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Cottonseed Vigor and Performance

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COTTONSEED VIGOR AND PERFORMANCE

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The quality of planting seeds is one of the most important factors affecting the performance and productivity of most agricultural crops. The technologically advanced, capital intensive, economically complex situation in business (whether seed production, conditioning, farming, etc.) today demands that every precaution be taken to minimize errors.

As more sophisticated precision planters and planting techniques become available, each viable seed will be expected to emerge and produce to its maximum genetic potential. Potential field performance must be known prior to planting; therefore, the demand has increased for accurate and reliable methods for ascertaining seed quality. This is made somewhat difficult due to the uncertainty of climatic and soil conditions to which the seeds will be subjected. It therefore becomes necessary to select seedlots for planting which have high emergence and survival capabilities under adverse conditions.

Definitions

Seed quality may be defined as "those seed properties" that make it desirable for its intended end use - food, feed, planting, etc. From an agronomic viewpoint, seed quality would largely refer to seed viability and vigor. Copeland and McDonald have defined seed viability as "Alive." This indicates that a seed contains structures and substances including enzyme systems that give it the capacity to germinate under favorable conditions in the absence of dormancy. The Association of Official Seed Analysts (AOSA) has defined vigor as, "those seed properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions." A major difference in these two definitions is that vigor gives an indication of what might be expected from the seeds in the field under adverse conditions (which usually exists), whereas, viability is a measure of seed/seedling performance under optimum conditions.

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A seed will either be viable or non-viable. Obviously, it is only those seeds that are viable in which varying degrees of vigor can be expressed (Figure 1). It is generally accepted that seed viability and vigor reach their maximum at physiological maturity and then subsequently decline (Figure 2). In addition, as deterioration occurs, vigor begins to decline earlier (Figure 3). This indicates that seeds with relatively high levels of viability may not necessarily have acceptable levels of vigor. It then becomes the responsibility of all who handle the seeds to do so in such a way to minimize this rate of viability/vigor loss.

Importance of Seed Vigor

The vigor of any lot of seeds is important to all of those who will be producing, conditioning, selling, and using the seeds for planting purposes. First, the seed producers (breeders and/or breeding institutions) are vitally concerned with seed vigor in that they want to produce and market only high quality seeds. In our competitive marketplace, this is the only way that seed companies remain in business. Secondly, conditioners of seeds do not want to invest money in the cleaning, sizing, treating, and bagging of seeds that are of poor quality. If they are aware that a seedlot is of such quality as to be unsuitable for planting, they can move it into various food or feed channels before investing any additional money in conditioning. Finally, the farmer is interested in the vigor of the seeds he will be planting. This information will be useful to him relative to the cost of the seeds, when to plant, planting rate, etc. Thus, all individuals associated with planting seed from its production to its ultimate planting in the field should be concerned with information relative to its vigor.

Seed Vigor Tests

The AOSA has placed vigor tests into three categories: (1) seedling growth and evaluation, (2) stress, and (3) biochemical. For any vigor test to be of value, it must satisfy a number of criteria not the least of which is providing useful information relative to field performance (emergence, stand establishment, etc.). If a producer can obtain a good stand (with an adequate number of plants per acre, a uniform spacing of plants, and healthy plants), his yield potential will certainly be increased.

We have conducted a number of laboratory tests on cottonseeds and correlated them with actual field performance. Laboratory tests have included the following:

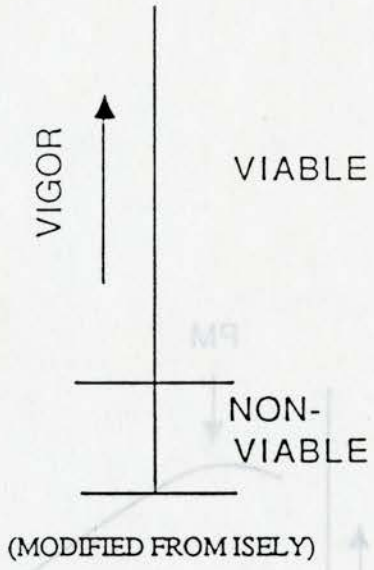

Figure 1. Relationship between vigor and viable/non-viable seed.

