TECHNICAL NOTES

U.S. Department of Agriculture **Natural Resources Conservation Service**

TN – PLANT MATERIALS - CA – 84 August, 2016

PLS, Bulk Seeding Rates and the eVeg Guide

The NRCS **eVegGuide** (electronic Vegetative Guide) is used to provide seeding rates and planting recommendations. It is a tool for finding plant alternatives based on NRCS vegetative guidelines for specific MLRAs (Major Land Resource Area) in California. An example of a report for a Range Planting from the eVegGuide is provided in Table 1. Seeding rates in the eVegGuide are stated as Pure Live Seed (PLS) quantities which must be converted to bulk seeding rates (the amount of seed planted) prior to planting. This Technical Note distributes a PLS/Bulk Seed Rate Calculator tool and defines terms used within the eVegGuide to ensure understanding of seed quality and how to use the information to calculate bulk seeding rates that will enable success in establishing a planting.

Table 1. Example report from the eVegGuide for Practice 550, Range Planting, in the Sierra Foothills.

PLANTS Symbol	Common / Scientific Name	Cultivar	Mix Percent	PLS lbs/Acre		Resident Status	Growth Cycle	Plant Type	Footnotes
				Drilled	Broadcast				
BRCA5	California brome *Bromus carinatus*	None	30%	3.2	4.4	native	Annual / Perennial	Grass or Grass-like	
NAPU4	Purple needlegrass *Stipa pulchra*	None	30%	3.0	4.2	native	Perennial	Grass or Grass-like	77
ELGL	Blue wildrye *Elymus glaucus*	None	40%	3.3	4.5	native	Perennial	Grass or Grass-like	77
Footnotes 77	Attracts beneficial insects								

Pure Live Seed (PLS) Seeding rates are expressed as “Pure Live Seed” (PLS), which is an expression of seed quality. Seed quality is a reflection of the **purity** and **viability** of the seeds, where **purity** is the actual amount of pure seed of the species in the lot (definition included below), and **viability** is a measure of the percentage of the seed that germinates when tested. Refer to Box 1 for additional information on how these properties are measured. Seeding rates in seeding recommendations are given in PLS because individual seed lots vary widely in purity and viability. When seed quality is poor, higher seeding rates are required because less of the weight is viable seed and/or fewer of the planted seeds will germinate and establish. For conservation plantings to be successful, seed quality variability among seed lots must be taken into account. Purity and viability information required to calculate PLS are listed on the seed tags

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which are attached to the seed bags (Figure 1). PLS is determined by multiplying percent total purity by percent total viability and dividing by 100. Thus:

$$PLS = \frac{\%\ purity\ \ x\ \ \%\ viability}{100}$$

Bulk Seeding Rate is the amount of seed required for the planting to be made at the appropriate PLS rate. It is calculated by dividing the recommended seeding rate by the PLS. The bulk seeding rate must be calculated separately for each seed lot if a planting includes more than one seed lot (even if the same species), and will always be greater than the PLS amount. The spreadsheet calculator (TN 84A) generates a recommended bulk seeding rate based on the PLS.

Seed Lot is a defined quantity of seeds identified by a lot number or mark, every portion or bag of which is uniform, within permitted tolerances, relative to the factors which appear in the labeling.

Seed Mixes. When preparing a seed mix the PLS and bulk seeding rate must be calculated separately for each species and different lots of seed. The spreadsheet calculator provided can be used for these calculations.

Seeding Rates for Broadcast and Drilled Seeding Methods. The success of a seeding depends upon the quality of the seed and using the correct seeding rate. It is a rule of thumb for conservation purposes that a standard seeding rate to achieve a suitable plant density is 20 - 60 seeds per square foot. This will vary to some extent based upon plant and seed size and the purpose of the planting. The eVegGuide recommendations are given in PLS and rates for both drilled and broadcast seeding methods. Note that the planting rates for drilled seed are lower than for a broadcast seeding, because soil to seed contact is better with a drilled seeding and germination and establishment tends to be better assuming that the seed is planted at the correct depth.

Seed Cost is affected by PLS because as the quality of seed declines more bulk seed will be needed and there will be an increased cost. Different seed lots can be compared prior to purchase to determine which one will be most cost effective. Depending on the funding for the project, seed mixtures may need to be adjusted to reflect variations in cost of desired seed. The spreadsheet calculator provided (TN 84A) includes examples of seed cost variations.

