The Seed Laboratory

Development of Tolerance Tables for Native Species

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Final Report

Objective

Develop two tolerance tables for native species (one for non-chaffy seeds and one for chaffy seeds) which are used to compare purity test results of two subsamples from the same or different submitted samples from the same seed lot tested in the same or different laboratories.

Justification

Planting seeds with high levels of viability, physical purity, and free from noxious weed seeds increases the likelihood of a successful stand establishment. The purity of native seeds, especially wild collections, can be low and uncertain as it is affected by unknown and/or harsh environmental conditions during seed development and maturation. Even when native seeds are produced under controlled-management practices, they may still have potential quality issues in physical purity and seed cleaning after harvest. These issues lead to discrepancy in purity test results within and among labs, causing problems to both seed buyers and sellers (Elias and Baalbaki, 2012). Currently, the AOSA Rules do not have purity tolerance tables. Developing tolerance tables for natives will help determine the magnitude of difference between two purity test results and determine whether this difference is significant (out of tolerance) or due to random sampling variation (within tolerance). The purpose of developing these tables is to include them in the AOSA Rules to be used by seed testing laboratories and help the native seed industry. It will provide understanding and explaining the magnitude of difference in test results in different laboratories.

Background

Quality seed of native crops is needed for land restoration, rehabilitation, reclamation and conservation (ASTA; Elias et al., 2006). Factors that may affect the quality of native seeds are the stage of maturation at harvest, methods of harvesting, drying, cleaning, and storage. Purity test is one of the important quality tests, which is conducted to detect and quantify the presence of contaminants in a sample, including weed seeds, other crop seeds, and inert matter. It is necessary for labeling and certification purposes. Variability in purity test results among labs is not uncommon, causing problems to the seed industry. Such problems include delivering inconsistent test results, stop-sales, fail to meet company contracts, variation in test results between seed production source and final destination of seeds, seed trade problems, and customers complain about getting different results from different labs.

Tolerance is a statistical tool that was developed to measure the magnitude of difference in two test results conducted in the same or different labs on subsamples from the same seed lot (Baalbaki, et al., 2018). Tolerance is defined as the largest insignificant difference between two test results or two replications (Elias et al., 2000). It is calculated based on theoretical and practical statistical procedures to determine whether the difference in test results is significant or due to chance alone. It is a well-established practice in seed testing (Leggatt, 1939; Miles, 1963).

Native seeds are very diverse. It includes a wide range of physical purity due to their various morphology, origins, and collection methods and locations. In addition, cleaning native crops, especially those with chaffy seeds, is challenging compared to the free-flowing seeds of domesticated crops. Thus, developing purity tolerance tables for natives is a useful tool in assessing the purity levels of different samples. The purity tolerance tables can be used for hundreds of families, species, and lots, including those collected from unknown sources, wild collections, and those developed and matured under a wide range of environmental conditions. Such tolerances should be wide enough to be applicable to a wide range of chaffy and super chaffy seeds.

There are two sources of variation contribute to discrepancy in test results:

1) Random sampling variation, which is unavoidable and is affected by improper sampling procedures, and lack of uniformity in the seed lots.

2) Systematic variation (errors), due to equipment and human errors defined as follow:
   - Equipment and calibration failure (reduced by QC measures, SOP's, and records).
   - Change in the physiological quality of seeds over time.
   - Variability and/or error in seed testing methods.
   - Level of analyst proficiency (analyst mistakes).
   - subjectivity in evaluation (reduced by using the Rules, training analysts, and QC system).
   - Incorrect sampling procedure and/or sampling from wrong seed lot.

There are two types of potential errors can happen in seed testing and negatively affect seed producer and buyer (Elias et al., 2012): Type-1 error, when rejecting a good sample, which is biased against seed producers, and Type-2 error, when accepting a poor-quality sample, which is biased against seed buyers. Both types are considered when calculating tolerances.

Source of Purity Tolerance Tables

The purity chapter listed in the "Handbook of Tolerances and of Measures of Precision for Seed Testing" (Miles, 1963) is the main source of statistical bases for developing and/or adapting the appropriate tolerance table for all crops, including purity of natives. Native crops require wider tolerances compared to those of domesticated crops. Reasons for wider tolerances are the nature of growing native crops under harsh environmental conditions, collecting seeds from wild areas, which result in seeds with uneven maturity levels, as well as the difficulty in identifying some of unfamiliar weed seed contaminants, and the complexity of cleaning some native seed.

