

Chapter 8: Wheat Seed Testing, Pure Live Seed, and Seeding Rates



Brent Turnipseed (Brent.Turnipseed@sdstate.edu)

Optimizing wheat yields starts with selecting an appropriate variety with high seed quality. Critical and basic information provided by a seed testing laboratory is the germination percentage, purity analysis (% pure seed, etc.), noxious weed seed examination, and a seed count (#/lb.). This chapter provides an outline for understanding how to use this information.

Standard tests

To legally sell wheat seed in South Dakota, a standard test—following AOSA seed testing protocols, for germination, purity, and noxious weeds—is required. This standard analysis plus a seed count provides information needed to determine the seeding rate. For example, the seeding rate for a seed batch with a 85% germination requires more seed per acre than a seed batch that has a germination of near 98%.

Not having seed testing information puts the producers and their investment at risk. At a minimum, seedsmen and savvy producers will always have a germination test and a seed count performed, and will clean their seed lot prior to planting. It is always wise to know if the seed is worth cleaning before making that investment (cleaning and/or planting). Planting low quality seed can result in stand failures, over- or under-planting rates, or disease outbreaks. Other tests commonly requested are seed counts, electrophoresis (used to verify the variety), and tetrazolium tests.

Required tests for seed sales

In South Dakota and most states, three tests are required to be performed before seed can be offered for sale: purity analysis, noxious weed seed exam and a germination test.

- **Purity analysis test**
This test provides information about the physical make-up of the seed lot (% pure seed, % inert, % other crop seed present, and % weed seed). Percentages are based on weight. This test should be conducted after the seed lot has been cleaned.
- **Noxious Weed Seed Examination**
In South Dakota, it is prohibited to sell certified wheat seed if noxious weed seed are present in the seed lot. If it contains noxious weed seeds, it must be re-cleaned, sampled, tested, and found to be free of the prohibited weed seed. If restricted weed seeds are found, the seed lot can still be sold, but any restricted weed seed present must be indicated by name and the rate of occurrence (number per pound) on the seed label. The minimum quantity (500 grams) examined in this test is at least five times the purity analysis sample size (100 grams). SD Certified seed cannot have prohibited or restricted noxious weed seed in the seed lots offered for sale.
- **Germination test**
This test tells you the percent germination of normal seedlings, ones that can be expected to grow and produce plants in the field. Laboratory germination tests are conducted under favorable conditions, which do not always occur in the field. Occasionally there is some dormancy in wheat seed, and the report will show % germination and % dormancy. But typically there is little to no dormancy in wheat seed in the standard germination test when it is conducted one or two months after harvest.

A wheat germination test takes 7 days on old crop wheat (wheat that is from the previous year's production), and 12 days on new crop wheat (wheat harvested in the current year). New crop wheat takes longer as the seed is put through a pre-chill period (five days at 5-10° C) to break any seed dormancy that might occur. Once the wheat is about 4 months old (after harvest), it typically does not need a pre-chill period as dormancy is usually broken.

Additional tests

- **Seed count** – is not a required test, but it is crucial for planting purposes. Seed counts in wheat will vary from 10,000 seeds per pound to as many as 26,000 seeds per pound. Variation is due to varietal differences and growing conditions each year. Knowing your seed count and germination rate are crucial in figuring out planting rates for desired plant population.
- **Electrophoresis test** – is used as a varietal verification test. This can be a critical test for assuring that the desired variety is planted. Both hard red spring (HRS) and hard red winter (HRW) wheat are grown in South Dakota, and planting HRS or HRW at the wrong time is a very costly mistake.
- **Tetrazolium test** – is a rapid (24-48 hr.) chemical viability test which can be used to estimate the results of the germination test; however, it cannot be used as a legal substitute for the germination test. Results of the TZ test will be phoned, faxed, or e-mailed to the customer when completed.

Pure Live Seed and Seeding Rate Calculations

Pure live seed (PLS) percentage is important to know when calculating seeding rates, or in calculating which is a better price between seed lots. Let's look at the example labels below and calculate PLS and compare our prices. Let's also consider the other information on the label.

