Seed QUALITY TESTING OF NATIVE SPECIES

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ABSTRACT

Testing native seed quality before planting cannot be overemphasized. Planting high quality seeds is the cornerstone for successful field emergence. The increasing use of seed certification for native species further emphasizes the need for accurate seed testing. Our objective in this article is to provide a summary of principles and procedures for some useful seed quality tests for natives and other species. Testing for physical purity and viability of seeds are the two most important tests needed to avoid weed problems and poor stand establishment. Other seed quality tests such as vigor tests, x-ray, and seed moisture content provide useful information about the quality of the seeds.

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NOMENCLATURE
USDA NRCS (2005)

Planting seeds with high levels of viability, physical purity, and freedom from noxious weed seeds increases the probability of successful establishment. Seed quality of native species, especially wild collections, can be uncertain on account of environmental conditions during seed development and maturation. Even when native seeds are produced under controlled-management practices, they may still have potential quality issues such as physical purity, viability, dormancy, and vigor.

Factors that may affect native seed quality are stage of maturation at harvest (Figure 1) and methods of harvesting, drying, cleaning, and storage (Elias and Copeland 1994). Seed testing can assess the effect of such factors on quality and determine the true value of the seeds for planting.

Seed testing is necessary for labeling and certification that require determination of the percentage of pure seeds, weed or other crop seeds, and inert mat-

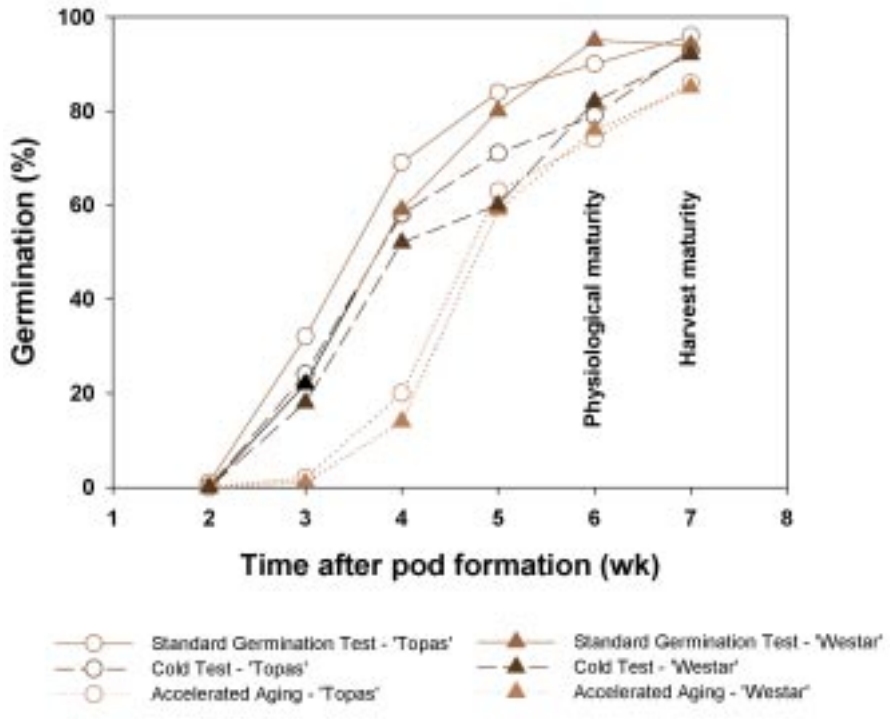

Figure 1. The effect of seed maturation stage on seed quality of 2 *Brassica napus* cultivars ('Topas' and 'Westar') as measured by standard germination test, cold test, and accelerated aging test.
Adapted from Elias and Copeland (2001)

ter as well as the viability level in each sample. Most important, seed testing provides useful information to seed producers and buyers about the quality of seeds for marketing and restoration decisions.

USEFUL TESTS FOR NATIVE SEEDS

The demand for native seeds has increased in the last few years. Table 1 shows many native species from various states that have been tested at Oregon State University Seed Laboratory. Among the challenges of testing native seeds are the nature of the seeds themselves (for example, very small, morphological similarity among species, attached appendages, hard seed coat, and so on); sample impurities due to insufficient cleaning; high dormancy levels; and the lack of seed testing procedures for some species. For you to obtain meaningful test results, a submitted sample should be truly representative of the seedlot from which it is drawn. The following seed quality tests are particularly useful for native species.

