

# Seed Testing

## INTERNATIONAL

ISTA News Bulletin No. 142 October 2011



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**No. 142 October 2011**

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Dear Reader,

This is the issue of Seed Testing International after the ISTA Annual Meeting 2011. You will therefore find various reports on this truly outstanding event. Outstanding not only because of the many interesting and even astounding contributions presented during the ISTA Germination Seminar and the Technical Committee Presentations, but also because of its high number of participants – this in spite of the unscheduled change of venue from Tsukuba, Japan to Zurich, Switzerland.

ISTA meetings are known to be full of activities, and this meeting was surely no exception – but it was an exceptional meeting anyhow: it was a Japanese meeting held in Zurich. It was most fascinating to see how the Japanese delegates in a most amiable way enchanted everyone with a Japanese sentiment – this being almost 10000 km or 6000 miles away from home.

My sincere appreciation goes to the Japanese delegates representing the National Organising Committee of Japan, Sylvie Ducournau, Chair of the ISTA Germination Committee and organiser of the ISTA Germination Seminar, all the speakers of the Seminar, the ISTA Technical Committee Chairs and their representatives, and the Members of the ISTA Executive Committee, foremost our President, Joël Léchappé, who most successfully concluded his first ISTA Meeting in this role.

Last but not least, this is to express thanks to all the 184 participants who were able to join us in Zurich for their great input to the many events of the Annual Meeting 2011, which contributed to its success. We hope to see you all again next year in Venlo, the Netherlands, where ISTA will hold its Annual Meeting 2012 from 11–14 June, in conjunction with the FLORIADE. A special focus will be: ‘New developments and technologies in seed testing’, this being the topic of the one-day seminar organised by the Chair of the ISTA Committee on Advanced Technologies, Bert van Duijn.

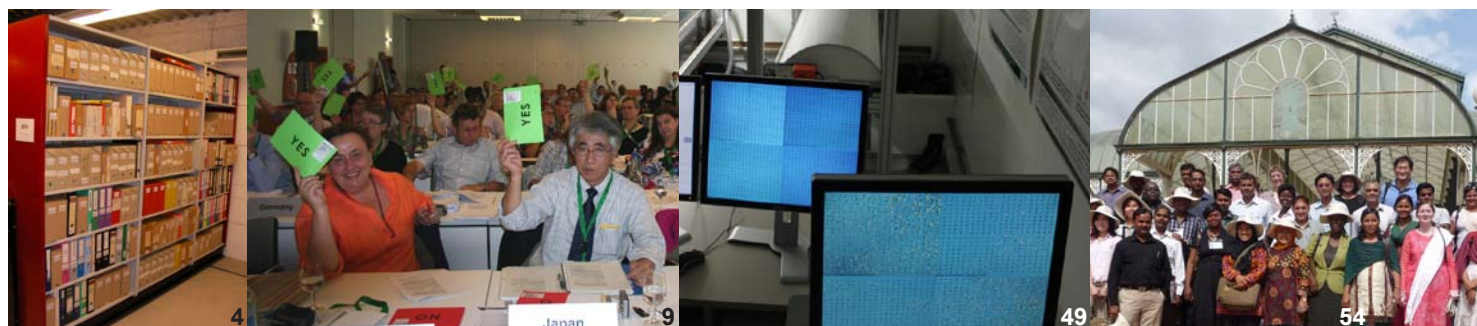
Also, planning is underway for the 30th ISTA Congress, to be held in Antalya, Turkey in 2013. This issue contains a first call for papers for the ISTA Seed Symposium 2013, one important part of the Congress programme. The Symposium Convenor, Alison Powell, invites people to present papers under the overall theme: ‘Evaluation of seed quality: a key step in exploiting the benefits of plant breeding and genetic conservation’.

Among the other scientific contributions to be found in this issue, I would like to draw your special attention to the feature article on the ISTA Secretariat archives, although its background is not really related to seed testing. However, it is no less interesting, giving a brief insight into the science of archiving, with some very interesting glimpses into the history of the Association, including pictures. These were found during a three-month archiving project, carried out by Raphaël Vaudaux, a Master student of History and Trades of Archives at the University of Angers, France. The project was initiated by our current President, Joël Léchappé, and was in fact only made possible with his help and commitment, for which we thank him sincerely.

I hope you will enjoy and benefit from reading this issue of Seed Testing International.

Yours sincerely,

Michael Muschick



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# President's Report

Joël Léchappé



The ISTA Annual Meeting, held in Zurich from 13 to 16 June 2011, was very successful, attracting 184 participants representing 49 countries. We had the great honour to welcome Mr. Junya Endo, Director of the Intellectual Property Division of the Ministry of Agriculture, Forestry and Fisheries of Japan, to introduce the Ordinary Meeting, followed by an impressive presentation of the seed industry in Japan by Mr. Madoka Koshibe, Chairman of the Board of Mikado Kyowa Seed.

