Rule Change Proposal No. 12

Purpose

To move **Table 2. Maximum tolerated ranges in germination percentage** from section **4.6 When to retest** to section **5.5 Germination tolerances**; to change the title of Table 2; to create a title for the existing table under section 5.5; and to add clear instructions and examples illustrating the use of both tables.

Present Rule

4.6 When to retest

a. *Retest when the range of 100-seed replicates of a given test exceeds the maximum tolerated range in Table 2 (Column C or D).* — To find the maximum tolerated range, compute the average percent of all replicates of a given test (drop a fraction less than 0.5, but increase to the next whole percent a fraction of 0.5 or more). The average is found in either Column A or B of Table 2 and the maximum tolerated range is found opposite in the appropriate Column (C or D). See also section 4.7b.

b. *Retest when at the time of the prescribed final count there are indications that a satisfactory germination has not been obtained.*

c. *Retest when there is evidence that the results may not be reliable due to any of the following:* (1) improper test conditions, (2) errors in seedling evaluations, (3) the presence of fungi or bacteria, (4) inaccuracies in counting and recording results.

d. *Retest when a sample shows seedling injury or abnormality as a result of chemical treatment, exposure to chemicals, or toxicity from any source.* The retest may be made in soil or in a mixture of sand and soil and the result of this test shall be reported.

e. Retest when no two satisfactory tests are within tolerance.

Note: In order to form 100-seed replicates, combine sub-replicates of 25 or 50 seeds which were closest together in the germinator.

Table 2. Maximum tolerated ranges in germination percentage[a]

Average percent germination		No. replicates of 100 seeds		Average percent germination		No. replicates of 100 seeds	
		4	2			4	2
A	B	C	D	A	B	C	D
99	2	5	---	75	26	17	14
98	3	6	---	74	27	17	14
97	4	7	6	73	28	17	14
96	5	8	6	72	29	18	14
95	6	9	7	71	30	18	14
94	7	10	8	70	31	18	14
93	8	10	8	69	32	18	14
92	9	11	9	68	33	18	15
91	10	11	9	67	34	18	15
90	11	12	9	66	35	19	15
89	12	12	10	65	36	19	15
88	13	13	10	64	37	19	15
87	14	13	11	63	38	19	15
86	15	14	11	62	39	19	15
85	16	14	11	61	40	19	15
84	17	14	11	60	41	19	15
83	18	15	12	59	42	19	15
82	19	15	12	58	43	19	15
81	20	15	12	57	44	19	15
80	21	16	13	56	45	19	15
79	22	16	13	55	46	20	15
78	23	16	13	54	47	20	16
77	24	17	13	53	48	20	16
76	25	17	13	52	49	20	16
				51	50	20	16

[a] Allowance for random sampling variation

5.5 Germination tolerances

The following tolerances are applicable to the percentages of germination and also to the sum of the germination plus the hard seed when 400 or more seeds are tested:

Mean	Tolerance	Mean	Tolerance
96 or more	5	70 or over but less than 80	8
90 or over but less than 96	6	60 or over but less than 70	9
80 or over but less than 90	7	Less than 60	10

When only 200 seeds of mixtures are tested, 2% shall be added to the above germination tolerances.

PROPOSED RULE

4.6 When to retest

a. *Retest when the range of germination of 100-seed replicates in a given test exceeds the maximum tolerated difference (see Table 2, section 5.5).*

Note: In order to form 100-seed replicates, combine sub-replicates of 25 or 50 seeds which were closest together in the germinator.

b. *Retest when at the time of the prescribed final count there are indications that a satisfactory germination has not been obtained.*

c. *Retest when there is evidence that the results may not be reliable due to any of the following:* (1) improper test conditions, (2) errors in seedling evaluations, (3) the presence of fungi or bacteria, (4) inaccuracies in counting and recording results.

d. *Retest when a sample shows seedling injury or abnormality as a result of chemical treatment, exposure to chemicals, or toxicity from any source.* The retest may be made in soil or in a mixture of sand and soil and the result of this test shall be reported.

e. *Retest when no two satisfactory tests are within tolerance (see Table 2a, section 5.5).*

5.5 Germination tolerances

a. Tolerances between replicates: Table 2 lists the maximum acceptable difference (i.e., tolerance) between two and four replicates of 100 seeds in a single germination test. The tolerance values were computed to allow for only random-sampling variation at the 0.025 probability level. Table 2 is adapted from S.R. Miles, 1963. Handbook of tolerances and of measures of precision for seed testing. P. 644. Table G1, Columns A, B, D, and L.

b. Procedure for finding the maximum acceptable difference between replicates in a germination test:

Calculate the average germination of the two or four replicates to the nearest whole number. Calculate the difference between the highest and the lowest germinating replicates. Locate the average germination in column A or B in Table 2. The maximum tolerated difference between four replicates appears in the same row in column C. For two replicates, it appears in the same row in column D. Compare the calculated difference between replicates with the maximum tolerated difference found in the table. If the difference between the replicates is equal to or less than the value found in Table 2, retest is not necessary. If greater, a retest must be performed.