Purity Test

The objective of a purity test is to detect and quantify the presence of contaminants, including weed seeds, other crop seeds, and inert matter in a seed sample. This test includes the All State Noxious Weed Exam (an exam for any of the noxious weed seeds listed by all the states). According to the Association of Official Seed Analysts (AOSA 2004), a minimum sample size of 2500 seeds is required for the purity test, and 25 000 seeds for the noxious weed exam. An Ergovision Microscopic Station (EMS) is used in some modern laboratories for purity testing and noxious weed exam. The EMS assists with seed inspection by using advanced optical systems combined with high quality illumination to provide optimum resolution views of small seeds. It also has a mechanical seed feeder to provide uniform continuous seed flow with controls for speed, stop, and start. The station has a tilt-adjustable microscope to fit the body position and height of the analyst. This ergonomic feature reduces neck and back pains that are typical in the traditional hand lens and purity board system. The seed certification program in each state determines minimum quality standards for the physical purity of various native species.

Standard Germination Test

This test determines the percentage of viable seeds in a sample that have potential to germinate and produce normal seedlings under favorable conditions. The standard germination test is conducted by planting four 100-seed replicates on moistened blotter or appropriate media (in plastic boxes or germination trays). Seeds are incubated under optimum temperature and light conditions for a period of time (for example, 14 d) depending on the species. At the end of the test period, seedlings with healthy root and shoot systems are counted as the percentage of germination. Methods of testing for laboratory germination of various species are listed in Table 3 of the AOSA Rules for Testing Seeds (AOSA 2004).

Because of dormancy in many native seeds, a germination test alone may not ascertain whether the nongerminated seeds are dead or dormant. A tetrazolium test (see description below), which determines the viability of seeds based on the respiration enzymatic activity (that is, dehydrogenases), may be needed to answer this question. Nongerminated seeds remaining at the end of the germination test period may be examined by the TZ test to determine whether they are dead or dormant (AOSA 2004). We use the following equation (which is not part of AOSA Rules) to estimate the percentage of dormant seeds in a sample: % TZ test result – % standard germination test result = % dormant seeds. The seed certification program in each state deter-

TABLE 1

Tetrazolium test results (percentage viable seed) of some of the native and uncommon species tested at the Oregon State University Seed Laboratory.

Species	Family	Viability (%)
alkaligrass (*Puccinellia* Parl.)	Poaceae	92
balsamroot (*Balsamorhiza* Nutt.)	Asteraceae	42
Wyeth biscuitroot (*Lomatium ambiguum* (Nutt.) Coult. & Rose)	Apiaceae	70
bitterbrush (*Purshia* DC. ex Poir.)	Rosaceae	67
buckthorn *(Frangula* P. Mill)	Rhamnaceae	95
buttercup (*Ranunculus* L.)	Ranunculaceae	76
coneflower (*Ratibida* Raf.)	Asteraceae	85
honeysuckle (*Lonicera japonica* Thunb.)	Caprifoliaceae	83
elderberry (*Sambucus* L.)	Caprifoliaceae	90
figwort (*Scrophularia* L.)	Scrophulariaceae	82
foxglove (*Digitalis* L.)	Scrophulariaceae	43
gumweed (*Grindelia* Willd.)	Asteraceae	93
huckleberry (*Vaccinium ovatum* Pursh)	Ericaceae	93
iris (*Iris* L.)	Iridaceae	93
mannagrass (*Glyceria* R. Br.)	Poaceae	82
mountain ash (*Sorbus* L.)	Rosaceae	92
mulatto/signalgrass (*Brachiaria* (Trin.) Griseb.)	Poaceae	55
needlegrass (*Stipa breviflora* Griseb.)	Poaceae	76
penstemon (*Penstemon cinicola* Keck)	Scrophulariaceae	86
sagebrush (*Artemisia* L.)	Asteraceae	81
saltbush (*Atriplex* L.)	Chenopodiaceae	33
scorpionweed/popcornflower (*Plagiobothrys* Fisch. & C.A. Mey.)	Boraginaceae	68
sloughgrass (*Beckmannia* Host)	Poaceae	79
snowbrush (*Ceanothus velutinus* Dougl. ex Hook.)	Rhamnaceae	90
Yampah (*Perideridia* Reichenb.)	Apiaceae	81
Yarrow (*Achillea* L.)	Asteraceae	95

mines minimum quality standards for germination of various native species.