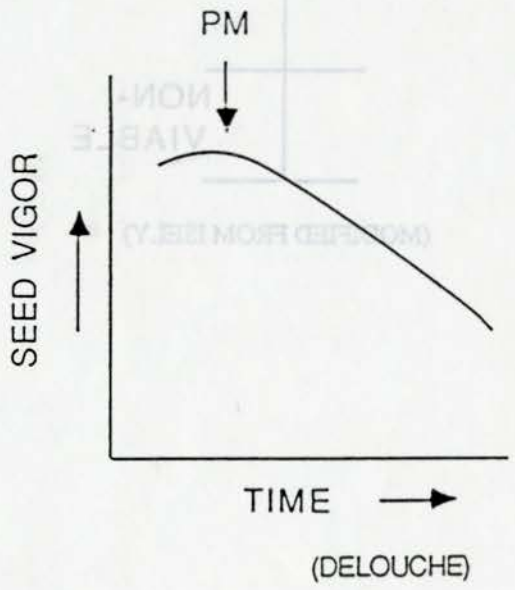

Figure 2. Relationship between seed vigor and time.

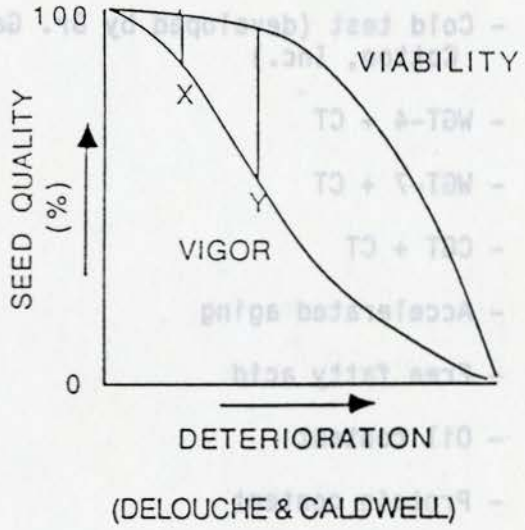

Figure 3. Relationship between seed quality and deterioration.

1. WGT-4 - Warm germination test counted after 4 days
2. WGT-7 - Warm germination test counted after 7 days
3. CGT - Cool germination test
4. W4C - WGT-4 + CGT
5. W7C - WGT-7 + CGT
6. CT - Cold test (developed by Dr. Gay Jividen of Cotton, Inc.)
7. W4CT - WGT-4 + CT
8. W7CT - WGT-7 + CT
9. CGTCT - CGT + CT
10. AA - Accelerated aging
11. FFA - Free fatty acid
12. Oil - Oil content
13. Pro - Protein content
14. Pro/Oil - Ratio of protein to oil
15. Phy - Phytin content
16. Phos - Phosphorus content
17. Phy/Phos - Ratio of phytin to phosphorus
18. EC - Electrical conductivity
19. Density - Seed density

The results from the above laboratory tests were subsequently correlated with the following field performance parameters:

1. ERI - Emergence rate index (a measure of the rate and totality of emergence).
2. EI-6 - Establishment Index 6 weeks after planting (a measure of the number of established plants present six weeks after planting expressed as a percentage of the total number of seeds planted).

3. DM - Dry matter production

4. LAI - Leaf area index

5. Lint yield

6. Seed yield

7. Turnout - Lint yield expressed as a percentage of total material harvested (burrs, lint, and seed).

These field performance parameters represent early season (ERI, EI-6), mid-season (DM, LAI), and late season (lint yield, seed yield, and turnout) criteria. In general, the highest correlations of the laboratory tests have been noted with the early season field parameters. The decrease in the correlations with the mid- and late-season parameters is largely due to the host of environmental conditions occurring during the season that tend to mask, to some degree, the early season vigor differences.

Of the laboratory tests evaluated, the W4C (warm germination test counted after four days numerically added to the cool germination test) has provided the most consistent estimate of vigor relative to emergence (ERI) and stand establishment (EI-6). We have subsequently labeled this test the "Cool-Warm Vigor Index."

The Cool Warm Vigor Index (CWVI) provided good estimates of the Emergence Rate Index (ERI) during both 1984 and 1985 (Figure 4). During both years, 12 cultivars were used and it may be noted that as the CWVI increased a concomitant increase in the ERI was observed. The same relationship was noted for the EI-6 during both years (Figure 5).

An interesting observation was that for both parameters (ERI and EI-6), the 1984 and 1985 regression lines were not superimposed on each other. This was due to the more stressful environmental conditions encountered during 1984 which resulted in lower emergence rates and establishment percentages. The fact that the regression lines for each parameter were essentially parallel indicated that the CWVI test was consistent across years in measuring vigor as evaluated by these field parameters.

