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Rapid Methods for Estimating Germinability

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RAPID METHODS FOR ESTIMATING GERMINABILITY

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Seedsmen are showing enthusiastic interest in methods and techniques for rapidly determining seed viability. They see in these "quick-test" methods the tools for increasing operational efficiency and minimizing risks.

It is not an uncommon occurrence that a seedsman buys a lot of seed, runs the lot through expensive conditioning and cleaning operations only to find, several weeks later, when a seed analysis report arrives, that low germination renders the seed almost worthless. An alternative to the above procedure is to not condition the seed and wait for the germination report. A simple, fairly accurate method for rapidly estimating viability would provide a much better solution to this problem.

Attempts at rapidly estimating the viability of seeds goes back more than three quarters of a century. In 1901, Waller (10) reported on an electrical method for determining viability of seeds. He demonstrated that viable seeds when subjected to an electrical current gave so-called "blaze currents" which could be measured galvanometrically. Dead Seeds reacted differently to the treatment. Subsequent work on Waller's method showed that the technique was fairly reliable but very time consuming and required considerable technical competence.

The use of electrical methods for estimating seed viability took a somewhat different turn in the work of Hibbard and Miller (5). Their experiments were based upon the premise that non-viable seeds were more permeable than live seeds, hence, electrolytes leached out of dead or aged seed more rapidly. By soaking a quantity of seeds in water or a dilute solution of potassium permanganate and measuring the electrical resistance of the soaking solution, they were able to estimate germinative capacity of seeds with some accuracy (Figure 1A). Electrical resistance varied directly with viability.

Electrical conductivity techniques have shown considerable promise in rapidly estimating viability. Agro-Sciences, Inc., Ann Arbor, MI, developed an instrument (ASA-610) which has the capability of measuring the current flow in "soak" water of individual seeds (Figure 1B). In recent work at Mississippi State University (6), a

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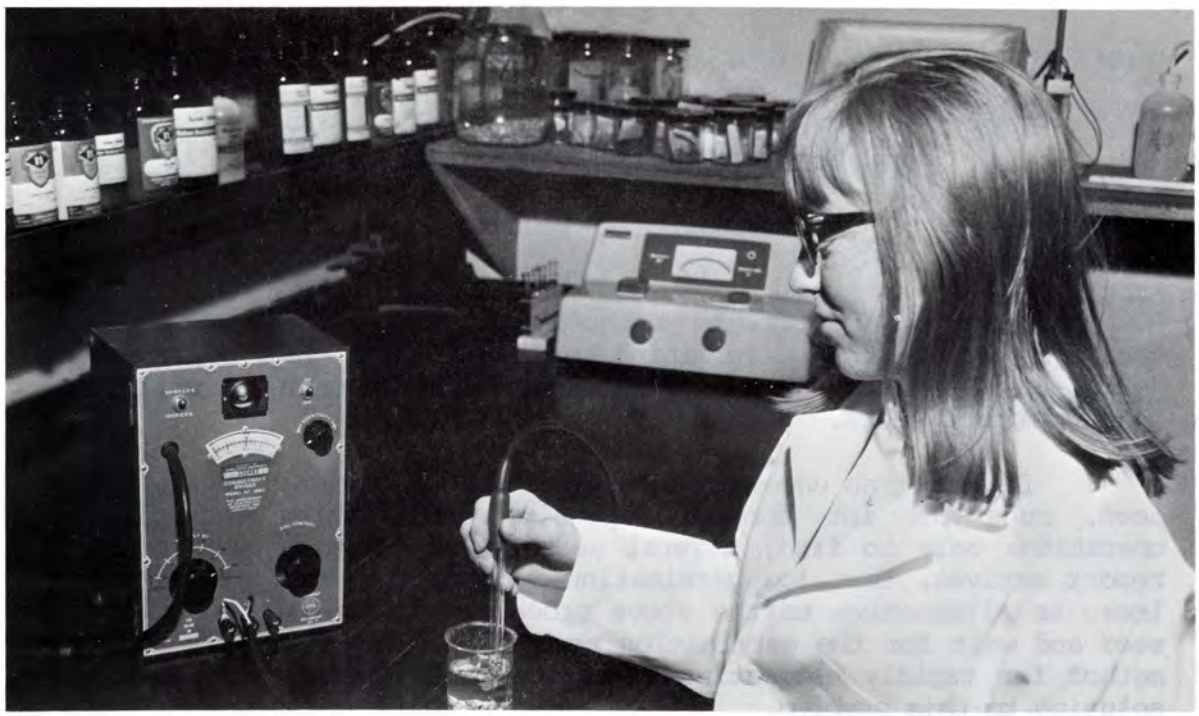