Tetrazolium Test (TZ)

This test is a reliable, quick biochemical viability test that determines the percentage of live seeds in a sample based on the pattern of staining within seed tissues (Table 1 and Figure 2). The procedure for conducting the TZ test includes: 1) hydrating seeds to activate the dehydrogenase enzymes; 2) cutting or puncturing the seed coat to allow the TZ solution into the internal seed tissues; 3) staining seeds in a TZ solution (0.1% to 1%) for a period of time as indicated in the AOSA TZ Handbook; and 4) evaluating seeds (viable tissues will stain red while dead tissues remain nonstained). The TZ test is not influenced by the dormancy level of the seeds and takes only 24 to 72 h as compared with 2+ wk for germination tests. A combination of TZ and germination tests provides better information on the planting value of a seedlot and the percentage of dormant seeds than the germination test alone.

Seed viability determined by the TZ test instead of the standard germination test is acceptable by the seed certification programs in some states. This is mainly because conducting the standard germination test is difficult in some native species due to a dormancy problem or lack of germination procedures in the AOSA rules.

X-ray Test

The x-ray test is used to detect abnormalities in the internal tissues of seeds, such as empty or immature seeds, insect infestation, or internal damage. It is used especially for seeds with hard coats, glumes, shells, and similar struc-

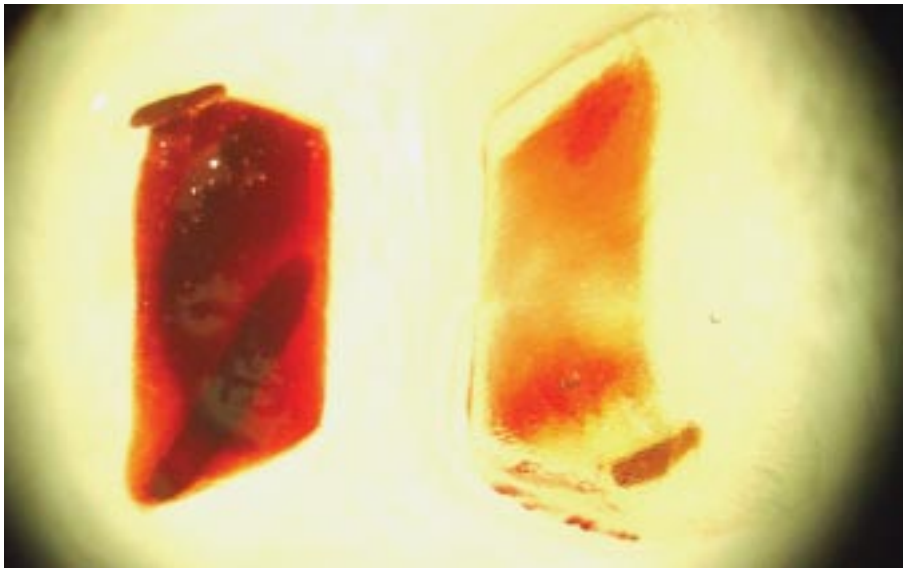

Figure 2. The TZ test is a quick biochemical viability test to determine the percentage of live seeds in a sample based on the pattern of staining. Viable (left) and nonviable (right) biscuitroot (*Lomatium* spp. Raf. [Apiaceae]) seeds.

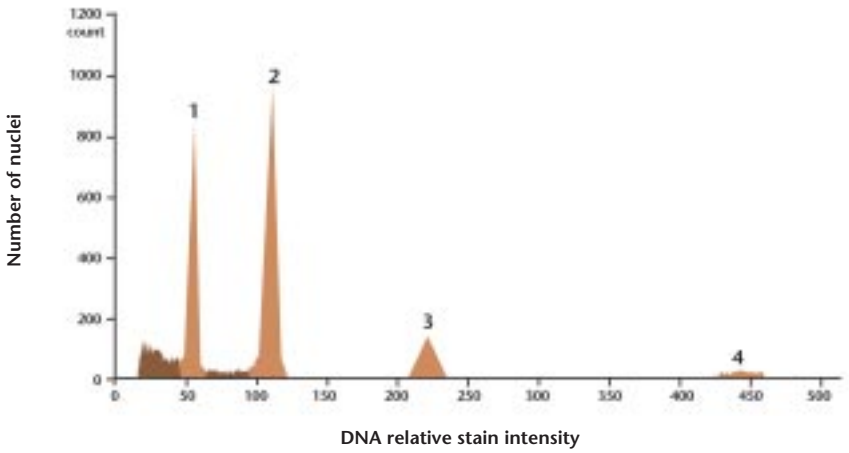

Figure 3. A sample that has a mixture of diploid and tetraploid ryegrass as detected by a flow cytometer. Courtesy of Oregon State University Seed Laboratory.

tures that do not allow observation of the internal tissues without damaging the seeds. This test can be done within 24 h. The main principle of x-ray testing is that different seed tissues absorb x-rays (electromagnetic waves) to varying extents depending on the thickness and (or) the density of the seeds. Thus, a visible image of varying shades of light and dark, depending on the internal structure of each seed is created on a film. The results are then interpreted by a seed analyst. Low energy x-rays (longer wavelengths) are suitable for seeds.