Seed Quality. Seed lots vary widely in quality. Seed from reputable seed dealers always carries a current tag. The law requires that each lot of seed offered for sale must be truthfully labeled. This applies to a single species, a seed mixture, and whether the seed is Certified or non-certified (common). By California law, all seed sold must include the results of a germination test done not more than 15 months before sale. Further information is available in a Seed Analysis Report, which can be requested from the seed seller (Figure 2).

Germination rates for different species can decline rapidly over time, depending upon the species and the conditions in which the seed is stored. Optimal seed storage conditions include controlled environments with constant, low temperatures and low humidity. Storing seed at ambient temperatures, where there may be variations in humidity and the potential for pest damage, can significantly decrease seed quality. Consulting a current seed analysis ensures that the PLS is calculated correctly and that seeding rates, established on a PLS basis, provide the same amount of viable seed per acre.

Box 1. Definitions for terms of Purity and Viability found on seed tag labels.

PURITY = Pure Seed

% Purity = bulk seed (total) – (% Inert matter + % Weed seed + % Other crop seed)

Purity is the actual amount of pure seed of the species in the lot. This is determined in the seed lab by weighing out a sample, dividing the pure seed from the inert matter, weighing it and determining percentage of the sample that is pure seed as well as the percentage of inert matter, other crop seed and weed seed. Seed batches with high purity offer a number of advantages over those with greater amounts of inert matter and weed seed. Seed testing protocols are developed and managed by the Association of Official Seed Analysists (AOSA). Each state has an official seed testing lab and follows the AOSA protocols.
The Federal Seed Act provides regulation of seed that is sold and shipped from state to state and State seed law regulates seed that is sold within a state; in California the regulation is the California Seed Act.

Inert Matter - Generally inert matter includes, dirt, plant parts, and damaged seeds, and is a reflection of the quality of seed production and cleaning process. Seed that has a lot of trash in it (inert matter, other crop seed, and damaged seed) can be difficult to run through a seed drill. The exception is that individual species vary based upon the morphology of the seed; for example, some native grasses may only have purities of 50-60 % due to awns or long seed appendages.

Weed Seed - The amount of weed seed allowed within a seed lot is regulated by law and subject to tolerances. Federal Noxious Weeds are prohibited. Certified seed may not contain Restricted Noxious Weed seed in California. Common seed allows sale of seed that includes restricted noxious weeds below 45 seeds per lb. and these must be named and listed.

Other Crop Seed - Seed of other crop species must be listed and must be below 5%.

VIABILITY

Total % viable seed = % germination + % hard and/or dormant seed

Germination - Seed that is expected to readily germinate is determined by running a germination test to find the percentage of normal seedlings that sprout. Seed labs use the same procedures nation-wide that are species specific, typically replicated lots of 100 seeds in containers under sterile and moist conditions. The actual germination you see in the field will be lower than the ideal germination environment of the lab.
Germination rates decline in seed as it ages. The rate of decline varies with species and also depending upon the conditions under which the seed is stored.

Hard Seed - This includes seed that is alive but does not germinate during the germination test due to a hard or impervious seed coat. This is common with species that have hard seed coats including many legumes.

Dormant seed - Also alive but does not germinate during the germination test for various reasons that may include physical and physiological dormancy. Many native species have seed dormancy mechanisms that prevent germination until ideal environmental conditions are present, this aids their survival. Some species seed, including weeds, may remain viable in soil for years or even decades.

TZ Test - The TZ (tetrazolium chloride test) is a rapid test used to determine the total viability of seed as living tissue is stained red. It is useful for testing hard seeded legumes and dormant seed and is used in place of the germination test for many native species that require lengthy dormancy breaking pre-treatments, fluctuating temperature or light treatments, or when germination protocols have not been developed. If a TZ test is listed on the seed tag use this in the PLS calculation.

TZ test result = Total viable seed

Figure 1. Seed Tag Examples

Example 1. Seed tag for 'California brome, Cucamonga' a California Native grass and Lockeford PMC release.

Seed Company Name:	Address:
Date Tested: 02/21/2015	Weight: 50 lb
Species: *Bromus carinatus*	Origin: Rancho Cucamonga, CA
Common Name: California brome 'Cucamonga'	Lot #: XXX-XXX
Purity: 98.06%	Germination: 90%
Other Crop Seed: 0.91%	Dormant Seed: 0%
Weed Seed: 0.09%	Total Viable: 90%
Noxious Weed Seed: None	Pure Live Seed: 88%

Example 2. Seed tag for Purple needlegrass a California Native grass.

