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Seed Quality Assessment

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SEED QUALITY ASSESSMENT

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Seeds set the maximum yield and quality potential of a crop. This is a message I am continually sending to farmers and if we are to convince farmers to stay away from bin-run and bootleg seeds you must deliver a product that lives up to their expectations.

When farmers and gardeners buy a bag of seeds they expect the seeds to perform well even if they plant too early when soil temperature is low or too late when soil crusting creates problems. If farmers plant the seeds in very poor soils with little production potential they still want to see quick germination and uniform emergence. They expect a quality product.

There are several laboratory tests that evaluate the quality of a seed lot. These tests can help seedsmen determine which seed lots are likely to perform poorly when planted in poor soil conditions. Utilizing these tests can reduce the time and money associated with poor stands.

Seed Quality

There are three important components that make up seed quality:

- ***Genetic Purity***
- ***Crop Purity***
- ***Physiological Potential***

Genetic purity is a key ingredient of seed quality. Keeping varieties separate in all phases of seed production and conditioning is the heart of any public or private certification program.

Crop purity is also important. Delivering a product that is free from weed seeds or other crop seeds, that has little trash or broken seeds is essential.

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Physiological components are the elements that give the seeds the ability to germinate and provide the energy for seedling growth and development. Physiological quality is composed of three components.

- ***Germination***
- ***Vigor***
- ***Health***

Germination

The germination test is the universally accepted seed quality test. It measures the ability of the seeds to develop into a "normal" seedling under favorable germinating conditions. A normal seedling is one that has the essential structures (root, shoot and food reserves) sufficient to produce a plant. Over the years this test has been standardized by the Association of Official Seed Analysts (AOSA) so that results are repeatable within and between labs.

There are several different testing procedures for germination. The media used, temperature and time the seeds remain in the test vary with the crop species. Recommended procedures for the different crop seeds can be found in the AOSA Rules For Testing Seed. In all cases the test conditions are considered ideal for germination. The germination test is said to measure the maximum plant producing potential of a seed lot.

The germination test, though universally accepted, is not without its problems. The test is considered an all-or-nothing test. Either a seed germinates or it does not. There is no measure of seedling strength, soundness or survival potential under field conditions. Germination test results can correlate well with field performance if the conditions in the field at planting time are close to ideal (adequate moisture and favorable temperatures). But how often are field conditions ideal?

Seed Vigor

Seeds are often slow to germinate or may fail to germinate when field conditions are cold and wet. Seedlings produced in these environments are often weak and may die before conditions improve. There are laboratory tests designed to measure the germination and seedling survival potential of seed lots planted in stressful soil conditions. These tests, known as vigor tests, are not as universally accepted as the germination test but they are widely used. A seed lot with high vigor has the potential to perform well under a wide range of conditions.

There is no desire or intent in the seed industry, regulatory agencies or research segment to label seeds for vigor. Rather the tests are intended to give seedsmen a better ideal of total performance potential. Seed vigor tests are useful in gathering information about:

- ***Carry-over Potential Of A Seed Lot***
- ***Field Performance***
- ***Grower Or Conditioner Problems***

Seeds reach their maximum quality potential about the same time they reach physiological maturity. But seeds are alive and like any living system they deteriorate. This deterioration ends in death. The rate of deterioration depends on the conditions encountered during seed development, maturation, harvesting, conditioning and storage. We can slow down the rate of deterioration by manipulating the storage environment, but we can not prevent it.

One of the last things affected during the deterioration phase is seed germination. If a seed lot has low germination, very little can be gained from further testing. However, a seed lot can have a very high germination and have a very low vigor level (Figure 1). These are the seed lots that benefit from vigor tests. There are several vigor tests available and they all have positive and negative sides. Details of suggested and recommended procedures can be found in the AOSA Vigor Testing Handbook.

Seed Vigor Tests

<u>Tetrazolium Test</u>

The Tetrazolium Test (TZ) has been around for many years and is often used to estimate germination. It is especially useful in dormant seeds. More recently the TZ test has been used as a vigor test.

The test is performed by soaking seeds in TZ stain which will turn the tissue a reddish color if the cells are alive. The location of the stain and its intensity are both taken into account. A trained analyst can read the staining pattern of seeds and determine if the seed is capable of germination and if the seed is high, medium or low in vigor.