Cool Warm Vigor Index

As a result of these data, we have been recommending the CWVI as a valid vigor test for cotton. The testing procedure is relatively simple. It consists of the following steps:

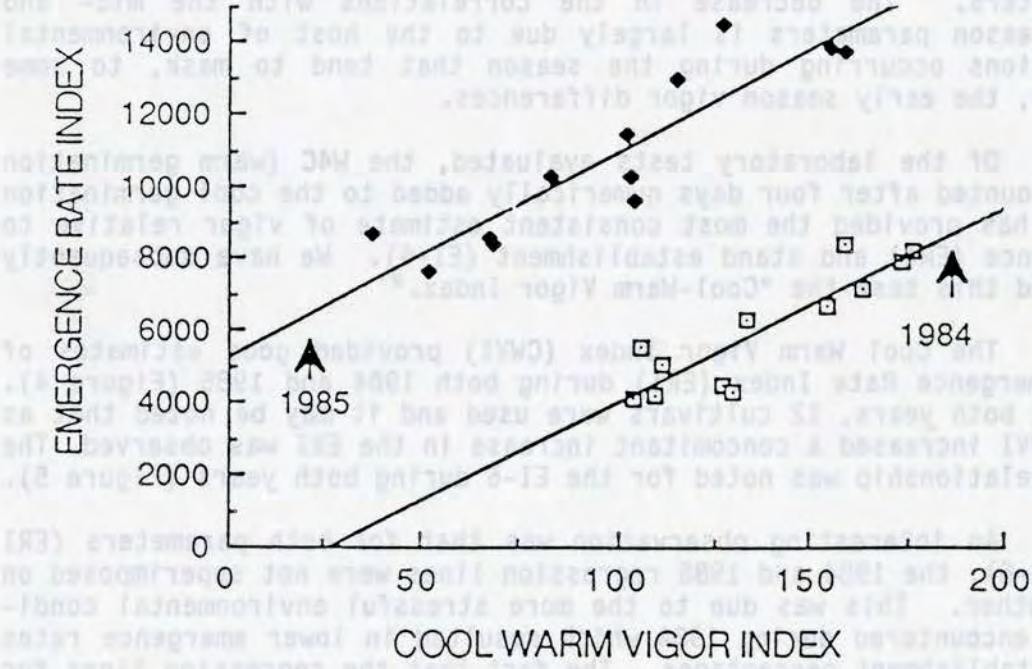

Figure 4. The emergence rate index as a function of increasing cool warm vigor index values.

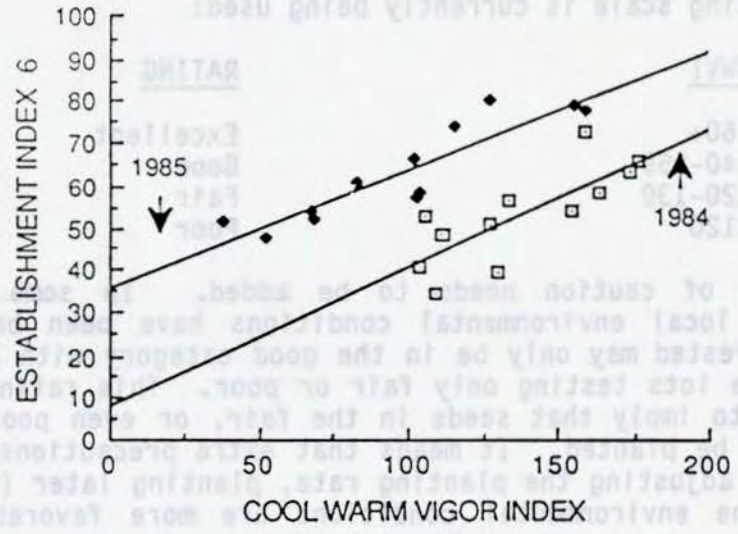

Figure 5. The establishment index six weeks after planting as a function of increasing cool

1. Conduct the cool germination test (64°F, 18°C) and count the number of normal seedlings greater than 1.5 inches long after seven days. (Refer to the Vigor Testing Handbook published by the AOSA for further detail.)

2. Conduct the standard warm germination test (alternating 68 and 86°F for 16 and 8 hours, respectively) and count the number of normal seedlings greater than 1.5" long after four days.

3. Add the results of the two tests.

The following rating scale is currently being used:

CWVI	RATING
160+	Excellent
140-159	Good
120-139	Fair
<120	Poor

One note of caution needs to be added. In some years, especially when local environmental conditions have been bad, the "best" seeds harvested may only be in the good category with a large percentage of the lots testing only fair or poor. This rating scale is not intended to imply that seeds in the fair, or even poor category, should not be planted. It means that extra precautions should be taken such as adjusting the planting rate, planting later (if time permits) when the environmental conditions are more favorable for germination and emergence, etc. Its intended use is to provide not only absolute information about the seedlot, but also to allow the relative ranking of seedlots so that intelligent decisions can be made relative to the use of the seeds.