INDUSTRY PERSPECTIVE OF VIGOR TESTING

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INTRODUCTION

A great deal of research has gone into investigating seed vigor and vigor test methods. The Association of Official Seed Analysts (AOSA), through the Seed Vigor Test Committee, published an excellent guideline, "Seed Vigor Testing Handbook" (1992). This handbook has proved to be an excellent guide to understanding vigor. The handbook also is an excellent starting point for setting up vigor test methods and can be said to be a way to standardize testing methods. Those individuals that have made major contributions to vigor testing are to be commended.

While initial publication of the Seed Vigor Testing Handbook in 1983 was being hailed as a success in the public sector, it was viewed as another potential set of regulations and labeling requirements to the seed industry. In response to publication of the Handbook, the American Seed Trade Association (ASTA) published a position paper recommending that vigor test results be used for in-house information only and not for any other purposes such as labeling or advertisement.

Seed companies use vigor tests, but the methods are not necessarily the same as described in the Handbook. This makes it difficult to compare results between public and private laboratories or even between private laboratories. There appears to be a desire on the part of some individuals to force the standardization of vigor testing methods and labeling of vigor results. This movement has led to some challenging situations. The challenge is more of a dilemma for the seed industry.

DILEMMA

Vigor testing is a dilemma for the seed industry. A dilemma is a predicament that seemingly defies a satisfactory solution. The industry's dilemma deals with the customer and the customer's understanding of seed vigor. How much the customer understands and should be told about seed vigor presents a challenge to both the industry as well as the public sector. Seed vigor can not be explained as a black and white issue. A seed lot may not always contain all high vigor seed or low vigor seed. A seed lot consists of a wide range of individual seeds with varying degrees of vigor and consequently constitutes a grey area. Trying to educate the customer in regard to this aspect of quality is very difficult.

First Dilemma—Communication and Meaning

Communication of vigor information to the customer is a dilemma. We might use analogies to indicate what seed vigor is. We could use the

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analogy of the horsepower of a tractor. A farmer can relate to the horsepower of a tractor and its ability to pull an implement. Supposedly, the higher the horsepower, the better the tractor for large tillage operations. But a person must keep in mind that horsepower is only one aspect of the requirements for the tractor. If we deliver to a customer a 250 horsepower tractor driven by a steam engine, as opposed to a modern-day diesel engine, the customer would be very disappointed with the performance. The point is seed vigor, like horsepower, is only one aspect of overall performance and we must keep vigor in perspective.

Indicating to the customer that a seed lot has high vigor may be misunderstood as a guarantee of performance. High vigor is difficult to explain. We can use the definition of seed vigor which is "Seed vigor comprises those seed properties which determine the potential for rapid, uniform emergence, and development of normal seedlings under a wide range of field conditions" (AOSA, 1992). This is a good working definition for a scientist involved in vigor testing, but trying to convey what this means to the customer is difficult. The customer may have heard of terms such as cold test, accelerated aging, quality index, cool germination, or glutamic acid dehydrogenase activity (GADA); but how does he relate to what these tests measure? We can explain to the customer the type of test and even the method by which the test is conducted, but the customer may still be in the dark. The customer probably will never be able to grasp the total aspect and relative importance of the type of vigor test or the results.

Second Dilemma — Format of Test Results

This leads to a second dilemma with the customer, the format of the vigor information. If the customer is told that the pure vigor seed profile is 67%, he may have no understanding of what this is. The pure vigor seed profile is:

$$\% \text{ Pure Seed} \times \text{Germination } \% \times \text{Accelerated Aging Test Score}$$

If we tell the customer that this seed lot has a vigor index of 7.4, again, the customer has a dilemma in understanding what this means. We can try to simplify matters by giving the customer a straight percentage linked to a specific test, but this still may be misleading because of the methodology and the intention of the test. Let's suppose that we have conveyed to the customer a vigor test score such as 75%. That customer may then ask questions such as: Do you have a better lot? Is 75% a good rating for this test? What does 75% mean to me in relationship to field performance? These questions from the customer open up a whole realm of possibilities and problems for the supplier or seed company. The seed company now faces the dilemma: Do we charge more for seed that has a higher test score than other seed lots? Do we now have to reorganize our whole inventory system around both germination and vigor testing, which causes inventory management problems? The seed company determines the minimum of performance and markets all of those seed lots meeting a minimum as opposed to placing seed lots into vigor categories.

