Plant Materials Technical Note No. 7

The Importance of Seed Quality for Natural Resource Conservation Practices
Acknowledgements

Issued April 2022

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Suggested citation:


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Preface

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the evaluation of conservation plants and planting technology for more than 80 years. The Plant Materials Program releases plant material for use in conservation applications. The quality of seed and plant materials is maintained through seed certification programs. This technical note provides some basic seed quality facts and information regarding seed certification. Appendix A is a quick reference guide to seeding calculations with examples.

For additional information on specific species of plants mentioned in this publication, please see the USDA PLANTS database at: (http://plants.usda.gov/java/) or contact the nearest Plant Materials Center or plant materials specialist (http://plant-materials.nrcs.usda.gov/contact/). Additional technical resources on the National Plant Materials Program Web site at: (http://www.plant-materials.nrcs.usda.gov/).
Introduction

Seed quality is a paramount consideration in all facets of agronomy; whether establishing a field of wheat or growing wildflowers for native plant gardens. It is a complex issue encompassing broad concerns including vigor, dormancy mechanisms, pests, pathogens, genetic integrity, costs, and physical characteristics among others. The effectiveness of conservation practices with a plant component depends on choosing the right plant(s), using high quality seed and successfully establishing those plants.

Seed quality is described with physical and physiological factors (McDonald, 1996). Physical factors of seed quality are primarily concerned with the logistics of seed production and include both purity and genetic integrity. High quality seed production requires years of in-depth planning and meticulous attention to concerns such as proper labeling, field maintenance to prevent contamination with weeds or unwanted seed, isolation distances to prevent cross pollination and seed cleaning technologies. Physiological factors include germination rate and seed vigor. These factors may be controlled or influenced by the plant breeder.

Seed quality and the seed trade are regulated by federal and state agencies to protect buyers from contaminated or defective seed. The Federal Seed Act (FSA) is a truth-in-labeling law that regulates the labeling of seed in interstate commerce. The FSA is enforced with the aid of State seed control programs as authorized under cooperative agreements between State Departments of Agriculture and USDA’s Agricultural Marketing Service. Seed quality of a particular seed lot (a designated quantity of seed uniquely identified by a lot number) is evaluated by examining the seed labels required to accompany the lot.

Highlights

• Federal and state agencies regulate the seed trade to protect buyers from contaminated or defective seed.
• To ensure the planting meets the seeding rate recommendation of NRCS Conservation Practice Standards and Implementation Requirements, always purchase and use seed based on pure live seed (PLS) (p.7). High PLS usually indicates high quality seed.
• Always obtain a seed label (sometimes called the “tag”) with your purchase.
• Request a seed analysis report if weed seed is identified on the label. Remember, noxious weed species vary by state and year.
• Certified seed is recommended for NRCS conservation practices. High seed quality should be the primary consideration when purchasing seed.

Figure 1: A seed mix loaded into a seed drill hopper.
Seed Labels

All seed purchases must be accompanied by labels with a current analysis for purity and germination (Figure 2). State laws vary but in general, grass, forb and legume seed tests should be updated every 9-18 months. Flower, shrub and tree seed tests should be updated every 9 months.

**Purity** specifies the percentage of the lot that is the desired seed, rather than other seed or inert matter. Inert matter includes broken seed, chaff, other plant materials or seed coating material, which is primarily a mineral such as limestone, gypsum, pumice, or mica, combined with a polymer to bind the material to the seed. Ingredients such as fungicide, fertilizer, colorant, and inoculant are often included with the coating. **Germination** indicates the percentage of seed that is live and capable of germinating. Sometimes germination percentage is determined with a tetrazolium (TZ) test in the lab (Figure 2). In this case, the label will list TZ rather than germination. Some species produce dormant (hard) seed, which means that the seed is alive, but germination may be delayed. The percentage of dormant seed is indicated on the label as applicable.

**Weeds**

**Noxious weed species vary by state.** USDA’s Agricultural Marketing Service updates and publishes federal and state listed noxious weeds **annually** (Figure 3). Seed lots must meet the regulations of the state where it is sold. By law, seed that comes from a state that has less restrictive weed lists must meet the more restrictive requirements of the receiving state. There are two types of noxious weeds, **prohibited** and **restricted**. Seed lots cannot be sold when they contain any prohibited noxious weed seeds. There should be no prohibited noxious weeds in seed lots. The name and number of seeds per pound of any restricted noxious weeds must be listed on the label. Restricted weed seeds must be below the threshold set for the State.

The FSA does not limit the percentage of weed seeds in a seed lot but does require truth-in-labeling as it pertains to weed seed content. Request a seed analysis report if weed seed is indicated on the seed label even if the label indicates “no noxious found” as in figure 2. The report will identify the species of weed seed in the lot (Figure 4). Even if a particular weed is not regulated as noxious, it can become problematic. The fewer weed seeds the better.

