THE ISTA PERSPECTIVE OF SEED VIGOR TESTING

J.G. Hampton[1]

The 1950 International Seed Testing Association (ISTA) Congress in Washington D.C. saw vigorous debate and discussion about discrepancies in germination test results between European and American laboratories (the so-called "commercial" versus "agricultural" concepts of seed testing). It was also the meeting at which ISTA became officially involved with seed vigor. The Biochemical and Seedling Vigor Committee (later to become the Vigor Test Committee) was established to "define seedling vigor and standardize methods for its determination." The difficulty of this task is illustrated by the following:

- It took twenty-seven years for the Vigor Test Committee to agree on a definition of seed vigor, i.e. "...the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence." This broadly based definition was adopted by the 1977 ISTA Congress.

- The ISTA Rules for Seed Testing do not yet include vigor testing methods, although suggested procedures have been published in the ISTA Handbook of Vigor Test Methods, the first edition of which appeared in 1981 and the second in 1987.

Internationally there is generally agreement among seed testers and seed technologists (though not necessarily the seed trade) about the importance of seed vigor and the need for vigor testing. In a 1988 survey, 83% of ISTA stations affirmed that methods for vigor testing were needed to meet client demand (primarily nationally but also internationally), and 65% of these laboratories were carrying out vigor tests. Similar data were recorded from a further survey of ISTA stations in 1991, although there were also a small number of stations that reported no demand for vigor testing. The conductivity test for large-seeded legumes (*Pisum, Phaseolus, Glycine*) and the cold test for maize (*Zea mays* L.) were used by 50% of stations (1991 survey). The total number of samples tested for vigor per year was 18,000 for maize and 6,000 for large seeded legumes (1988 survey). Vigor tests for other species (cereals, other crop, horticultural, herbage, and tree seeds) totalled around 5,000 samples per year. Within individual laboratories, the number of tests per year varied from less than 10 to more than 1,500, with the type of test and number of seed lots tested being entirely dependent on client demand.

For nearly forty years the ISTA Vigor Test Committee has been engaged in trying to achieve the following objectives:

[1] Chairman, ISTA Vigor Test Committee; Massey University Seed Technology Center, Palmerston North, New Zealand.

- To examine the reproducibility of vigor test methods.

- To determine the relationship between vigor test results and seedling emergence in field soil.

The collaborative trials of the Vigor Test Committee (which began with the first report by Heydecker in 1962) led to the development of methodology for eight vigor tests. Results from these vigor tests often, but not always, correlated better with field emergence than the standard germination test. These trials also led to a greater realization and understanding of the problems involved in the standardization and reproducibility of different methods, particularly among stations where staff differed in experience and familiarity with the methodology. However, progress has been slow and unspectacular. In a 1990 review, my colleague Dr. Pete Coolbear and I questioned whether in fact any progress had been made at all, particularly as only one test for one species, the conductivity test for peas (*Pisum sativum* L.), appeared to us to have met the requirements to be accepted internationally as a vigor test. These requirements are:

- To provide a more sensitive index of seed quality than the germination test.

- To provide a consistent ranking of seed lots in terms of potential performance.

- To be objective, rapid, simple, and economically practical.

- To be reproducible and interpretable.

During the discussion following the Vigor Test Committee report at the 1962 ISTA Congress, the viewpoint of many delegates was that vigor tests were essentially for local use and could not be internationalized. This view has continued to be discussed at ISTA meetings, and there are many examples of single vigor tests or a combination of results from several vigor tests that have been successfully used in a local context for many years. The cold test for maize is of course the prime example. Other examples include the "expected field emergence" index (a function of germination), conductivity and hollow heart test results (used for 15 years in New Zealand by garden pea growers for determining sowing rates to achieve optimum plant populations), and a combination of cold test and aleurone tetrazolium test results (in accordance with Austrian legislation which requires that maize seed lots meet the standards for "bad weather resistance").

At the 1989 ISTA Congress, the Vigor Test Committee, after a review of the previous four decades of work, reached two important decisions with regard to vigor testing.

- "Internationally it will be possible to standardize those vigor tests which consistently rank seed lots in terms of their potential performance in the field or in storage."

The primary purpose of such tests will be to indicate to the seed purchaser, or seed store manager, whether or not trouble may be expected from a high germinating seed lot if the lot is placed under environmental stress in the field, seed store, or during transit. Single tests based on some aspect of germination behavior (e.g., accelerated aging, controlled deterioration, cold test) and the conductivity test show the most promise for this purpose.

- "Problems will arise internationally when testing is designed to produce an absolute vigor value, or an indication of expected field emergence, particularly because environments differ so greatly within and among countries."

Vigor tests designed to produce some index of expected field performance will not necessarily produce meaningful results internationally. However, the development of a range of methods shown to be useful under anticipated local conditions should nevertheless be encouraged. Such tests may have no applicability internationally and would not become part of an ISTA Vigor Test Committee program.

The 1992 ISTA Congress allowed the opportunity for further discussion as to the direction that the Vigor Test Committee should follow. Four objectives were set for the 1992-95 triennium. These are:

- To standardize those vigor tests which consistently rank seed lots in terms of their potential performance in the field or in storage (accelerated aging, conductivity, cold test).

