A Comparative Look at AOSA and ISTA Tolerances

by

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PURPOSE
To provide a review the respective tolerances of both organizations and suggest some changes that might be considered in the interest of the harmonization of ISTA and AOSA Rules.
The tolerances of both organizations are based on a wealth of past statistical studies and a great many people deserve mention.
However, the most of the current tolerances of both organizations were developed by Professor Miles of Purdue University in the late 1950s and early 1960s.
In the preface to his handbook of tolerances published in 1963, Miles stated that “the tolerances for comparing tests made in different laboratories allow for variation due to the amount of inter-laboratory bias which existed in the 1950s.” He went on to say that “when the laboratories reduce the inter-laboratory bias, the tolerances may be reduced.”
He further stated that “if the bias is eliminated, the inter-laboratory tolerances should be computed from the binomial distribution model (random sampling error) only; they would then be the minimum possible.”
This presentation will provide a summary overview of ISTA & AOSA tolerances for:

• Purity (pure seed, inert matter, etc.)
• Germination
• Incidental seed contamination (e.g., noxious weed seeds)
• Miscellaneous tests results.
Let’s look first at ISTA Purity Tolerances for which there are three choices, depending on the law enforcement philosophy:

- Two-sided test at 5% significance level.
- One-sided test at 1% significance level.
- Two-sided test at 1% significance level.
• The AOSA Rules state that the purity tolerances are for a probability of error of 5%, but do not clearly state whether they are one-sided or two-sided.

• However, the AOSA Rules do state that they are used to determine if a deficiency exists. This would seem to imply that they are applied as one-sided tolerances.
AOSA has both **Regular** and **Special** Tolerances

- Regular tolerances are used when the sample is comprised of components of generally similar particle weight.
- Special tolerances are **MUCH MORE COMPLICATED** to compute and are used when the sample is comprised of components of substantially different particle weight.
The AOSA Purity Tolerance Where the average of two tests is **90.00-90.99**

- Nonchaffy seeds - **1.75**  
- Chaffy seeds - **2.06**  
- ISTA 2-S 5% - 2.00  
- ISTA 2-S 1% - 2.48  
- ISTA 1-S 1% - 2.50  
- ISTA 2-S 1% - 2.90  
- ISTA 2-S 1% - 2.92  
- ISTA 1-S 1% - 2.92


The Preceding Slide Shows Two Primary Factors Which Should be Recognized

- First, although the differences may not be that great, there are inconsistencies that perhaps should be recognized and addressed in the interest of harmonization.
- Second, it is important to recognize what is obvious - the principle of recognizing both random sampling error and experimental error is recognized by both associations. This is demonstrated in the increased purity tolerances for chaffy vs. nonchaffy species.
Finally, if the AOSA purity tolerances are calculated at the 5% significance level, it should be made clear whether they are to be applied as 1, or 2-sided tolerances.

I know that in Michigan they are applied as 1-sided tolerances in label enforcement.

If they are established as to be applied as 2-sided tolerances, but are being applied only on the under side, would make their application at the 2.5% level.
The fact that tolerances recognize and account for both

(1) **random sampling error**

and

(2) **experimental error**

is an important one and, in my view, relates to some of the problems with AOSA tolerances. Furthermore, this should be considered when establishing new tolerances, including those for **genetic purity testing**.
### ISTA Germination Tolerances

(From Miles 1963 ISTA Handbook)

<table>
<thead>
<tr>
<th>Mean</th>
<th>2.5% 2-way</th>
<th>Mean</th>
<th>5% 1-way</th>
</tr>
</thead>
<tbody>
<tr>
<td>98 to 99</td>
<td>2</td>
<td>99</td>
<td>2</td>
</tr>
<tr>
<td>95 to 97</td>
<td>3</td>
<td>97 to 98</td>
<td>3</td>
</tr>
<tr>
<td>91 to 94</td>
<td>4</td>
<td>94 to 96</td>
<td>4</td>
</tr>
<tr>
<td>85 to 90</td>
<td>5</td>
<td>91 to 93</td>
<td>5</td>
</tr>
<tr>
<td>77 to 84</td>
<td>6</td>
<td>87 to 90</td>
<td>6</td>
</tr>
<tr>
<td>60 to 76</td>
<td>7</td>
<td>82 to 86</td>
<td>7</td>
</tr>
<tr>
<td>51 to 59</td>
<td>8</td>
<td>76 to 81</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 to 75</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60 to 69</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>51 to 59</td>
<td>11</td>
</tr>
</tbody>
</table>
## AOSA Germination Tolerances

(Adopted in 1917 based on Rodewald, 1889)

<table>
<thead>
<tr>
<th>Range</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5</td>
</tr>
<tr>
<td>96 or more</td>
<td>6</td>
</tr>
<tr>
<td>90 to 95</td>
<td>7</td>
</tr>
<tr>
<td>80 to 89</td>
<td>8</td>
</tr>
<tr>
<td>70 to 79</td>
<td>9</td>
</tr>
<tr>
<td>60 to 69</td>
<td>10</td>
</tr>
<tr>
<td>Less than 60</td>
<td>11</td>
</tr>
</tbody>
</table>
Next, I want to compare AOSA and ISTA tolerances for other seeds, or noxious weed seeds.
Other than the obvious difference in terminology, again the ISTA gives a choice of two tolerances for other seeds, one based on a one-sided test at the 5% significance, and the other based on a 2-sided test at the same (5%) significance level.
The ISTA table shows the appropriate tolerance to be applied based on the average of the first (labeled) and second test results.
AOSA has only one table which gives the maximum number of noxious weed seeds within tolerance of the number labeled or represented.
According to the AOSA Rules, the tolerances are based on the formula
\[ Y = X + 1 + 1.96 \times \text{sq. root of } X \]
and have a significance level of 5%.
Since we are not concerned about whether there are actually less noxious weed seeds than labeled, the tolerance, in reality, has a 2.5% significance level.
My biggest criticism of AOSA tolerances concerns more recently developed tolerances for fluorescence and endophyte test results.
Some AOSA tolerances have been established without recognition of experimental error. This is the case for both the tolerances for fluorescence and endophyte tests which recognize only random sampling error. I am certain that if Miles were still active, this would not have happened.
During my tenure as Chair of the AOSA Statistics Committee, I have made a thorough review of the tolerances. Although I have noted many problems, I have not had either the leadership nor the statistical background to do much about these problems.
Now AOSA Statistics Committee has access to more capable statisticians who will be able to look again at the tolerances and address the problems that still exist.