Sample A	Price \$26/bushel	Sample B	Price \$24/bushel
SD Certified Seed		SD Certified Seed	
Certification #xxxxxx	Lot No. 82611	Certification #xxxxxx	Lot No. 82612
Select HRS Wheat	Germination = 96%	Select HRS Wheat	Germination = 85%
Pure Seed = 99.50%	Dormant = 0%	Pure Seed = 99.50%	Dormant = 0%
Inert Matter = 0.48%	Total Viable = 96%	Inert Matter = 0.48%	Total Viable = 85%
Other Crop = 0.01%	Seed count ≈ 13,600 seed/lb.	Other Crop = 0.01%	Seed Count ≈ 15,040 seed/lb.
Weed Seed = 0.01%		Weed Seed = 0.01%	
Date Tested 11/2/2011	XCO Seed Company	Date Tested 11/2/2011	XCO Seed Company
Noxious Weed Seed: None	Brookings, SD 57006	Noxious Weed Seed: None	Brookings, SD57006

Calculating Pure Live Seed (PLS)

$$\% \text{ PLS} = \frac{\% \text{ pure seed} \times \% \text{ total viable}}{100}$$

$$\text{Sample A – PLS} = \frac{99.50 \times 96}{100} = 95.52\% \text{ pure live seed in one pound of seed}$$

$$\text{Sample B – PLS} = \frac{99.50 \times 85}{100} = 84.58\% \text{ pure live seed in one pound of seed}$$

Now that you know the PLS, you can calculate the actual cost per bushel (per unit) that each lot costs.

$$\text{Actual cost per bushel of PLS} = \frac{\text{Price per bushel}}{\% \text{ PLS}}$$

$$\text{Sample A – Priced } \$26/\text{bu.} \quad \text{Actual cost/bu.} = \frac{\$26}{.9552} = \$27.22/\text{PLS Bushel}$$

$$\text{Sample B – Priced } \$24/\text{bu.} \quad \text{Actual cost/bu.} = \frac{\$24}{.8458} = \$28.38/\text{PLS Bushel}$$

So you can see how much you are actually paying per PLS bushel. Sample B may have looked like the better deal, but it wasn't when you calculate the price per PLS bushel.

Other things that buyers should look at is the "Noxious Weed" heading on the label. SD Certified Seed cannot contain noxious weed seeds in the seed lot offered for sale. Non-certified wheat may contain restricted noxious weed seed if it is properly labeled (i.e., "Noxious Weed: Wild Oats 4/lb.") showing the species present and the rate of occurrence.

The seed count (if available) is another item to consider. A lower seed count indicates greater seed size, which is correlated with greater yield and better vigor potential. Your seed conditioner can clean and size seed according to requests. For wheat, a slotted screen size of $\frac{5}{64} \times \frac{3}{4}$ is recommended as it will yield seed counts of approximately 15,000 seeds/lb. Sizing needs will vary each year with variety selection and production environments. Your seed conditioner/cleaner should be able to adjust sizing as needed.

Seeding Rate Calculations

To calculate actual seeding rates, one needs to know the seed lot purity (% pure seed), germination rate (% germination or % total viable), and the seed count (#/lb.). Seeding recommendations for spring and winter wheat are provided in Chapters 4 and 5. Sample calculations for determining seeding rates are below.

Wheat is recommended to be planted at the below rates:

- Firm Seedbed → 28 pure live seeds per square foot (approx. 1.22 million pure live seed/acre)
- Soft Seedbed → 32-35 pure live seeds per square foot (approx. 1.39 to 1.5 million live seed/acre)
- Late Seeded → 35 pure live seeds per square foot (approx. 1.5 million pure live seed /acre)

Calculations

Example 1:

Determine the seeding rate if the goal is 28 pure live seed per square foot seeding density or 1,219,680 pure live seeds per acre. In this calculation, the % pure seed, % germination, and seedcount/lb is 99.5%, 96%, and 13,600 seeds/lb.