Seed Moisture Content

This test determines the percentage of moisture in seeds. Moisture influences seed storage potential, shipment, viability, and vigor levels over time. This test can help in determining the appropriate harvest time. As seeds mature, they lose moisture and will reach an appropriate moisture content that is safe for mechanical or manual harvest. Harvesting at optimum seed moisture content contributes to better yield and seed quality. The moisture content of a sample is the loss in weight when it is dried. It is expressed as a percentage of the weight of the original sample and is calculated based on the fresh weight of the seeds. Detailed procedures for various crops are described in the International Seed Testing Association Rules, Chapter 9 (ISTA 2003).

Vigor Tests

The objective of vigor tests is to assess the potential of seeds to produce normal seedlings under a wide range of field conditions. Vigor tests are especially useful for carryover seeds (old seeds), weather-damaged seeds, and to compare seedlots with different quality levels. This group of tests is recommended as they provide additional useful information about seed quality; however, they are not required for certification. Examples of vigor tests are cold, accelerated aging, and electrical conductivity tests. In general, vigor test results may be more closely associated with field emergence than the standard germination test, which is conducted under optimum germination conditions of moisture and temperatures that may not occur in the field.

Cold Test

A cold test indicates the potential field emergence under cold, wet conditions, as can occur in the early spring. Seedlots, collections, or varieties may have different tolerance levels for various cold conditions. The procedures involve planting seeds in wet soils and exposing them to a low temperature (for example, 5 to 10 °C [41 to 50 °F]) for a period of time (for example, 7 d), then transferring them into warm temperature (for example, 20 to 25 °C [68 to 77 °F]) for final germination. Evaluation of seeds that germinate and produce normal seedlings is made after a specified time (for example, 7 to 14 d). The ability

of seeds to germinate in cold, wet soils is affected by heredity, physiological conditions of the seeds, and mechanical damage (AOSA 2002). The cold temperature, the period of exposure, and the warm temperatures vary from species to species.

Accelerated Aging Test

The principle of this test is that seeds are stressed with high temperature and humidity for a period of time prior to germination. High quality seeds tolerate such conditions better and produce normal seedlings (AOSA 2002).

Electrical Conductivity Test

The principle of this test is based on the fact that poor or degenerated membrane structure and leaky cells are usually associated with deteriorating and low-vigor seeds. High conductivity readings indicate high electrolyte leakage and low-vigor seeds (AOSA 2002).

Ploidy by Cytometry

Seeds can be tested to differentiate between species with various ploidy levels (that is, diploid, tetraploid, hexaploid, and so on). It determines the ploidy level by measuring the nuclear DNA in plant cells using a flow cytometer (Figure 3).

The Grow-out Test

This test is used to differentiate between various genotypes that may have similar seed morphology. It involves growing and evaluating seedlings and plants in a controlled uniform environment, such as a greenhouse and (or) growth chamber. Morphological differences such as flower colors, shape and color of leaves, coleoptile or stem color, head formation, and so forth are used to differentiate among species (Figure 4).

CONCLUSION

Seed testing represents an important component in today's seed production and marketing systems. It ensures meeting specific quality standards that may be required by various seed certification programs. It is also required for labeling to prevent misrepresentation of seeds. More than one test may be needed to provide information about various physical, biochemical, and physiological aspects of seeds.

Photo courtesy of Oregon State University Seed Laboratory

Figure 4. The grow-out test clearly distinguishes between annual and perennial ryegrass types.

REFERENCES

[AOSA] Association of Official Seed Analysts. 2002. Seed vigor testing handbook. Las Cruces (NM): Contribution No. 32.

[AOSA] Association of Official Seed Analysts. 2004. Rules for testing seeds. Las Cruces, NM.

Elias SG, Copeland LO. 1994. The effect of storage conditions on canola seed quality. Seed Technology 18(1):21–29.

Elias SG, Copeland LO. 2001. Physiological and harvest maturity of canola in relation to seed quality. Agronomy Journal 93:1054–1058.

[ISTA] International Seed Testing Association. 2003. Rules for seed testing. Seed Science and Technology 31.

[USDA NRCS] USDA Natural Resources Conservation Service. 2005. The PLANTS database, version 3.5. URL: http://plants..usda.gov (accessed 12 Dec 2005). Baton Rouge (LA): National Plant Data Center.

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