Third Dilemma — Comparing Vigor Test Results

Another dilemma seed companies face is comparing test methods between private and public laboratories. AOSA regional committees have conducted vigor test referees with limited repeatability. At a recent meeting of the Illinois Seed Dealers Association Liaison Committee, 1993, results of a cold test referee were shared. There were 25 participating laboratories. Yet, within these 25 laboratories, 13 different methods or modifications of the standard cold test procedure could be found. Differences existed in the length of the stress period, soil content, water content, length of time after the cold stress has been applied, method by which seedlings are evaluated, etc. Each company has developed a modified cold test that delivers a level of stress they feel comfortable with and which has meaning for their staff. Some companies may desire a very stressful cold test, while others want results that relate to average or minimum stress. Therefore, standards for lot release are not the same. This leads to the topic of standardization.

STANDARDIZATION

We find three testing situations that challenge our ability to standardize:

- Inter-Laboratory
- Intra-Laboratory
- Intra-Company

Each of these testing arrangements offers a different challenge with regard to repeatability.

Inter-Laboratory Standardization

For the inter-laboratory or among laboratory situations, standardization is the biggest challenge. Most seed companies know through both research and dealing with customer complaints what vigor results mean in relationship to potential field performance. The company that markets a seed lot that does not perform is going to have to face the customer and make a satisfactory resolution with that customer or suffer a business loss. For this reason, a company laboratory may use a modified form of a vigor test and the results of that test have a specific meaning to the people in charge of quality. Standards of performance are applied to that test method based on a long history of seed sales. For a company to change their test method to the Handbook method presents a dilemma and more work.

Public laboratories only have to stand behind their test results. They do not have to stand behind the seed that is sold. A state or public laboratory can use methods published in the Handbook to try to achieve standardization. The problem comes when comparing test results between public and private labs. Each private lab has established its test protocol based on a long history of field testing and customer actions that relate to satisfaction.

For a company lab, a change to the Handbook method would require additional research and the re-establishment of the specifications in regard to inventory management. The test might be added only because of a regulatory change. The company may continue using their proven method and add the Handbook method. This simply adds work to laboratory staff, driving up cost to provide information that may only be used for labeling or regulatory purposes.

Some vigor tests have the potential to be more repeatable. However, each seed company has a different way of looking at vigor. Companies may want more stress than the Handbook method. Even when standardized methods have been used, the comparison of results among labs has been less than acceptable.

Byrum and Copeland (1991) found that the accelerated aging test was not reproducible among laboratories; whereas, the cold test was reproducible on four seed lots of hybrid corn in ten laboratories. Burris and Navratil (1979) reported variability between tests results on the same sample by as much as 60% in a cold test study using 11 laboratories. Other referee tests, such as the recent one conducted by the Illinois Seed Dealers Association Liaison Committee, lead to frustrating results with poor correlation. Much work remains to be completed in training, equipment, and procedures before we have any hope of inter-laboratory standardization. Even if tests can be standardized among labs, the industry is not motivated to move to a standardized method.

Intra-Laboratory Standardization

Repeatability in the intra-laboratory systems is probably the easiest to standardize. Differences between technician interpretation, training, and methods are minimal over time. Operating a single laboratory gives the advantage of having good repeatability in vigor testing. Byrum and Copeland (1991) indicated that within-laboratory repeatability for vigor testing was as good as for germination tests for both cold and accelerated aging test on corn. Intra-laboratory variation should be minimal provided good equipment, training, and reference samples are diligently used. Repeatability should be good because the same staff are always conducting the tests with the same methods.

Intra-Company Laboratory Standardization

Some companies have two or more laboratories. Maintaining consistency between two laboratories even when the methods appear to be identical is a challenge. Diligence must be followed and cross-training between the staff of two laboratories must be constantly undertaken to maintain good repeatability. Aspects such as using the same soil in cold tests, the same equipment for the cold period, the same amount of medium are all key to standardization.

The same can be said about other popular methods such as the accelerated aging test. It is extremely important that the type of equipment, down to the AA boxes and even the after-germination testing method, be kept the same. Specific procedures in well-written manuals are not even

enough. People's biases are one of the biggest challenges in standardization.