The staining patterns can also be interpreted in terms of mechanical damage, field weathering, freeze injury, insect damage and heat injury during drying or storage. TZ can also be used to identify seed lots with mineral deficiencies. Peanut seedsmen often use TZ to determine whether the seeds have calcium or boron

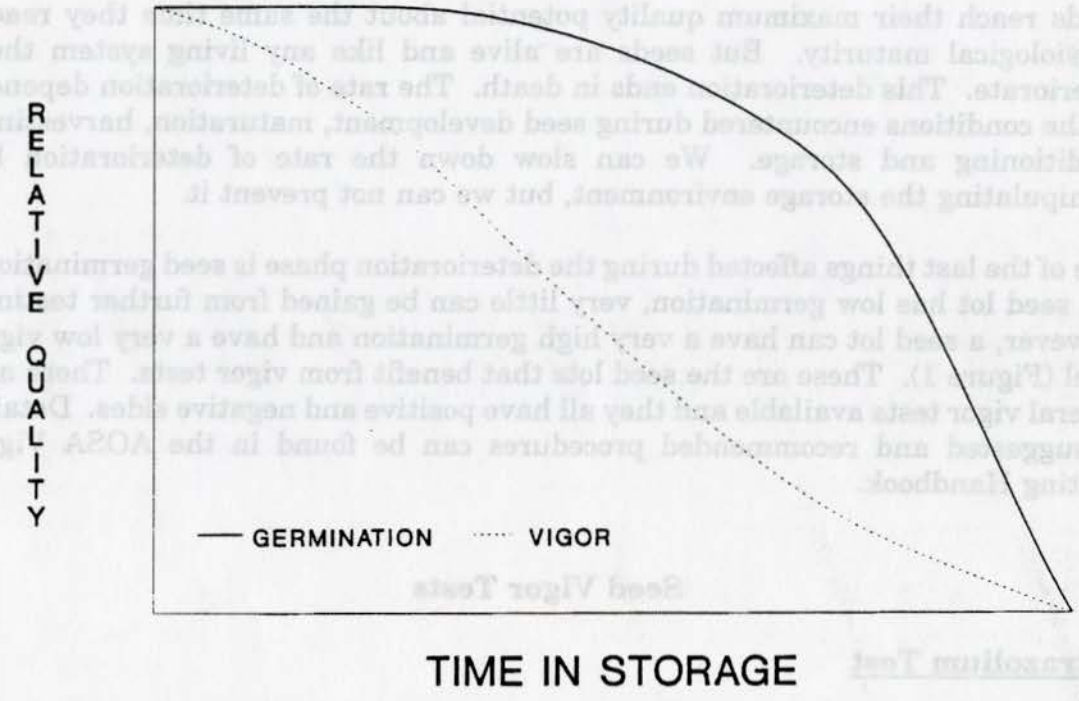

Figure 1. Changes in seed germination and vigor over time.

deficiency, both of which can cause problems during seedling development that may not show up in the germination test.

The TZ test is quick. Results can be obtained in 24 hours or less. But, it takes a skilled analyst to accurately interpret the test for vigor. This is one of the problems with the test. Work is being done through the Vigor Testing Committee of the AOSA to evaluate to potential of using TZ tests on corn and soybeans and refine the procedures. The AOSA does list TZ as a suggested seed vigor test on the following crops: alfalfa, cereal grains, beans, clovers, corn, cotton, peanut, pea, rape, rice, sorghum, soybean and sunflower.

Conductivity

The electrical conductivity test is another test for estimating the potential germination of seed lots that is now being used to evaluate seed vigor.

Seeds decrease in moisture content as they mature on the plant. It is thought that when seeds are dry the cell membranes are disorganized. When seeds take up water during the early phase of germination, sugars and other cell components can leak out into the surrounding media. This leakage is normal. The cell membranes recover quickly and become fully functional within a few minutes.

Many researchers feel that the membranes can undergo damage through a series of natural changes that occur during seed storage. This damage is thought to be one of the major causes of seed deterioration. The damage to the membranes results in slower membrane recovery and, therefore, increased leakage during imbibition. The more the seeds "leak," the lower the seed quality.

Excessive leakage can have a negative effect on seed performance in the field. The sugars and other cell components that leak out of the seeds are perfect food sources for soil-borne pathogens. When low vigor seeds are planted in cool, wet soils they are slow to germinate, often remaining idle for days or even weeks. Pathogens begin to feed on the sugars and eventually the seed itself, causing the seed to rot or decay. Seedlings from slow germinating seeds in these conditions are often subject to seedling decays or damping off. The end result is a poor stand or weak seedlings.