On behalf of all of us, I would like to thank the Japanese delegates and our colleague Masatoshi Sato, member of the Executive Committee, for their highly appreciated contribution to the success of the Annual Meeting.

The Annual Meeting was preceded by a seminar on germination. It started with a presentation on physiology of germination and dormancy, giving the basis on the biological aspects. Then many topics around the germination tests were presented, such as seedling evaluation, quality assurance, the relationship with the tetrazolium test and seed health. The germination characteristics of the main categories of crops and species were presented, including flowers and tropical and subtropical species. The presentation of new technologies, including the use of image analysis, x-rays and chlorophyll fluorescence, showed new perspectives, but confirmed that the current

tests based on human expertise will remain for a long time. The Statistics Committee organized practical exercises with the existing tools and provided new statistical tools for calculating tolerances (available on the ISTA web site: [www.seedtest.org/stats-tools](http://www.seedtest.org/stats-tools)).

This seminar followed a series of seminars held before the ISTA Annual Meeting. They all combined scientific and applied presentations in various disciplines, as illustrated above. This form of seminar, linking science and its applications for controlling seed quality, is unique to ISTA.

I strongly believe that we should encourage and develop this role of ISTA.

The presentations of the Technical Committees over two days were indicative of the high level of expertise of these ISTA Members, who often do their ISTA work during their free time.

The participation of 43 voting delegates shows the great interest of the member states in the Association and its development. The support of the countries is of major importance for our Association to continue to guarantee the availability to the seed industry of up-to-date and internationally recognized methods on seed quality.

During the Annual Meeting, major issues regarding the future of the association were discussed. Among them, I would like to mention the following.

## 1. The analysis of the accreditation system

Following the request from the Designated Authorities of Australia and New Zealand supported by the ISTA Voting Delegates in 2010, Rita Zecchinelli presented on behalf of the ECOM a thorough and complete analysis of the ISTA accreditation system. This analysis included a comparison with other international standards and national accreditation schemes for testing and calibration laboratories. The analysis of the ISTA accreditation system showed that harmonization is truly guaranteed and unique, with the same system

auditors auditing worldwide, accompanied by technical auditors from different countries. The frequency of ISTA audits is in compliance with the minimum required by ISO standards. These audits are complemented by the proficiency tests. Compared to national accreditation systems complying with the ISO standard, the ISTA fees were lower in all situations analysed. In addition to this already detailed information, a cost-accounting system for ISTA products and services will be introduced within several years. The results will be presented when available. The analysis showed the high quality of the service provided by the ISTA accreditation system, characterized by its specificity and adaptation to the needs of the seed sector. The ISTA accreditation system is a true international evaluation of the competence of laboratories.

## 2. Constitution changes

Four changes to the constitution were adopted. The first was to clarify the procedures to be followed when a serving ISTA president resigns during their term of presidency. The second and the third adopted a procedure of "by correspondence" vote for meetings which are not quorate (applying to elections and adoption of ordinary meeting agenda items). The fourth change allows membership approval of the Executive Committee version of the ordinary meeting minutes to be obtained earlier than at the next meeting. These changes are aimed to clarify, to be more efficient and ensure the functioning of the Association taking in account the possible difficulties for attending the meetings.

## 3. Certificates for sublots

In response to the request from the Dutch authorities to allow the issuing of original certificates for seed sublots, Grethe Tarp as ECOM liaison officer presented the work done together with the Sampling Committee. They submitted for discussion a proposal to allow issuing original certificates for sublots without resampling or reanalysing. This proposal included the conditions

that the number of sublots should be limited to five, the size of the smallest subplot should be more than 20% of the size of the original lot, and the necessary information should be reported on the Orange Certificate as requested in the Rules (when adopted). This new rule, if voted on, will reflect the usual practice, reduce delays and costs, and facilitate trade, while guaranteeing the traceability and quality of the ISTA analyses. The proposal was discussed and received favourably by the Voting Delegates, and will be submitted to the vote in 2012.

#### 4. Rules changes

As usual, many Rules proposals were voted on, the result of the active work of the Technical Committees. I would like to bring your attention to the Rules proposals for seed mixtures. A new Chapter 18, with rules for purity, other seed determination and germination, was adopted. Rules for sampling the seed lot were not proposed as the complexity needs more statistical studies. All other Rules proposals were accepted, such as a method for the detection of *Orobanche* (broomrape), germination amendments, vigour tests on maize and seed health methods. These changes have been published on the ISTA web site and will be incorporated into the 2012 Edition of the ISTA Rules.

#### ECOM Working Groups

Three new ECOM Working Groups were set up after the Annual Meeting:

**The management of the Association:** the ECOM decided to set up a Working Group on 'Management and Finances of the Association', in very close connection with the Secretariat, who is fully involved.