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Figure 2: A seed label for ‘El Reno’ sideoats grama showing purity and germination (TZ = by tetrazolium test).
### 2022 State Noxious-Weed Seed Requirements Recognized in the Administration of the Federal Seed Act

**ALASKA**

<table>
<thead>
<tr>
<th>Prohibited</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common name</td>
<td>Scientific name</td>
</tr>
<tr>
<td>Birdseed, field</td>
<td>Convolvulus arvensis</td>
</tr>
<tr>
<td>Fieldcress, Austrian</td>
<td>Rorippa austriaca</td>
</tr>
<tr>
<td>Galinsoga</td>
<td>Galinsoga parviflora</td>
</tr>
<tr>
<td>Hawkweed, orange</td>
<td>Hieracium aurantiacum</td>
</tr>
<tr>
<td>Hempnettle</td>
<td>Galeopsis terrahit</td>
</tr>
<tr>
<td>Horsetail</td>
<td>Solanum carolinense</td>
</tr>
<tr>
<td>Knapweed, Russian</td>
<td>Centaurea repens</td>
</tr>
<tr>
<td>Lettuce, blue flowering</td>
<td>Lactuca pulchella</td>
</tr>
<tr>
<td>Loosestrife, purple</td>
<td>Lythrum salicaria</td>
</tr>
<tr>
<td>Quackgrass</td>
<td>Elymus repens</td>
</tr>
<tr>
<td>Sowthistle, perennial</td>
<td>Sonchus arvensis</td>
</tr>
<tr>
<td>Spurge, leafy</td>
<td>Euphorbia esula</td>
</tr>
<tr>
<td>Thistle, Canada</td>
<td>Cirsium arvense</td>
</tr>
<tr>
<td>Whitecaps and its varieties</td>
<td>Cardaria draba or Cardaria pubescens or Lepidium latifolium</td>
</tr>
</tbody>
</table>

Alaska law prohibits the shipment of agricultural seed containing any prohibited noxious-weed seeds.

<table>
<thead>
<tr>
<th>Restricted</th>
<th>Scientific name</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common name</td>
<td>Scientific name</td>
<td>Limitations</td>
</tr>
<tr>
<td>Bluegrass, annual</td>
<td>Poa annua</td>
<td>90 per pound</td>
</tr>
<tr>
<td>Buckwheat, wild</td>
<td>Polygonum convolvulus</td>
<td>2 per pound</td>
</tr>
<tr>
<td>Blueburr</td>
<td>Lappula echinata</td>
<td>18 per pound</td>
</tr>
<tr>
<td>Mustard</td>
<td>Brassica juncea or Brassica kaber</td>
<td>36 per pound</td>
</tr>
<tr>
<td>Oats, wild</td>
<td>Avena fatua</td>
<td>7 per pound</td>
</tr>
<tr>
<td>Plantain, buckhorn</td>
<td>Plantago spp.</td>
<td>90 per pound</td>
</tr>
<tr>
<td>Radish</td>
<td>Raphanus raphanistrum</td>
<td>27 per pound</td>
</tr>
<tr>
<td>Toadflax, yellow</td>
<td>Linaria vulgaris</td>
<td>1 per pound</td>
</tr>
<tr>
<td>Vetch, tufted</td>
<td>Vicia cracca</td>
<td>2 per pound</td>
</tr>
</tbody>
</table>

Agricultural seed sold or offered for sale within the State of Alaska shall be labeled to show the name and approximate number per pound of each kind of restricted noxious-weed seeds.

*Figure 3: The 2022 prohibited and restricted noxious weed seed requirements for the state of Alaska.*
Figure 4: A seed analysis report for alkali sacaton. Purity and germination percentages are highlighted along with the date of analysis.

**Pure Live Seed**

Pure live seed (PLS) is the amount of germinable seed and is calculated by multiplying purity and germination (including dormancy and hard) percentages. Pure live seed calculations for seeding rates are the same for coated or uncoated seed. Most native seed are sold on a PLS basis because of inherent variability in germination and purity. Non-native, cool-season turf-type grasses (fescues, orchardgrass) and agronomic seed (oats, rye) are typically sold by bulk pounds as long as they meet the germination and purity minimums regulated by the FSA. Pre-mixed seed blends designed for particular purposes such as pollinator or wildlife habitat plantings are often sold on a bulk pound basis instead of a PLS basis. Buying seed blends on a bulk pound basis is a risky proposition because of the potential to purchase unwanted species or poor-quality seed that fails to meet the planting objective. Purchasing seed as individual species lots and mixing them prior to planting achieves better results. Always purchase and use seed based on a PLS basis to ensure the planting meets the seeding rate recommendation of the NRCS Conservation Practice Standards and Implementation Requirements.
Using the Seed Label to Evaluate Seed Quality