Seed Company Name:	Address:
Date Tested: 08/14/2013	Weight: 50 lb
Species: *Stipa pulchra*	Origin: Sacramento County
Common Name: Purple needlegrass	Lot #: XXX-XXX
Purity: 97.39%	Germination: 68%
Other Crop Seed: 1.53%	Dormant Seed: 0%
Weed Seed: 0.0%	Total Viable: 68%
Inert: 1.08%	
Noxious Weed Seed: None	Pure Seed: 66%

Example 3. Seed tag for Hairy Vetch (*Vicia villosa*) used for cover crops.

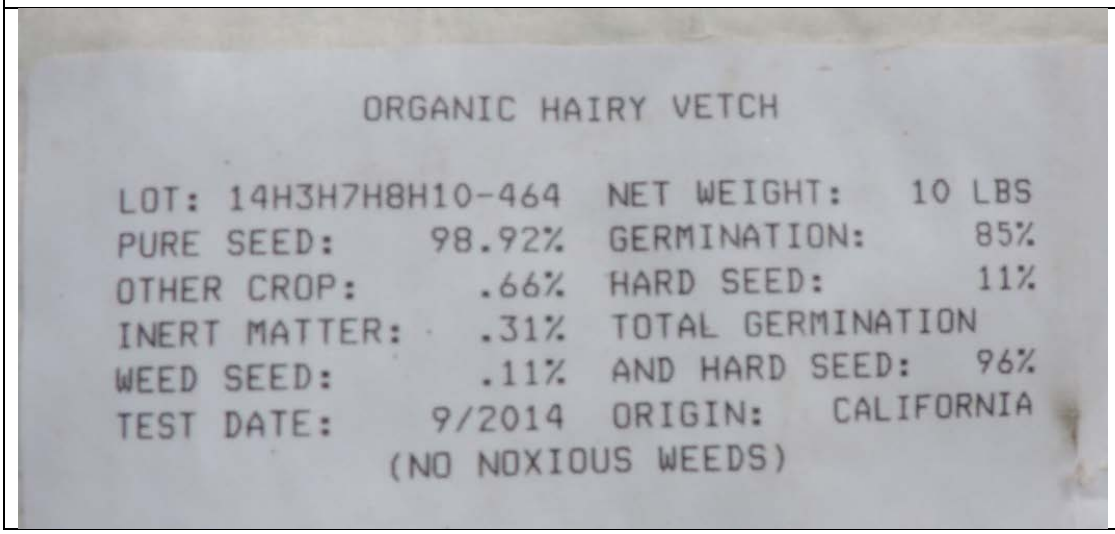
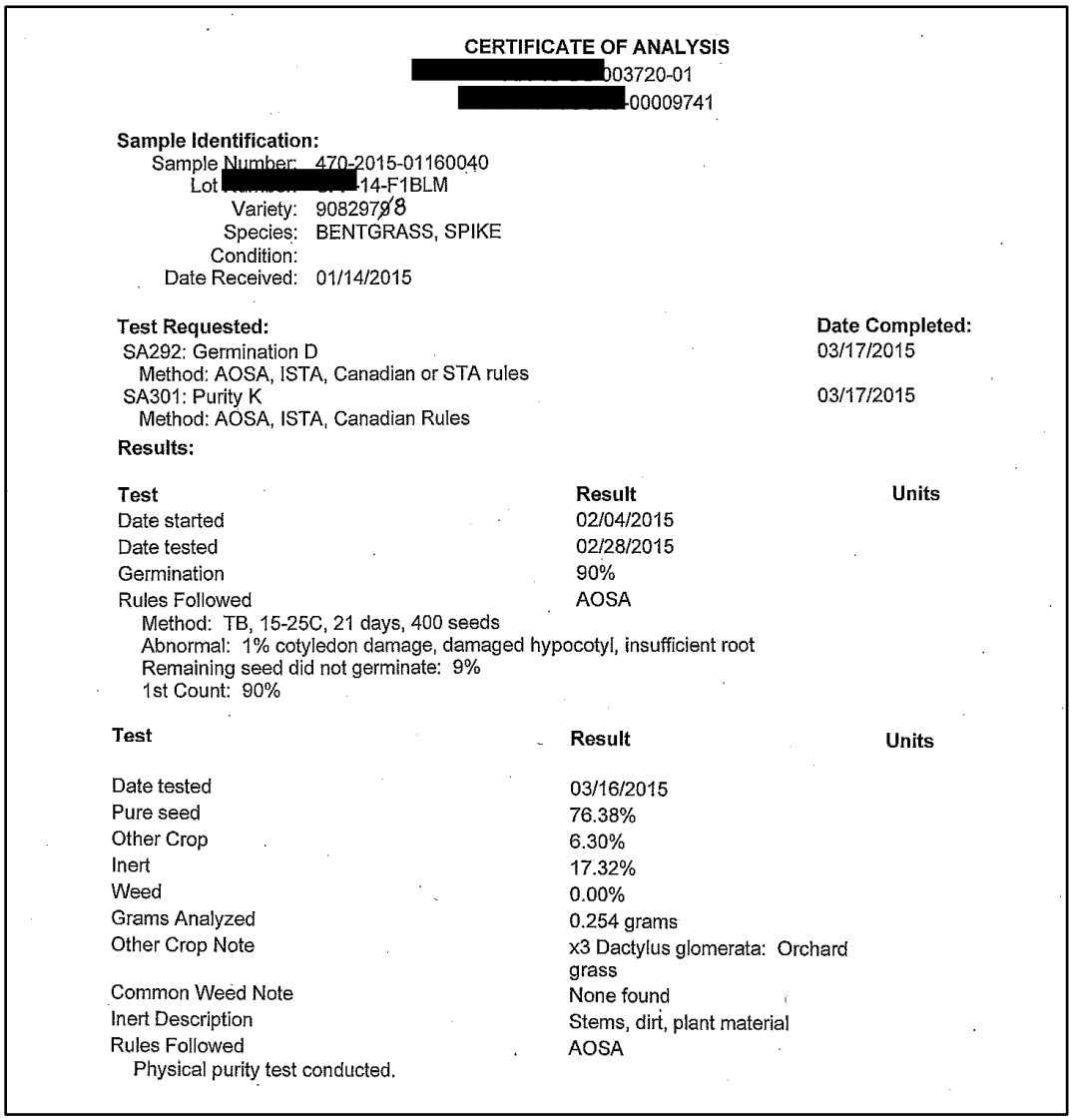