$$\text{Seed Rate (lbs./A)} = \frac{1,219,680 \text{ pure live seeds/A}}{(\% \text{ pure seed}/100) \times (\% \text{ germ}/100) \times (\text{seedcount in \#/lb.})}$$

$$\text{Seed Rate (lbs./A)} = \frac{1,219,680 \text{ pure live seeds/A} = 93.88 \text{ or } 94 \text{ lbs./A}}{(0.9950) \times (0.96) \times (13,600)}$$

Example 2:

Determine the seeding rate if the goal is 1,219,680 pure live seed/a, and the % pure seeds, % germination rate, and seed count in lbs/acre are 99.5%, 85%, and 15,040 seeds/lb.

$$\text{Seed Rate (lbs./A)} = \frac{1,219,680 \text{ pure live seeds/A} = 95.87 \text{ or } 96 \text{ lbs./A}}{(0.9950) \times (0.85) \times (15,040)}$$

Calculating seeding rates is not hard when you have the necessary information.

Seed diseases

Two major wheat seed diseases have caused seeding, seedling and production problems: scab (*Fusarium*) and bunt (*Tilletia*). Chapter 23 provides additional information on wheat diseases.

Scab damaged seeds

Scab-damaged seed is typically lighter in test weight, smaller in size, has lower vigor and carries *Fusarium* spores. Seed wheat which has scab damage should always be rigorously cleaned over a gravity table, and infected seed lots should be treated with a fungicide (prior to planting) to help in seedling emergence and early season (1st month) growth. Fungicides can help increase your germination rates by suppressing/controlling *Fusarium* growth and helping protect seedlings during the early season growth. Planting scabby wheat **does not** mean you will produce scabby wheat as that depends on the environment (amount of rainfall) during wheat flowering.

Visual symptoms of infected seed are not always present on seed or grain, but usually scab-infected wheat kernels are shriveled and discolored with a white, pink, or light brown scaly appearance. These kernels are often referred to as “tombstones.” Infection of scab can also lead to production of mycotoxins in the seed. The most prevalent one, *deoxynivalenol* (also known as DON or by the common name “vomitoxin”), is often tested for as it can cause problems for grain utilization.

Scab-infected seed, if not dead, will have lower vigor and be more susceptible to other field fungi when the seeds germinate in the soil, and plants will remain vulnerable to infections in the seedling stage. In germination testing, infected seeds/seedlings can reduce germination percentages because of primary or secondary infections.

The SDSU Seed Lab has been planting suspect scabby wheat samples in eight replications of 50 seeds to spread out seeds/seedlings in order to reduce secondary infections and provide more accurate results. Normally tests consist of 4 replications of 100 seeds. From past experience, the practice of planting 8 x 50 can increase the rate of normal seedlings (those that have all essential structures for growth) by up to 10 percent.

Bunt

This is a disease where the inside of the kernel is replaced by black spores, which have a fishy odor when the kernel breaks open. Bunt is usually controlled easily with a fungicide seed treatment. Over the past several years, this disease has shown up again.

Seed Treatment

An option that growers should always be using is a fungicide seed treatment. Using a seed treatment will not enable germination of dead seed, but it will protect live seeds and seedlings from early season fungal infections. It will also suppress surface-based or endosperm-based Fusarium (less severe infections) from growing during the germination test and prevent infection of the seedling, thus allowing that seedling a chance to grow into a productive plant. From past experience, this practice usually increases the rate of normal seedlings (those that have all essential structures for growth) on average by 10 percent or higher. An effective fungicide will normally prevent bunt infection. ***Fungicide seed treatments in wheat are highly recommended, and when used consistently year in and year out, the returns always outweigh the seed treatment costs.***

The SDSU Seed Testing Lab offers a seed treated germination test (using a current and effective fungicide) along with the standard (untreated) germination test to compare potential germination benefits provided by seed treatment. There are several effective fungicides on the market and SDSU does not endorse one over the other. Contact your county Extension educator, your crop consultant, or local cooperative, for treatment products and options.

Seed sources

Seed quality is crucial and it is recommended that growers purchase seed from reputable producers. Certified seed is highly recommended as it has been field inspected, and lab tested, including a variety identification check in South Dakota. Private companies also sell high quality wheat seed that may or may not be in the Certification program.