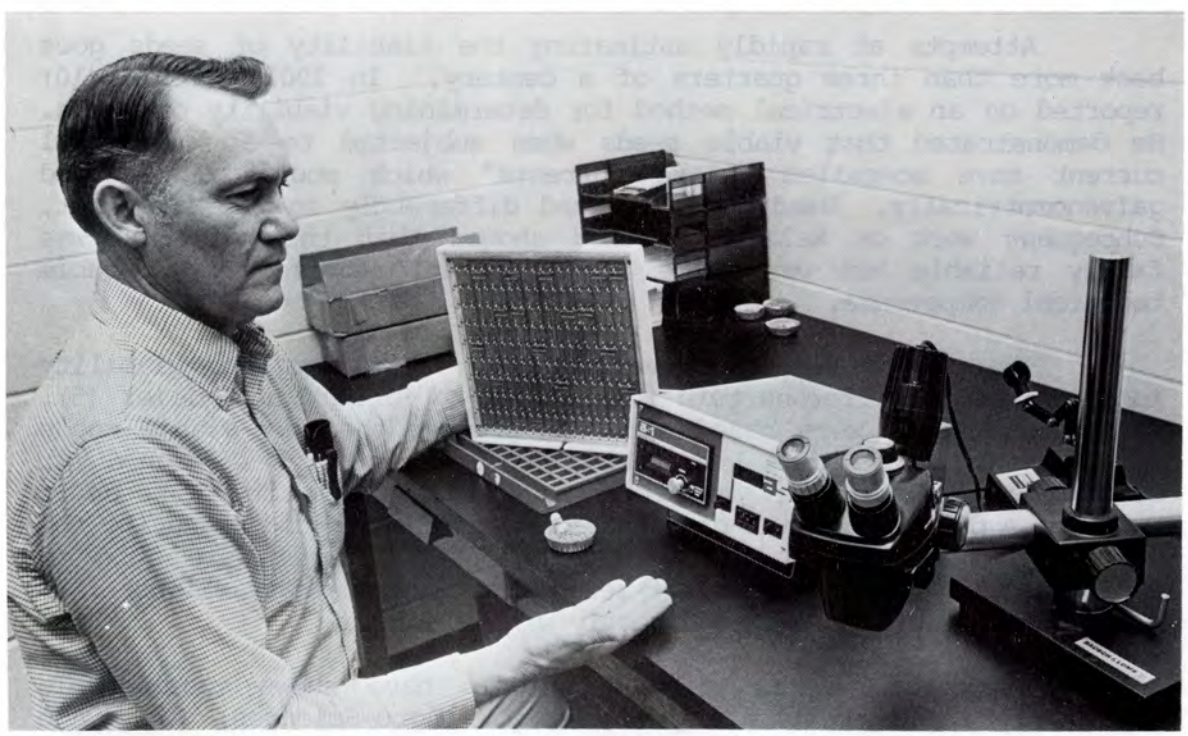

Figure 1. (Above) Measuring the electrical conductivity of the seep water from one seed lot. (Below) The ASA 610 apparatus permits determination of seep water conductivity of up to to 100 individual seed with each loading.

comparison of predicted germination and standard germination percentages was made for more than 100 lots of soybean seed. Predicted germination was within ± 10% of standard germination for slightly over 60% of the lots. Since over and under estimates of standard germination occurred with about equal frequency, use of the ASA-610 for assessing the quality of incoming soybean seed lots would result, on the average, in acceptance of lots of unacceptable quality, or discard of lots with acceptable quality in 4 out of every 10 cases.

