INTERNATIONAL SEED TESTING ASSOCIATION
Secretariat, Zürichstrasse 50, P.O. Box 308, 8303 Bassersdorf, CH-Switzerland
Phone: +41 44 838 60 00 - Fax: +41 44 838 60 01 - Email: ista.office@ista.ch - http://www.seedtest.org

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ISTA Position Paper on Quantifying and Reporting Uncertainty of Measurement in Seed Testing

This document was prepared by the ISTA Statistics Committee, endorsed by the ISTA Executive Committee and submitted as proposal to the ISTA Ordinary Meeting 2007 for voting by the nominated ISTA Designated Members voting on behalf of their respective Government.

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ISTA Position Paper on Quantifying and Reporting Uncertainty of Measurement in Seed Testing

The ISTA Rules provide methods for sampling and testing seeds that allow the issue of seed sample certificates and seed lot certificates.

Uncertainty of measurement is a key aspect of ISTA's technical work in Rules establishment.

ISTA's long tradition in working on uncertainty started in 1931, as the very first edition of the ISTA Rules contained tolerance tables. S.R. Miles revised their statistical basis and published a "Handbook of tolerances and of measures of precision for seed testing" (Miles, S.R. (1963), Proc. ISTA, 28(3), 523-686). New tolerance tables continue to be introduced by ISTA as required.

Tolerance tables provide a mechanism for deciding whether the differences in results recorded among replicates for a quality test, or between tests, are acceptable or not acceptable.

The ISTA Accreditation Standard based on ISO Standard 17025 is the basis for ISTA laboratory accreditation. This standard requires under specific conditions a statement on uncertainty of measurement on the test report. For determining uncertainty, the ISO/Guide "Guide to the expression of uncertainty in measurement" is broadly accepted.

In this position paper, it is explained that ISTA is dealing with uncertainty in agreement with ISO requirements to the benefit of its clients by using the concept of tolerance tables for seed testing. Two aspects are specified, quantifying uncertainty of measurement, and reporting uncertainty.

1. Quantifying uncertainty of measurement

Uncertainty of measurement is defined as "A parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand." (International Vocabulary of basic and general terms in Metrology. ISO, Geneva, (1993).

The ISO-Guide and other literature describe two different approaches for quantifying uncertainty:

1. Individual "uncertainty sources" are identified and their contributions quantified. These so called "uncertainty components" are then combined mathematically to obtain a "combined standard uncertainty", from which in a next step an "expanded uncertainty" is derived. Usually, quantifications are made on the standard deviation level.

2. The total variation of estimates is quantified directly in comparative tests, without a detailed analysis of identity and contribution of the various uncertainty sources. From these data, the "combined standard uncertainty" and the "expanded uncertainty" are computed.

ISTA is using a combination of both approaches.

In comparative tests, the total variation of test results is determined according to approach 2. In-house replicates and other factors are also included, allowing the estimation of effects which are considered as potentially being uncertainty components according to approach 1 (e.g. the absolute level of the test result). Statistical distributions, e.g. the binomial or Poisson distribution, are also used as the basis for the random sampling error. From this total variation and identified uncertainty sources tolerance tables are developed. They contain those uncertainty sources that are relevant to specific test situations.

As ISTA is working worldwide, these routine data sets represent variation reported by experienced laboratories at an international level.

Statistical evaluations of the data are carried out according to good statistical practice. Technical steps, (search for outliers for instance), are not described in this paper.

With more than 750 species and more than 40 different types of tests covered by the ISTA Rules, individual tables for each test x species combination would be unpractical, and are not necessary. ISTA Technical Committees are careful when selecting species for uncertainty evaluations, and check for differences between species, or groups of species. If differences are not significant, uncertainty is seen as being not species specific, and one tolerance table can cover all species, or appropriate groups of species.

As the ISTA Rules ensure uniformity in seed testing, uncertainties are determined within ISTA, not within countries or for individual laboratories. Customers know that uncertainty of results is comparable from one ISTA laboratory to the other. To achieve and maintain this is a key element of ISTA's strategy and work, as mentioned in the ISTA logo "Uniformity in Seed Testing".

2. Reporting uncertainty of measurement in ISTA

ISTA does not report uncertainty on its certificates. Instead, the tolerance tables are published in ISTA documents like the ISTA Rules and ISTA Handbooks. These tables are known and available to ISTA customers.

Tolerance tables address specific situations, which are of practical interest for the laboratories, sellers, buyers, and regulatory authorities (e.g. a comparison of two test results obtained in different laboratories on the same submitted sample). Thus, for a seed testing method there is a set of tolerance tables available to cover different test situations of interest. Among existing tolerance tables, none is defined as the standard to be reported on an ISTA Certificate.

Indication of a value for uncertainty along with the result in the test report would create confusion for the users of the certificate. ISTA users know the value of uncertainty depend on the question (e.g. check the compatibility of replicates within a laboratory; compare two results obtained by two different laboratories, etc).

Many test results in seed testing are reported as percentage values. Tolerance tables illustrate the dependency of uncertainty on the level of the test result.

In germination testing uncertainty is 66 % higher when the test result is 50 % compared to when the test result is 90 %. This example is given to illustrate uncertainty in seed testing and how tolerance tables give appropriate uncertainty measurements to the customers.

Tolerance tables are user-friendly and can easily be applied in practice, even by staff or customers who are not able to compute. When comparing two test results there is no need to compute the maximum tolerable difference by means of the two expanded standard deviations. The answer is provided by the table from the two test values.

ISTA is committed to tolerance tables as the way to give information on uncertainty to its customers for seed testing. It is part of ISTA's service, has been well established for decades, and is recognized as appropriate by the seed sector worldwide. There is no contradiction between the ISTA system and ISO documents on uncertainty.