergence data indicate that seed lots of similar germinability may not always produce the same number of seedlings in the field. One example of this is illustrated in Figure 5. In this case, soybean seeds one, two and three years old were planted in the field. Field emergence of one-year old seed was almost equal to germination percentage. Two and three-year old seeds were susceptible to soil-borne seed rotting organisms and stands were as much as 50% lower than germination. When fungicide treatment was applied, field emergence was nearly equal to germination.

Yields

We have long suspected that crop yields can be lowered by small losses in seed quality that cannot be detected by germination tests. To study this, we conducted several yield trials with corn and oat seed of different vigor levels. Different levels of deterioration were obtained both by artificial aging and natural storage. Vigor ratings were made on the basis of seedling growth rate and glutamic acid decarboxylase enzyme activity. All yields were based on equal plant populations. Under these experimental conditions, we have been able to demonstrate yield differences in the neighborhood of 10% for both corn and oats.

Figure 1. The cold test.

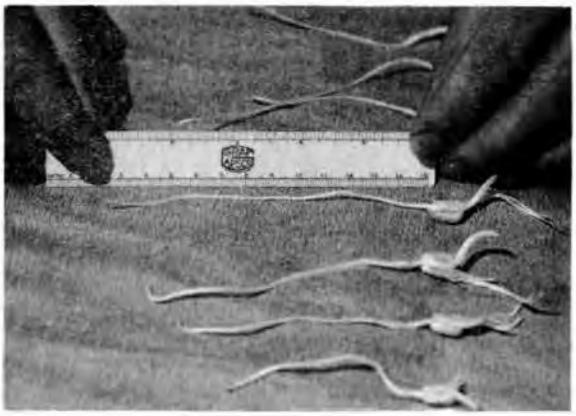

Figure 2. Measurement of seedling growth rate.

Figure 3. The GADA test.

Figure 4. Measurement of electrical conductivity.

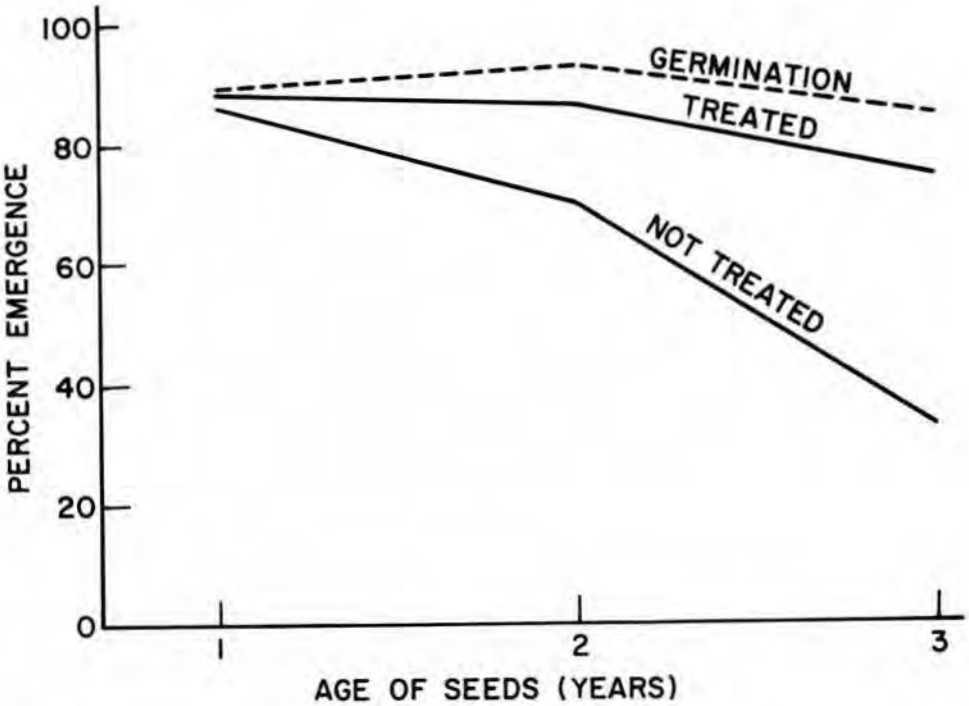

Figure 5. Effect of seed age and fungicide treatment on field emergence of soybean seedlings.