High PLS usually indicates high quality seed. To calculate PLS, in figure 4, the purity of the alkali sacaton is 99.8%. Germination includes the percentage of dormant and hard seed. The germination percentage is 89.0% + 0% dormant seed + 0% hard seed. Appendix A is a quick reference sheet with additional information and examples for seeding rate calculations and seed cost comparisons.

\[ PLS = \frac{\text{percent purity} \times \text{percent germination}}{100} \]

\[ PLS = \frac{99.8 \times 89.0}{100} = 88.8\% \]

Seed Certification

The Association of Official Seed Certification Agencies (AOSCA) develops certification requirements and standards to protect the consumer with third-party verification of source, genetic identity, and genetic purity, i.e. seed quality, of products produced by plant developers. Additional seed labels with specific colors based on certification class are added to seed lots meeting these standards and requirements. NRCS Conservation Practice Standards and Implementation Requirements often require the use of Certified seed, where available. Certified seed is a class of seed certification in the seed production industry. 

High seed quality is the most important consideration when purchasing seed for conservation plantings. Seed certification is a method of reinforcing high seed quality but does not always equate to the highest quality seed available.

Plant developers may follow two separate but related tracks when releasing plant material for commercial use: formal variety/cultivar release or Pre-Variety Germplasm (PVG) release. Formal variety/cultivar release is most commonly used for broadly adapted plant materials that can be protected under the Plant Variety Protection Act and result in a cultivar designation. Cultivars are designated with single quotes at the beginning and end of the name (e.g. ‘El Reno’). Pre-variety germplasms are typically recommended for restoration, revegetation and stabilization of natural communities, where adapted. Either track may produce named cultivars or varieties but PVG releases carry the designation of germplasm in their title (e.g. Vegas Germplasm alkali sacaton).

Pre-variety germplasm releases have three certification classes available: Tested Class – germplasm that is similar in development to cultivars but with less adaptation testing; Selected Class – germplasm or populations from known origins that are evaluated for performance and applicability for conservation practices, but have limited adaptation testing; and Source Identified Class – germplasm or populations from known origins typically used in the area they came from with little or no performance or adaptation testing.

Plant Species for Conservation Practices

USDA NRCS Plant Materials Centers (PMCs) are plant developers that provide their products, e.g. “releases”, to commercial seed growers for large scale production. Over the past 80 years, PMCs have selected and released over 550 conservation plants that are currently available on the commercial market for use in conservation practices. Most PMC releases are cultivars or selected class releases. The use of named cultivars or germplasms, where available and adapted, greatly improves long-term success of the conservation planting once the plant is established.
important to note that cultivars and germplasm selections are developed for particular areas. If grown outside the area where they are developed and adapted for, performance may vary. The area of adaptation and use of PMC releases is indicated on plant release brochures.

Conservation practices address many different resource concerns, including stabilization of difficult sites, providing cover to reduce erosion and improve water quality, enhancing the productivity of sites, and providing habitat for wildlife. Each practice has unique requirements that will determine the most appropriate type of seed used. For instance, Critical Area Planting (342), is used to establish permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal seeding/planting methods. In critical areas, the use of plant releases that have proven adaptation and performance, i.e. cultivars, are recommended because the priority is to stabilize the area as quickly as possible. In contrast, Restoration of Rare or Declining Natural Communities (643) is used to restore the physical conditions and/or unique plant community on sites that partially support, or once supported, a rare or declining natural community. In these instances, PVG releases are recommended because the priority is to support natural assemblages of native plants. Further examples are in the table below.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Pre-Variety Germplasm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas of use</td>
<td>Broadly adapted plant materials with known performance over large areas.</td>
</tr>
<tr>
<td>Release example</td>
<td>‘El Reno’ sideoats grama</td>
</tr>
<tr>
<td>Applicable Conservation Practices</td>
<td>Critical Area Planting (342), Conservation Cover (327), Cover Crop (340), Pasture and Hay Planting (512), Range Planting (550)</td>
</tr>
</tbody>
</table>

In all instances, to ensure the highest probability of success of any vegetative conservation practice, evaluate and understand the seed quality of each lot of seed purchased. Choose lots with high PLS and low to no weed content.
Appendix A: Seed Quality Quick Reference Guide

Seed Quality Statement for Use in State Specifications

The following statement is applicable to all vegetative conservation practices and implementation requirements.