High vigor seeds in the same circumstances do not leak as much and can stay in the soil for longer periods before succumbing to the pathogens.

In the conductivity test seeds are soaked, generally for 24 hours, and the electrical conductivity of the soak water is measured. Equipment is available to measure the conductivity of a single seed or of a bulk seed sample. In general, high conductivity is associated with low quality seeds.

The test is easy to run and results are available in one to two days. There are, however, several problems associated with this test.

- Initial seed moisture and temperature of the soak water are important and should be regulated.
- Cracked seed coats will increase the amount of leakage.
- If labs are using the bulk method, one bad seed can give a "false" high reading.
- Seeds stored in cold temperatures may be low in vigor (as indicated by other vigor tests) yet have low conductivity.

In spite of the associated problems with the conductivity test, it remains a viable vigor test. It is used regularly for vigor tests of wrinkled seeded garden peas and soybeans. Research is being conducted to determine if the test can also be used on peanuts.

Accelerated Aging

The accelerated aging test (AA), which was developed at Mississippi State University, is one of the most popular vigor tests. In the AA test seeds are exposed to high humidity and high temperatures for 3 to 4 days, and then placed in a standard germination test. High vigor seeds can withstand a certain amount of stress before starting to decrease in germination energy and potential. Low vigor seeds deteriorate rapidly during the 3 to 4 day stressful "storage" period with the result that germination declines.

The AOSA Vigor Testing committee has made great progress in making this test reliable and repeatable. Over the years this test has become one of the better vigor tests. But like all tests it has problems. First the test takes about 10 days to complete. In a quality control program this is not a draw back. However, this can cause a problem if a rapid test is needed for quick decisions.

One problem encountered with AA is standardizing equipment. The AA chamber must be constructed so that the temperature can be regulated to within 0.1°C. Fluctuations above this range can cause unreliable results. Efforts are underway to update equipment and to provide accurate procedures. AA is routinely run on soybeans, peanuts, corn, pepper, cotton, wheat and peas.

Cold Test

The cold test is another test that has been around for many years. Like the AA test, seeds are exposed to a period of stress before evaluating germination potential. The seeds are placed in cold, wet conditions for a specified period of time, transferred to warm temperatures and evaluated for normal seedling development several days later.

The cold test typically uses soil or other media that contains naturally occurring soil-borne pathogens. It was mentioned earlier in the section on conductivity that these pathogens use the leachate from seeds as a food source. It is not unusual in the cold test to see pathogen growth around low vigor seeds and seedlings even if fungicide seed treatments have been applied prior to planting.

The cold test is routinely used to evaluate corn seed vigor. Most seed companies use this test to determine which seed lots enter the seed trade. Several companies have adapted the cold test to evaluate seed vigor in soybeans. Although most soybeans in the Southeast are not planted in cold soils, the test is still a valuable tool for evaluating vigor and can help identify potential emergence problems if soils are dry and/or crusted.

The AOSA Vigor Testing committee has made a great deal of progress in standardizing the cold test. Recommended procedures for cold test on field and sweet corn were added to the AOSA Vigor Testing Handbook in 1992. Most seed companies have become comfortable with the procedures and feel confident in the interpretation of the results.

Cool Germination Test

The cold test is often too severe for crops like cotton. The cool germination test, therefore, was developed to provide enough stress on the seeds to identify poor quality lots. Cotton is often planted early in the mid-south, when the weather can fluctuate from warm to cool within a few hours. The cool test has become a means to identify seed lots that are not suitable for planting in cool soils.

Farmers can ask seed dealers about cool test results and decide for themselves which lots can be planted early and which should be held until conditions improve.

Seedling Growth Tests

One of the first manifestations of decreasing seed vigor is the reduction in energy available for seedling growth. Therefore, measuring the rate of growth or evaluating the soundness of the seedling can provide a good description of the

overall quality of the seed lot. These tests are a good tool for quality evaluation but are time consuming.

Classifying seedlings as strong or weak is a subjective call and obtaining reproducible results on visual ratings can be difficult. The seedling growth rate test, however, is based on seedling weight and can be a valuable test.

How Well Do Quality Tests Relate To Field Performance?

The question posed for this section is a valid one that is frequently asked. It was mentioned earlier that the standard germination test can correlate well with field emergence if the soil conditions are favorable. However, when temperatures are low and/or if soils are crusted, germination is frequently not a reliable measurement of emergence potential.