Darsie et al. (3) based their approach to rapid viability testing on a phenomenon long known to physiologists, i.e., that germinating seeds liberated heat. They placed moist seeds in silvered Dewar flasks and measured heat production. Heat production was directly correlated with viability and vigor. For example, they found that the normal daily heat yield of 10g barley was 0.88°C and suggested that abnormally high heat yields resulted from contamination by fungi, that abnormally low heat yields were attributable to low viability and vigor.

It has long been known that temperature has great influence on the rapidity of germination. For most kinds of non-dormant seeds there is a temperature range over which final germination percentages are equivalent, however, within this range the higher temperatures promote more rapid germination.

Delouche (4) reported that germination tests of corn and soybeans carried out at 30°C could be terminated two or three days sooner than at the recommended 20°-30°C temperature and without reduction in accuracy. Also, reversing the temperature recommended for watermelons from 20°-30° to 30°-20°C (30° for 16 hours, 20° for 8 hours) allowed a four to five day reduction in test period.

Presoaking seeds in water prior to the germination test reduces, in some cases, the time required for the test (2). Moore (7) found that soaking cotton seed in a dilute soapy solution increased the rapidity of germination. Cotton seed germination can be determined in two to three days with fair accuracy by presoaking the seeds for several hours and germinating them at 30°C.

Seed buyers have traditionally based many of their decisions on the visual appearance of the seed under consideration. Certain characteristics affecting seed quality such as insect damage, mechanical damage, weathering, presence of weed seed and trash are easily evaluated by this method. It has also been determined, however, that more subtle characteristics are also related to or associated with seed quality, especially, seed viability. One of these characteristics is seed color. The possible use of seed color in red clover, white clover and crimson clover as an index of viability has been investigated. In general, dark colored (brown or rust) seeds of these crops were found to be low in germinability and vigor. The proportion

of brown seeds in crimson clover was as high as 30%. Germination of the brown seeds was less than half that of the natural, straw colored seeds. These results indicate that with further development, seed color might serve as a rough index of seed viability.

Another test that provides a great deal of information about the viability of seed is the cutting test for cotton. When cotton seeds are split in half the embryo can be evaluated. The visual appearance or condition of the embryo provides a basis for judging the viability of individual seeds. The evaluation is based on the color of the embryo, the percentage of seed units completely filled and the number of immature seed found in the sample. The test is reliable and provides a lot of supplemental information.

Rate of seed swelling (water absorption) of small seeded legumes appears to be consistently and directly related to viability (8). It is also a very easily evaluated characteristic. Seeds are placed on moist blotters at 20^0C and the number of seeds swollen after various time intervals is determined. Seeds swollen at the end of one hour were generally dead. Seeds of white and red clover swollen by two hours were also very low in viability. With further refinement, rate of seed swelling has considerable potential as an index of viability even though it can probably never be applied with the precision of the tetrazolium test.

Several useful modifications of basic radiographic procedures have been developed for medical purposes. With little technical change, these procedures can be applied to seed research and to rapidly viability testing. They are, however, most useful in evaluating the difficult-to-germinate tree seeds. One such technique is tomography (9).

Tomography is a non-destructive X-ray technique for obtaining an image of any preselected plane with the specimen. Unlike a radiography, which is an image of all planes superimposed, a tomogram is an image of a single plane; it is similar to a photograph of a microtomed section. Tomography offers particular advantages to plant anatomists and physiologists because it is non-destructive. The same seed can be studied and then germinated.

Perhaps the tetrazolium test (Figure 2) is the most widely used and accurate method of rapidly estimating germinability. The test has been available since the mid-1940's and is relatively simple. The seeds are properly prepared, placed in a small beaker or other container, and covered with a solution of the chemical. After a period of time, they are removed and examined for the amount and pattern of staining. Proper interpretation of the color reaction provides a quick estimate of the viability of the seed.