*Purchase seed on a pure live seed (PLS) basis to ensure the planting meets the seeding rate recommendation of the NRCS Conservation Practice Standards and Implementation Requirements. Seed is of high quality with minimal weed content. The purchase of Certified seed, where available and adapted, is recommended for NRCS conservation practices to ensure the plant material is as genetically similar to the original plant release as possible.*

Pure Live Seed

Germination = % germination + % dormant seed + % hard seed

PLS Calculation:  \[
\text{PLS} = \frac{\text{percent purity} \times \text{percent germination}}{100}
\]

Comparing Seed Lots

Pure live seed provides a basis for comparing seed lot costs to ensure the highest quality seed is purchased. For example, seed vendor X has the same variety of alfalfa as seed vendor Y, but it is $0.20 cheaper than seed vendor Y’s seed. To evaluate which lot is more economical, use the following formula:

\[
\text{Price per pound (PLS)} = \frac{\text{price per pound bulk}}{\text{PLS}}
\]

<table>
<thead>
<tr>
<th>Seed Purity%</th>
<th>Germination%</th>
<th>Price/lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed vendor Y</td>
<td>99.5</td>
<td>90.0</td>
</tr>
<tr>
<td>Seed vendor X</td>
<td>93.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>
Using this information, the actual price per pound of PLS is:

**Seed vendor Y**

\[
\text{PLS} = \frac{(99.5)(90.0)}{100} = 89.55
\]

bulk price per pound (PLS) = \$0.90 per bulk pound = \$1.01 per PLS pound

\[
\text{0.8955 PLS}
\]

**Seed vendor X**

\[
\text{PLS} = \frac{(93.0)(60.0)}{100} = 55.80
\]

bulk price per pound (PLS) = \$0.70 per bulk pound = \$1.25 per PLS pound

\[
\text{0.558 PLS}
\]

---

**Seeding Rates**

Pure live seed is also used to calculate the amount of seed to buy for a planting. To seed the recommended PLS seeding rate, the planting rate needs to be determined. The planting rate will always be greater than the pure live seed rate. The formula to calculate the planting rate is:

\[
\text{Planting rate per acre} = \text{pounds PLS recommended rate per acre} \div \text{PLS of seed lot}
\]

For example: The NRCS recommended seeding rate for 'Hycrest' crested wheatgrass is 5 pounds PLS per acre. The calculated PLS is 80.0 %.

The planting rate needed to seed the recommended PLS rate is determined by:

\[
\text{Planting rate per acre} = \frac{5 \text{ pounds}}{0.80 \text{ PLS}} = 6.25 \text{ pounds}
\]
## Seed Label Key

**Net weight**
How much material is in the container.

**Lot number**
A series of letters or numbers assigned by the grower for tracking purposes.

**Variety Name**
Reliable Seed Company ‘Rumsey’ yellow Indian grass
Sorghastrum nutans

**Species Name**

**Pure seed – Purity**
The % by weight of seed that is the desired seed.

**Other Crop**
The % by weight that is other non-weed species. Specific species must be listed if over 5%.

**Inert**
The % by weight of the material in the bag is plant debris or other materials that are not seed.

**Weed Seed**
The % of weed seeds found in this lot. A listing of the species can be obtained by requesting the Seed Analysis Report.

**Date tested**
Date should be within 12 months of the planned date for using the seed. Most states require a test dated within 9 months for retail sales unless seed is hermetically sealed (USDA, 2009), although a few states only require a test be done within 18 months.

**Origin**
Where the seed was grown.

**Noxious weeds**
Name of restricted noxious seed (with number per pound of seed). Noxious weed species vary by state. There are 2 types of noxious weeds – restricted and prohibited. Restricted weeds are listed as seeds per pound of material in the bag. There should be no prohibited weeds.

**Germination**
How much of the seed will germinate readily (laboratory conditions). A tetrazolium test (TZ) estimates germination and can be as accurate as 95%.

**Dormant seed**
Seed which does not germinate readily because it requires a pre-treatment or weathering in the soil. (Some suppliers may combine hard and dormant seed on the label.)

**Hard Seed**
seed which does not germinate readily because of a hard seed coat

You may also see the following additional information on the label:
Total Viability/Germination – this may or may not be stated. Add Germination + Hard Seed + Dormant Seed. Total Viability may not equal 100%. This just means that some of the seed is not viable and will not germinate.
References/More Information


USDA, Natural Resources Conservation Service. 2002. Reading Seed Packaging Labels and Calculating Seed Mixtures. Technical Note Plant Materials No. 4. Boise, ID.


USDA, Natural Resources Conservation Service. 2007. A simplified guide to understanding seed labels. Maryland Plant Materials Center technical note no. 2. USDA-NRCS National Plant Materials Center, Beltsville, MD.