Two tables were developed for comparing purity test results of natives:

1) Comparing results of two subsamples from the same submitted sample from the same seed lot, and
2) Comparing two results from two different submitted samples from the same seed lot.

The first table is a one-way test which is used to determine whether a second test result is poorer than the first test (or a label) since there is no objection if the second test result is better than the first test (or a label).

The second table is a two-way test to determine whether the second test is poorer or better than the first test. This test is used to compare two tests conducted within the same lab or different labs. It is also used for quality control to assess the performance of different analysts.

The source of the Tables is S. R. Miles. (1963), Handbook of tolerances and of measures of precision for seed testing. Proc. Int. Seed Testing. Assoc. 28 (3): 555, 566.

Table 14.x B. Native species tolerances for comparing purity test results of two subsamples from the same submitted sample of the same seed lot analyzed in the same or different laboratory (2-way test, *P=0.1*%).

Average of 2 analyses (tests)		Tolerance (%)	
		Non-chaffy seeds	Chaffy seeds
A	B	C	D
99.95 - 100.00	0.00 - 0.04	0.26	0.28
99.90 - 99.94	0.05 - 0.09	0.40	0.42
99.85 - 99.89	0.10 - 0.14	0.49	0.53
99.80 - 99.84	0.15 - 0.19	0.56	0.60
99.75 - 99.79	0.20 -0.24	0.62	0.67
99.70 - 99.74	0.25 - 0.29	0.68	0.74
99.65 - 99.69	0.30 - 0.34	0.73	0.79
99.60 - 99.64	0.35 - 0.39	0.78	0.84
99.55 - 99.59	0.40 - 0.44	0.83	0.89
99.50 - 99.54	0.45 - 0.49	0.87	0.94
99.40 - 99.49	0.50 - 0.59	0.93	1.00
99.30 - 99.39	0.60 - 0.69	1.01	1.03
99.20-99.29	0.70 - 0.79	1.08	1.15
99.10 - 99.19	0.80 - 0.89	1.14	1.22
99.00 - 99.09	0.90 - 0.99	1.20	1.29
98.75 - 98.99	1.00 - 1.24	1.30	1.39
98.50 - 98.74	1.25 - 1.49	1.43	1.55
98.25 - 98.49	1.50 - 1.74	1.55	1.65
98.00 - 98.24	1.75 - 1.99	1.63	1.76
97.75 - 97.99	2.00 - 2.24	1.76	1.87
97.50 - 97.74	2.25 - 2.49	1.85	1.97
97.25 - 97.49	2.50 - 2.74	1.93	2.06

97.00 - 97.24	2.75 - 2.99	2.01	2.15
96.50 - 96.99	3.00 - 3.49	2.13	2.28
96.00 - 96.49	3.50 - 3.99	2.28	2.42
95.50 - 95.99	4.00 - 4.49	2.42	2.57
95.00 - 95.49	4.50 - 4.99	2.53	2.69
94.00 - 94.99	5.00 - 5.99	2.71	2.87
93.00 - 93.99	6.00 - 6.99	2.92	3.10
92.00 - 92.99	7.00 - 7.99	3.11	3.30
91.00 - 91.99	8.00 - 8.99	3.28	3.45
90.00 - 90.99	9.00 - 9.99	3.43	3.64
88.00 - 89.99	10.00 - 11.99	3.66	3.87
86.00 - 87.99	12.00 - 13.99	3.93	4.15
84.00 - 85.99	14.00 - 15.99	4.17	4.40
82.00 - 83.99	16.00 - 17.99	4.39	4.63
80.00 - 81.99	18.00 - 19.99	4.58	4.83
78.00 - 79.99	20.00 - 21.99	4.76	5.02
76.00 - 77.99	22.00 - 23.99	4.92	5.19
74.00 - 75.99	24.00 - 25.99	5.06	5.34
72.00 - 73.99	26.00 - 27.99	5.19	5.47
70.00 - 71.99	28.00 - 29.99	5.30	5.59
65.00 - 69.99	30.00 - 34.99	5.47	5.77
60.00 - 64.99	35.00 - 39.99	5.66	5.96
50.00 - 59.99	40.00 -49.99	5.81	6.13

Source: Table P11, columns E&H, Miles, 1963.