Craig Nelson, a graduate student at the University of Kentucky, did a study where the cold test, AA, conductivity, TZ and germination tests were compared to field emergence of soybeans. In 1987 when seeds were planted under stress conditions, he found that all of the vigor tests correlated very well with emergence, but the standard germination test did not. In 1988 when soil conditions were better, the standard germination test was a much more reliable predictor of emergence than any of the vigor tests. So the correlation of any lab test to field performance depends on the condition encountered in the field.

Seed Health

The third component of physiological quality is seed health: the presence or absence of seed borne pathogens or seed transmitted diseases. Seed health is becoming very important to the seed industry, especially as we begin to export more seeds. Many foreign countries have strict regulations about seed health and seed lots must often have phytosanitary certificates to enter the seed trade.

Seed transmitted diseases like smut or scab can cause serious yield and quality problems for farmers. Other diseases like *Phomopsis*, one of the causal agents of pod and stem blight, can reduce germination potential. The relationship between *Phomopsis* infection and germination of four 1991 soybean seed lots can be seen in Figure 2. As the level of *Phomopsis* infection increases (more seeds infected), the lower the germination. Three of the four seed lots were substandard and could not be sold for seeds in North Carolina. Treating the seeds with Vitavax brought the germination of all four seed lots to 80% or higher.

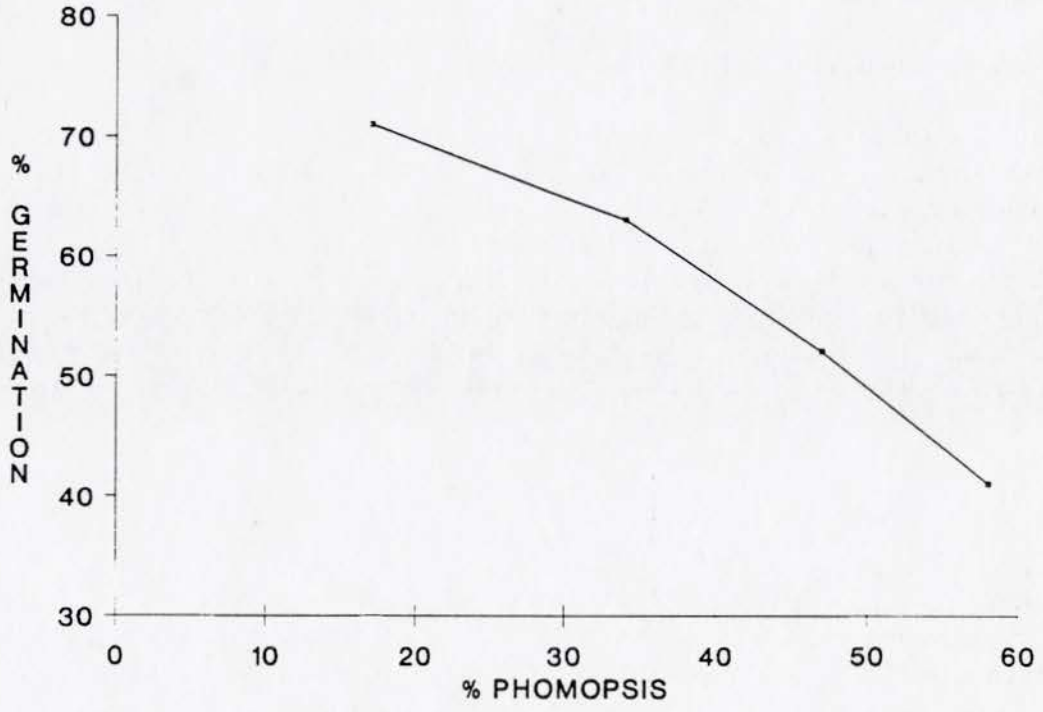

Figure 2. The relationship between seed *Phomopsis* infection and germination of four soybean seed lots.

Summary

The measurement of seed quality is extremely important to the seed industry. Germination, vigor and health tests are available to assure that the seeds delivered to the farmer, gardener or home owner are high quality. It is critical for the seed industry as a whole to use these tests to determine the potential use of seed lots.

The AOSA Vigor Testing committee continues to evaluate old and new vigor tests. Copies of the Vigor Testing Handbook can be obtained by writing to Larry J. Prentice, Nebraska Crop Improvement Association, 268 Plant Science; IANR - UNL, Lincoln, NE 68583-0911.