- To develop a chapter on "Vigor Testing" for the ISTA Rules (specifically for the conductivity test and accelerated aging test).

- To produce a revised edition of the "Handbook of Vigor Test Methods".

- To promote international awareness of seed vigor and seed vigor testing.

I would now like to comment on three of those four objectives.

The standardization of methodology for the accelerated aging and conductivity tests is a realistic and achievable objective. Research by teams from the United States, Europe, Asia, and Australia has provided the data and refinement of technique required to allow the achievement of reproducible results. An important goal in this work is the standardization of methodology between ISTA and AOSA, and we have a team, ably lead by Professor Dennis TeKrony, who is actively working on this topic. I do not envisage too many problems in reaching this goal. Two questions probably have occurred to you. Why was controlled deterioration not mentioned in the objective, and why did I not include the cold test in the achievability of the objective? The members of the Vigor Test Committee believe that the

controlled deterioration test is superfluous, provided the accelerated aging test methodology takes account of initial seed moisture content; I will leave it to Dr. TeKrony to explain further. The committee also considers that the cold test, because of its use of field soil, cannot be internationally standardized. Nevertheless, because internationally the cold test is the most widely used vigor test, the committee will continue to work with the test. The leader of the cold test working group, Dr. Harry Nijenstein from the Netherlands, is currently formulating a program for this test.

The announcement of the second objective caused much comment, particularly from certain sections of the seed trade, but within ISTA the reaction is mostly "about time." ISTA's technical committees are charged with evaluating new scientific findings, particularly for seed testing methodologies, and introducing new principles, test conditions, species, and test methods into the appropriate chapter of the Rules. The Vigor Test Committee believe it is time to prepare a "Vigor Testing" chapter for the Rules, with the goal being to have a formal proposal ready to submit to the 1995 ISTA Congress. In the ISTA Rules, a chapter contains information on general principles, materials and apparatus, procedures, calculation and expression of results, and reporting results. The annex to each chapter contains more detailed methodology appropriate to any particular test. We believe we are in a position to prepare the necessary vigor chapter, but only propose to include two vigor test methods in the annex: the conductivity test and the accelerated aging test, both only for large-seeded legumes (*Pisum sativum*, *Glycine max,* and possibly *Phaseolus vulgaris* and *Vicia* spp.) As more data become available, other species may be added if appropriate. The committee is well aware that there is still information on expression of results and tolerances to be determined, but this topic is currently being addressed. The Vigor Test Committee does not envisage the addition of any other vigor test in the near future because of problems with standardization (e.g. the cold test) or major defects, problems or limitations with other tests. The purpose of introducing a seed vigor chapter into the ISTA Rules is twofold:

- To acknowledge the importance and significance of seed vigor.
- To give consumers access to further information about the performance potential of high germinating seed lots.

At a recent meeting between ISTA and the Federation Internationale des Semences (FIS), the FIS delegates voiced strong reservations about this proposal, mainly on the grounds that vigor test results would complicate trading and enable buyers to refuse seed lots. (Conversely, of course, vigor test results can also be used as a basis for purchasing seed lots!) However, it was also obvious that some delegates had a poor grasp of the meaning of seed vigor, and after explanation from ISTA President Don Scott, the meeting ended with a better acceptance of the idea. The FIS concern is a genuine one, and ISTA will work closely with FIS on this issue. It should be noted of course that seed vigor testing is not compulsory. The presence of a Vigor Test Chapter in the ISTA Rules will provide

the assurance that a vigor test (if requested), has been carried out using internationally standardized methodology. A direct comparison can be made with other aspects of seed quality that have special chapters in the ISTA Rules (e.g. seed moisture testing and seed health testing).

Through recent ISTA surveys, and as a result of FIS perceptions, it is evident that internationally there is a poor understanding of seed vigor and its implications. This is hardly surprising, considering the length of time it has taken us to develop reliable tests, and the fact that as seed production researchers, we still know very little about what we do wrong during production to lower seed vigor. The Vigor Awareness working group of the Vigor Test Committee, under the able and enthusiastic leadership of Professor Albie van de Venter from South Africa, is currently launched into a program of promoting international awareness of seed vigor and vigor testing.

In summary, the current ISTA perspective of vigor testing is as follows:

- The germination test remains the principal and accepted criterion for seed viability.
- A germination test result less than an acceptable standard (e.g. 90% for temperate herbage grasses) usually indicates seed deterioration and hence by itself is a strong indication that seed lot performance is likely to be poor.
- Vigor testing (when requested) should be used to provide further information on the potential performance of high germinating (greater than or equal to 90%) seed lots. This performance may relate to field emergence and/or storage behavior.
- It will be possible to standardize internationally only those vigor tests that consistently rank seed lots in terms of their potential performance in the field or in storage.
- Vigor tests designed to produce some index of expected performance will not necessarily produce meaningful results internationally, and are therefore unlikely to be included in the ISTA Rules.
- Vigor tests which are accepted into the ISTA rules must have been shown to be able to produce consistently reproducible results, will not be compulsory, will not provide a planting or storage index, but will be capable of ranking seed lots, allowing better informed decisions to be made regarding sowing, transit, and storage.

In concluding, I thank AOSA and the organizers of this symposium for the invitation to talk to you today, and sincerely thank both AOSA and ISTA for the financial support that made my trip possible.