Table 14.x A. Native species tolerances for comparing purity test results of two different submitted samples from the same seed lot analyzed in the same or in different laboratories (1-way test, *P=0.01%*).

Average of 2 analyses (tests)		Tolerance (%)	
		Non-chaffy seeds	Chaffy seeds
A	B	C	D
99.95 - 100.00	0.00 - 0.04	0.24	0.28
99.90 - 99.94	0.05 - 0.09	0.38	0.44
99.85 - 99.89	0.10 - 0.14	0.47	0.55
99.80 - 99.84	0.15 - 0.19	0.54	0.64
99.75 - 99.79	0.20 -0.24	0.60	0.72
99.70 - 99.74	0.25 - 0.29	0.66	0.78
99.65 - 99.69	0.30 - 0.34	0.71	0.84
99.60 - 99.64	0.35 - 0.39	0.76	0.9
99.55 - 99.59	0.40 - 0.44	0.80	0.95
99.50 - 99.54	0.45 - 0.49	0.84	1.00

99.40 - 99.49	**0.50 - 0.59**	**0.90**	**1.07**
99.30 - 99.39	**0.60 - 0.69**	**0.97**	**1.15**
99.20-99.29	**0.70 - 0.79**	**1.04**	**1.23**
99.10 - 99.19	**0.80 - 0.89**	**1.10**	**1.30**
99.00 - 99.09	**0.90 - 0.99**	**1.16**	**1.37**
98.75 - 98.99	**1.00 - 1.24**	**1.25**	**1.48**
98.50 - 98.74	**1.25 - 1.49**	**1.38**	**1.63**
98.25 - 98.49	**1.50 - 1.74**	**1.49**	**1.76**
98.00 - 98.24	**1.75 - 1.99**	**1.59**	**1.88**
97.75 - 97.99	**2.00 - 2.24**	**1.69**	**1.99**
97.50 - 97.74	**2.25 - 2.49**	**1.78**	**2.10**
97.25 - 97.49	**2.50 - 2.74**	**1.86**	**2.20**
97.00 - 97.24	**2.75 - 2.99**	**1.94**	**2.29**
96.50 - 96.99	**3.00 - 3.49**	**2.05**	**2.43**
96.00 - 96.49	**3.50 - 3.99**	**2.19**	**2.59**
95.50 - 95.99	**4.00 - 4.49**	**2.33**	**2.74**
95.00 - 95.49	**4.50 - 4.99**	**2.44**	**2.88**
94.00 - 94.99	**5.00 - 5.99**	**2.61**	**3.07**
93.00 - 93.99	**6.00 - 6.99**	**2.81**	**3.31**
92.00 - 92.99	**7.00 - 7.99**	**2.99**	**3.53**
91.00 - 91.99	**8.00 - 8.99**	**3.15**	**3.72**
90.00 - 90.99	**9.00 - 9.99**	**3.30**	**3.90**
88.00 - 89.99	**10.00 - 11.99**	**3.51**	**4.14**
86.00 - 87.99	**12.00 - 13.99**	**3.78**	**4.44**
84.00 - 85.99	**14.00 - 15.99**	**4.01**	**4.71**
82.00 - 83.99	**16.00 - 17.99**	**4.22**	**4.96**
80.00 - 81.99	**18.00 - 19.99**	**4.41**	**5.18**
78.00 - 79.99	**20.00 - 21.99**	**4.58**	**5.37**
76.00 - 77.99	**22.00 - 23.99**	**4.72**	**5.55**
74.00 - 75.99	**24.00 - 25.99**	**4.86**	**5.71**
72.00 - 73.99	**26.00 - 27.99**	**4.99**	**5.86**
70.00 - 71.99	**28.00 - 29.99**	**5.10**	**5.99**
65.00 - 69.99	**30.00 - 34.99**	**5.26**	**6.18**
60.00 - 64.99	**35.00 - 39.99**	**4.55**	**6.39**
50.00 - 59.99	**40.00 -49.99**	**5.59**	**6.56**

Source: Table P1, columns E&H, Miles, 1963.

Impact

The author presented the proposed tables in the AOSA Purity. If approved, I will be submitted to the Rule committee to be voted on and included in the Rules. It is expected to help both seed testing laboratories and the native seed industry. It will provide the native seed industry with a statistical tool to determine whether the difference between two purity test results conducted in the same or different laboratories are significant from each other.

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