INTERPRETATION OF RESULTS

The challenge of interpreting research results to field performance and measuring the various aspects of vigor related to field performance has been a big challenge to both the public and the private sector. TeKrony and Egli (1991) published an excellent review article on the subject relating seed vigor and crop yield. It is very important to realize what aspect and to what extent claims can be made in regard to seed vigor. The seed industry would not prefer to make any claims in regard to what a vigor test may or may not indicate in relationship to yield. The seed industry has conducted research to measure vigor and field performance and uses this information internally to make decisions in regard to the usefulness of seed. Vigor information can be used to make decisions as to whether upgrading of a seed lot can and should be achieved or whether a seed lot should be sold.

Some have indicated that for a vigor test to be useful, it must have a high correlation coefficient with field performance. A good correlation coefficient in a research paper indicates some usefulness, but other things must be considered. Interpretations must be carefully made in regard to correlation coefficients. Some research work with high correlation coefficients to field performance have been conducted with untreated seed; but in the market place the seed is treated with a fungicide which greatly changes the relationship and the results. Research related to vigor and field performance must be viewed with caution.

Second, and probably a more important aspect of interpreting vigor test results, is accuracy. An excellent correlation coefficient may be achieved; however, if test results in the laboratory are 20 points higher than the emergence results in the field, such a correlation coefficient can be very misleading. A particular test may be designed to add additional stress to achieve worst-case conditions in the field, but when additional stress conditions are applied in the laboratory, the correlation coefficient may drop and the test may look undesirable based on statistics. Each seed company has a different objective with vigor test methods as opposed to standardization. An article by Burris and Navratil (1979) showed wide ranges in coefficient of variability (CV) and correlation coefficient related to vigor cold test stress conditions. The more the cold test stress, the higher the CV, and worse the correlation to field emergence. Some companies want a more stressful cold test, even if it brings a higher CV and lower correlation coefficient.

OTHER FACTORS IN VIGOR TESTING

Other factors can make an interesting challenge for us in vigor testing. Seed moisture can have a huge effect on final results. The moisture content of samples can change while in the lab awaiting testing and affect the outcome of vigor testing. Seed treatment amounts and types will affect the outcome of various vigor tests. We must be careful of what we are measuring: vigor or seed treatment. Pathological aspects can confound vigor

test's validity and change the results over time. We must guard against the relationship between the time when a vigor test is conducted relative to when the customer will plant the seed and the intended purpose of that vigor test. Vigor tests are used by industry quality control departments to estimate product life span and the time when follow up quality tests are needed. This aspect of vigor testing ensures that product arrives to the customer in top condition. The time factor in relation to vigor testing is very important.

MINIMUMS OF PERFORMANCE

One of the final challenges the seed industry faces is that of establishing acceptable minimums of performance. An 80% vigor test reading may be unacceptable to one company based on their methods, but acceptable to another company because their methods are more stressful. We also must consider geographical differences as it relates to vigor testing. For example, the cold test is good for use in the corn belt of the U.S., but in a more southerly climate it can be totally useless.

CONCLUSION

In conclusion, we must remember to keep seed vigor within perspective. We must remember that quality encompasses a list of many aspects. A seed company is concerned about genetic purity, physical purity, pathological contamination, plantability, and physiological aspects of the seed relating to germination, dormancy, and, last but not least, vigor.

The dilemma for the industry in relationship to vigor testing revolves around five aspects: standardization, education, communication of vigor information, inter-laboratory test uniformity, and vigor test results in inventory management. There is strong agreement between the public and private seed sectors in regard to vigor tests: the information is very useful. Vigor test information is added information that helps companies determine the fitness of seed lots for use and assess the degree of risk that a company may want to avoid in distributing seed lots. The industry uses vigor testing as a means to avoid problems with field performance and uses vigor information to make improvements in seed production and genetic quality which will lead to higher customer satisfaction. Companies rely on their own laboratories to be standardized. Or they use a single public lab to achieve repeatability. The system works. High quality seed is supplied to customers. Vigor tests are used to make improvements in the overall quality of seed in the market place.

REFERENCES

1. Association of Official Seed Analysts (AOSA). 1992. Seed Vigor Testing Handbook. Contribution No. 32 to the Handbook on Seed Testing.
2. Burris, J.S., and R.J. Navratil. 1979. Relationship between laboratory cold-test methods and field emergence in maize inbreds. Agron. J. 71:985–988.

3. Byrum, J.R., and L.O. Copeland. 1991. Confidence limits in vigor testing. Verbal presentation to Annual Meeting of Association of Official Seed Analysts.
4. TeKrony, D.M., and D.B. Egli. 1991. Relationship of seed vigor to crop yield: a review. Crop Sci. 31:816–822.