Most varieties are protected under the Plant Variety Protection Act (PVP) and can only be sold as a class of certified seed or by the variety owner/developer. “Bin-run” seed is often saved and replanted for one to three years by farmers, depending on the producer’s ability to keep it clean and pure. Bin-run seed should always be cleaned and tested prior to planting.

No one should ever risk planting un-tested seed. Planting bin-run wheat is not a recommended practice, but producers do it to save “seed” money, and will usually re-invest every two to four years in new seed for improved genetics, yield, disease resistance, etc.

If producers raise and sell wheat seed, they need to make sure they follow the laws in doing so. Their best option in South Dakota is to join the South Dakota Seed Certification program and become a Certified Seed Grower.

Seed Testing

Any of the seed tests mentioned can be performed at the SDSU Seed Testing Lab. A germination or a seed treatment applied germination test is a small price to pay for insuring a good stand. Many producers will request both an untreated germination test and a seed treated germination test on wheat seed. When time is an issue, many producers request the germination assessment potential using the tetrazolium (TZ) test. The TZ test is a biochemical test that can provide estimated germination results in 24 hours. A major drawback with the TZ test on scabby wheat is that it will overestimate (sometimes by 20 percent) the actual germination rate, as TZ does not distinguish scab damage. On non-diseased wheat seed, the TZ test is usually very accurate.

Germination testing takes approximately two weeks on new crop and about one week on old crop. Make sure you mark your sample as new crop or old crop—there is a five-day difference in testing time. New crop must be pre-chilled for five days to break any seed dormancy present. Make sure and ask for a seed count (free with germination test) so you can better calculate planting rates. Seed counts in wheat can range from 10,000 to 26,000 seeds per pound. You do not need to send payment with the sample. The lab bills clients for samples after testing is complete.

Purity analyses and noxious weed seed exams usually only take one to three days to complete once they are received at the Seed Testing Lab. Electrophoresis testing can take up to two weeks.

Send samples to:

- SDSU Seed Testing Lab, Box 2207-A, Brookings, SD, 57007 (US Postal Service)
- or*
- SDSU Seed Testing Lab, 2380 Research Parkway, Brookings, SD 57006 (UPS/FedEx/Spree-Dee)

Please indicate which tests you need, your name and mailing address, telephone number, and your email address if you wish to receive email results (faster turn-around). You can also find us on the web at <https://www.sdstate.edu/agronomy-horticulture-and-plant-science/sdsu-seed-testing-lab>.

Seed sample envelopes may be obtained through either the closest Extension office or by contacting the SDSU Seed Testing Lab directly. Growers of certified seed are to use the mailing bag supplied to them after field inspection.

Samples for deoxynivalenol (DON) level tests on grain should be sent to:

- SDSU Plant Diagnostic Clinic,
Plant Science, SPB 101,
Box: 2108, Brookings, SD 57007.
Telephone Number: 605.688.5543

Additional information and references

SDSU Seed Testing Lab. Available at <https://www.sdstate.edu/agronomy-horticulture-and-plant-science/sdsu-seed-testing-lab>

SDSU Plant Diagnostic Clinic. Available at <https://www.sdstate.edu/agronomy-horticulture-plant-science/sdsu-plant-diagnostic-clinic>

SD Crop Improvement Association. Available at <https://www.sdcrop.org/>

SD Department of Agriculture. Available at <https://sdda.sd.gov/>

Acknowledgements

Support provided by South Dakota Seed Testing Laboratory.

Turnipseed, Brent. 2012. Wheat seed testing, pure live seed, and seeding rates. In Clay, D.E., C.G. Carlson, and K. Dalsted (eds). iGrow Wheat: Best Management Practices for Wheat Production. South Dakota State University, SDSU Extension, Brookings, SD.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotope, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

*(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;*

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

SDSU Extension is an equal opportunity provider and employer in accordance with the nondiscrimination policies of South Dakota State University, the South Dakota Board of Regents and the United States Department of Agriculture.