Table 2. Maximum tolerance values between two and four replicates of 100 seeds in a germination test

Average percent germination		No. replicates of 100 seeds		Average percent germination		No. replicates of 100 seeds	
		4	2			4	2
A	B	C	D	A	B	C	D
99	2	5	---	75	26	17	14
98	3	6	---	74	27	17	14
97	4	7	6	73	28	17	14
96	5	8	6	72	29	18	14
95	6	9	7	71	30	18	14
94	7	10	8	70	31	18	14
93	8	10	8	69	32	18	14
92	9	11	9	68	33	18	15
91	10	11	9	67	34	18	15
90	11	12	9	66	35	19	15
89	12	12	10	65	36	19	15
88	13	13	10	64	37	19	15
87	14	13	11	63	38	19	15
86	15	14	11	62	39	19	15
85	16	14	11	61	40	19	15
84	17	14	11	60	41	19	15
83	18	15	12	59	42	19	15
82	19	15	12	58	43	19	15
81	20	15	12	57	44	19	15
80	21	16	13	56	45	19	15
79	22	16	13	55	46	20	15
78	23	16	13	54	47	20	16
77	24	17	13	53	48	20	16
76	25	17	13	52	49	20	16
				51	50	20	16

Example 1

Replicate 1 = 92%
Replicate 2 = 88%
Replicate 3 = 79%
Replicate 4 = 86%

Average germination % = $\frac{92 + 88 + 79 + 86}{4}$ = 86.25 (rounded to nearest whole number = 86%)

Difference between the highest and lowest germinating replicates = 92 -79 = 13%

In Table 2, for 86% average germination (column A), the maximum tolerance for four100-seed replicates is 14 (column C). Since the difference between the highest and lowest replicates (13%) is less than the maximum tolerance value (14%), retest is not necessary. The differences in germination among replicates are assumed to be due to random-sampling variation.

Example 2

Replicate 1 = 92%
Replicate 2 = 79%

Average germination % = $\frac{92 + 79}{2}$ = 85.5 (rounded to nearest whole number=86%)

Difference between the two replicates = 92 - 79 = 13%

In Table 2, for 86% average germination (column A), the maximum tolerance for two 100-seed replicates is 11 (column D). Since the difference between the highest and lowest replicates (13%) is more than the maximum tolerance value (11%), a retest is necessary. The difference in germination between replicates exceeds the maximum that can be assumed due to random-sampling variation.

c. Tolerances between germination tests. Table 2a lists the maximum acceptable difference (i.e., tolerance) between two germination tests on the same seed lot. The values are to be used to compare germination percentages (or the sum of germination and hard seed) determined from 400-seed tests or more. The tolerances are applicable for comparison of tests of the same seed lot, whether from the same or different submitted samples of that lot, and whether performed in one laboratory or different laboratories.

d. Procedure for determining whether two tests are within tolerance

Calculate the average of the two germination test results to the nearest whole number. Calculate the difference between the two germination results.
Locate the average in Table 2a (column A) and the acceptable difference (tolerance) for that average (column B). When the difference between the two germination tests is equal to or less than the tolerance, the two results can be assumed to be due to random-sampling variation.

Table 2a. Maximum tolerance values for 400 (or more)-seed germination tests of the same or different submitted samples tested in the same or different laboratories

Average percent germination	Tolerance	Average percent germination	Tolerance
A	B	A	B
96 or more	5	70 or over but less than 80	8
90 or over but less than 96	6	60 or over but less than 70	9
80 or over but less than 90	7	Less than 60	10

When only 200 seeds of mixtures are tested, 2% shall be added to the above germination tolerances.

Example 1

The germination for a 400-seed test of wheat is 87%. The germination of a sub-sample of the same seed lot submitted to another laboratory was reported to be 76%. Are these two test results within tolerance?

Average germination % = $\frac{87 + 76}{2}$ = 81.5 (rounded to nearest whole number = 82%

Difference between the two germination results = 87 - 76 = 11%
In Table 2a, for 82% average germination, the tolerance is 7.

Since the difference between the two tests results (11%) is greater than 7%, the difference is significant and not due to random-sampling variation. Differences among results might be due to sampling method, test conditions, seedling evaluation, or reporting error.

Example 2

A 200-seed germination test of orchardgrass from a forage mixture resulted in 79% germination. The label on the mixture indicated a germination of 87%. Are these two test results within tolerance?

Average germination % = $\frac{79 + 87}{2}$ = 83%

Difference between the two germination results = 87 - 79 = 8%

In Table 2a, for 83% average germination, the tolerance is 7%. Since the tests being compared are 200-seed tests, 2% is added to the tolerance, for a total of 9%. Since the difference between the two test results (8%) is less than 9%, it can be assumed to be due to random sample variation, thus the two test results are within tolerance.

HARMONIZATION STATEMENT

This proposal is just re-organization and clarification to the current germination tolerance tables in the AOSA Rules. It does not bring the tolerance neither apart nor closer to ISTA. It keeps every thing as is.

SUPPORTING EVIDENCE

There are two germination tolerance tables in the AOSA Rules. The first is Table 2 in page 40, which lists the maximum tolerances values between two and four replicates of 100 seeds in a germination test. However, the current title of the table "Maximum tolerated range in germination percentage" does not tell the reader what this table is about. Is it about comparing two test results or about comparing various replications among a germination test? In addition, it is not under the germination tolerance section (5.5), where seed analysts would normally expect to find germination tolerance tables. Furthermore, there is no clear instruction in section 4.6.a to explain how to use the table, and there is no example to help seed analysts to apply the procedures.

The proposed rule change would give an appropriate descriptive title to the table, move it to the germination tolerance section (i.e., 5.5), describe step by step how to use it and give an example on how to apply it in a real situation.

The second germination tolerance table is in page 58 in the Rule. It lists the maximum tolerance values for germination tests on the same or different submitted samples tested in the same or different laboratories on 400 or more seeds. However, this table has no number, no title, no procedures to explain how or when to use it. The only information currently given in the Rules about this table is that it is about germination tolerance. Thus, a seed analyst would have to figure out everything about this table from sources other than the Rules, or find ways to avoid using it.

The proposed rule change would give a number to the table, and an appropriate descriptive title. It will also describe step by step how to use it and give an example on how to apply it in a real situation.

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