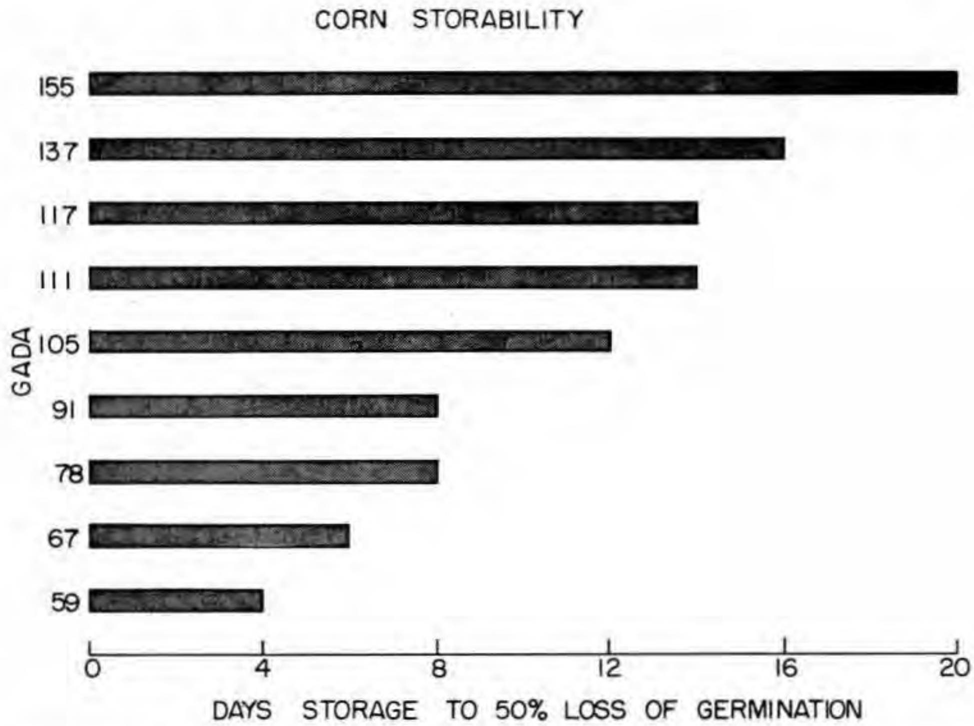

Figure 6. Relationship of glutamic acid decarboxylase activity (GADA) to corn seed storability. Seed lots with the highest enzyme activity possessed the greatest storage potential.

Data from one experiment with corn are given in Table 1 to illustrate this relationship.

Table 1. Effect of Seed Vigor on Relative Corn Yields*

Storage Conditions			Vigor	Relative
Temperature	Moisture	Germination	Level	Yield
77° F	11%	96	High	100
77° F	14%	95	Medium	98
77° F	17%	93	Low	93

* Yields were based on equal numbers of plants per plot.

Three seed lots were artifically aged by maintaining them at 11, 14 and 17% moisture sealed storage at 77° F. After enzyme activity had decreased, but before germinability was impaired, the seeds were removed from storage and maintained at a low moisture content until planting. The seeds with lowest enzyme activity (stored at 17%) yielded 7% less than the seeds with highest enzyme activity (stored at 11%).

Storability

We have also felt that longevity of seed lots in storage is governed by the physiological condition of the seed at thebeginning of storage. Experiments with corn have proven this to be true. In one storability study, nine lots of one seed corn hybrid were placed under adverse storage conditions to determine their relative storage life. They were analyzed for germination, cold test, and glutamic acid decarboxylase activity before storage. The lots were nearly identical in regard to germination and cold test performance, but varied greatly in enzyme activity. As indicated by the bar graph in Figure 6, storage longevity of the lots was in direct proportion to the amount of original enzyme activity. Germination and cold test gave no indication of potential storability differences.

Use Of Vigor Tests In Quality Control

Different kinds of tests are probably needed to rate seed lots according to their potential for stands, yields, and storage life. For example, in one series of experiments, a lower yield of corn was not related to cold test performance. On the other hand the cold test was a better indicator of potential stand establishment than was enzyme activity or seedling growth rate. Enzyme activity shows great promise as an indicator of relative storage longevity of seed lots.

When the appropriate tests are perfected, seedsmen will be able to use quality control tests to monitor the quality of their seed production in much the same way that manufacturers control the quality of the goods they produce. Some of these tests have already proven themselves in the laboratory and are ready for field testing under commercial conditions.