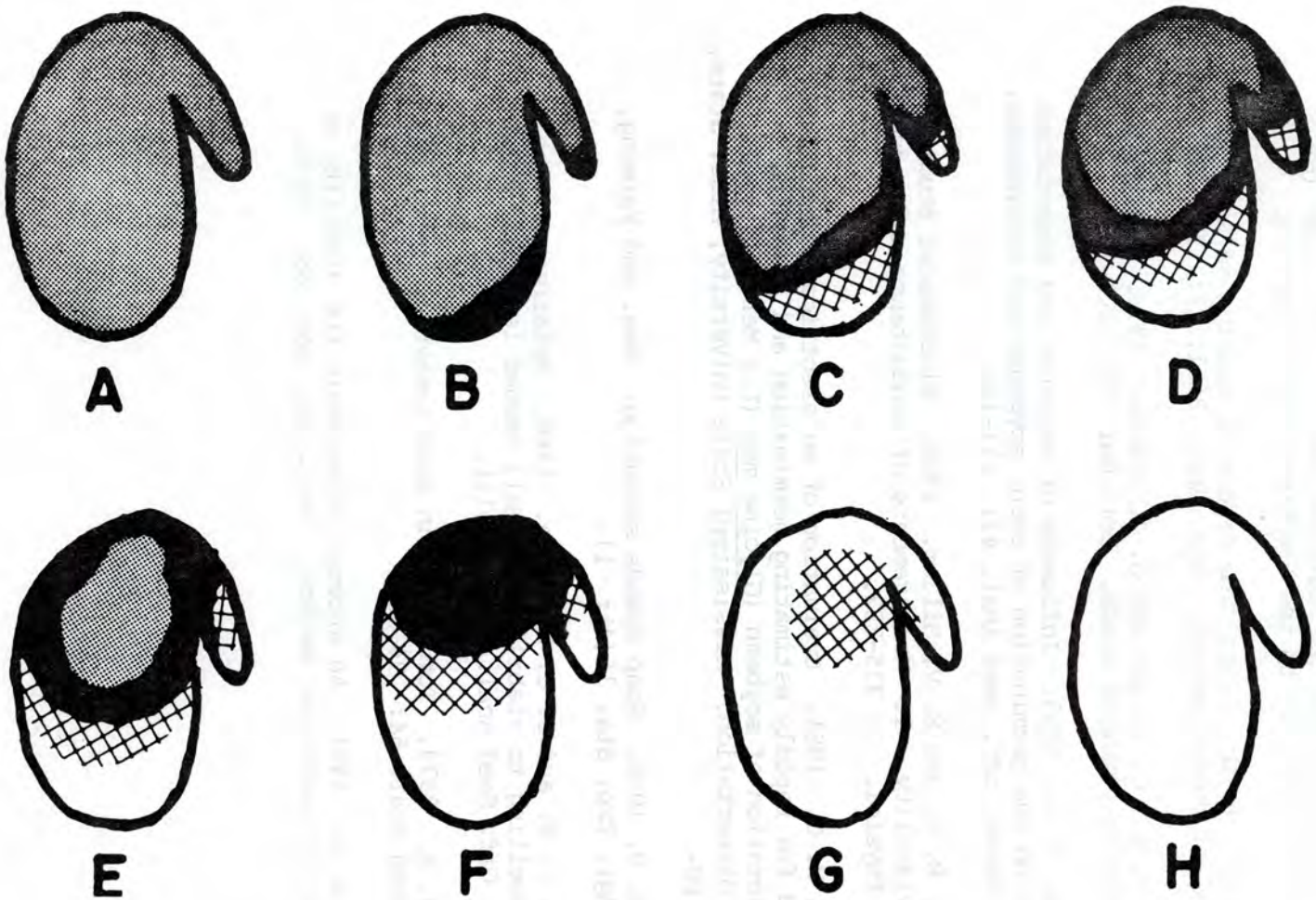

Figure 2. Pattern of deterioration in crimson clover seed as manifested in tetrazolium test reactions. Fine stippled areas represent normal, cherry red stains; black areas represent abnormal, dark purple stains; cross-hatched areas represent milky or cloudy red stains; white areas represent absence of stains.

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