Figure 2. Example of a Seed Analysis Report



CERTIFICATE OF ANALYSIS
[redacted]003720-01
[redacted]-00009741

Sample Identification:
Sample Number: 470-2015-01160040
Lot [redacted]14-F1BLM
Variety: 90829798
Species: BENTGRASS, SPIKE
Condition:
Date Received: 01/14/2015

Test Requested: | **Date Completed:**
SA292: Germination D — 03/17/2015
Method: AOSA, ISTA, Canadian or STA rules
SA301: Purity K — 03/17/2015
Method: AOSA, ISTA, Canadian Rules

Results:

Test	Result	Units
Date started	02/04/2015	
Date tested	02/28/2015	
Germination	90%	
Rules Followed	AOSA	
Method: TB, 15-25C, 21 days, 400 seeds		
Abnormal: 1% cotyledon damage, damaged hypocotyl, insufficient root		
Remaining seed did not germinate: 9%		
1st Count: 90%		

Test	Result	Units
Date tested	03/16/2015	
Pure seed	76.38%	
Other Crop	6.30%	
Inert	17.32%	
Weed	0.00%	
Grams Analyzed	0.254 grams	
Other Crop Note	x3 Dactylus glomerata: Orchard grass	
Common Weed Note	None found	
Inert Description	Stems, dirt, plant material	
Rules Followed	AOSA	
Physical purity test conducted.		

Agronomic Exception to use of PLS. Many agronomic crops such a wheat and barley do not use PLS. This is because the seed is generally clean and has good germination, typically between 90 and 100%. Cover crop seeds for use in agronomic cropping systems may fall into this category; however, always examine the seed label carefully to ensure the seed is of good quality.

REFERENCES

CDFA California Seed Law, Extracts from the Food and Agriculture Code 2014, CDFA https://www.cdfa.ca.gov/plant/pe/nsc/docs/seed/SeedLaw_2014.pdf (accessed 4/8/2016).

Englert, J.M. 2007. A Simplified Guide to Understanding Seed Labels. Maryland Plant Materials Technical Note No. 2. USDA-NRCS National Plant Materials Center, Beltsville, MD. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mdpmctn7615.pdf (accessed 7/22/2016).

Houck, M. 2009, Understanding seeding rates, recommended planting rates and pure live seed. USDA-NRCS LAPMC TN 11 http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/lapmctn9045.pdf (accessed 4/8/2016).

Young, S.A., Schrumpf, B. and Amberson, E. 2003. The AOSCA Native Plant Connection bulletin. http://www.aosca.org/SiteContent/Documents///aoscanativeplantbrochure.pdf (accessed 4/8/2016).