**International relations:** the main objective is to strengthen and formalize collaboration with other organizations and regions. A lot of work is done regularly by the Secretary General and ECOM members. The new efforts will aim to cover more topics in small groups to share the work. As an example, in July, with Rita Zecchinelli and Michael Muschick, we had a meeting with the Head of OECD Codes and Schemes, Michael Ryan, and the Head of Division Agro-food Trade and Market, Wayne Jones. It was decided that ISTA would provide the OECD with a document presenting ISTA to be included in OECD documents. It was also decided to work on strengthening the collaboration between the two organizations.

**Working group on accreditation:** the Accreditation Department is supported by a Working Group reinstalled after interruption. The aims are to answer questions on accreditation from the Membership on a day-to-day basis, to enhance the ISTA Accreditation Standard, and to follow international developments in quality assurance.

Besides the Working Groups, the ECOM is dealing with several issues:

**Alison Powell as current Chief Editor of our journal Seed Science and Technology (SST)** has proposed several improvements, such as shortening the delays before publication to attract more high quality papers, organization, etc.

Alison agreed to take on this high responsibility on a short-term basis and has now found a new Chief Editor. On behalf of Alison, the ECOM and Michael Muschick, I am very pleased to announce that Fiona Hay, Scientist at the IRRI, the Philippines, formerly at the Millennium Seed Bank at the Royal Botanic Gardens Kew, UK, has agreed to be the next Chief Editor of SST.

On behalf of all I thank Alison for the tremendous work that she has done for us, both in seed science and as Chief Editor of SST.

We look forward to welcoming Fiona Hay as the future Chief Editor, starting in October 2011.

**Herbage seed lot size.** Grethe Tarp, as ECOM liaison officer, with the Sampling Committee and the Technical Department (Christof Neuhaus), are seeking to design a suitable organization and the financial means to finalize the experiment. One of the tasks is to define a proposal for a permanent regime. These proposals are being elaborated in close collaboration with the ISF, the partner in this experiment.

**Check sampling** is a very sensitive topic, identified by the auditors during a series of audits. The ECOM listened to the difficulties presented by some laboratories. The ECOM is very attentive to the quality of the sampling performed by the accredited laboratories, as the ISTA Rules and the accreditation for sampling are unique in the seed world. It is the guarantee of the traceability from the seed lot to the results of the analyses reported on the Orange Certificate. For these reasons, the ECOM asked the Accreditation Department, Ronald Don, Grethe Tarp and the Sampling Committee to consult the accredited laboratories via

an important and complete questionnaire on their usual practices. Based on the analysis of the questionnaire and the advice of the Sampling Committee, the ECOM decided that it is compulsory to have a monitoring system for samplers. It is strongly recommended to include check sampling and monitoring in audits. Guidelines will be elaborated to help the laboratories to implement the check sampling.

Before concluding, I would like to present some personal thoughts on the subject of the performance-based approach or flexibility of tests, such as for germination or seed health tests, discussed by the membership first in Cologne (2010) and then in Zurich in June.

In a general context of world economic crisis, combined with the necessity to guarantee the quality and safety of the products, the concept of reducing costs and lead times while continuing to guarantee the analyses is moving more and more to the heart of ISTA objectives. The first question was raised by Joost van der Burg (STI No. 139, April 2010), who proposed to extend the concept of the performance-based approach to germination tests. One example would be to authorize the laboratories to use in-house substrates for germination tests. The laboratory should demonstrate that the test complies with the general rules for germination. In addition, the results should be within the tolerances as obtained with the standard method published in the Rules. The performance-based approach is already used for GMO tests.

Another approach would be to adapt the existing methods to the objective of the tests and to the context of use. An example could be finalizing germination tests as soon as the required level of germination is reached (e.g. a certification standard of 90%), instead of waiting until the maximum germination. Other examples could be adapting the size of the working sample according to the accuracy requested, or, in the case of seed health tests, to the threshold of contamination. The level of risk and the level of accuracy requested should be evaluated. This would introduce more flexibility while maintaining accuracy. The support of statistics to guarantee accuracy and reliability will be crucial. The knowledge and the tools already exist; work should be done to adapt the tools to seed testing. If

(continued on page 56)

# The ISTA Secretariat archives: management tool and historical record

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The International Seed Testing Association (ISTA) was founded in 1924 at the fourth International Seed Testing Congress in Cambridge (UK). However, the objective of this article is not to offer a brief and necessarily incomplete history of ISTA or its Secretariat, but to present a few important elements for a good understanding of the procedures regarding archive production and management.

## Historical background

In the early years of the Association, the centre for all ISTA correspondence and requests moved with the office of the President. Between 1924 and 1939, the head office was located in Copenhagen (Denmark) at the Danish Seed Testing Station, directed by Knud Dorph-Petersen, the first President of ISTA. In 1939, when Hernfrid Witte became President, the office moved to Stockholm (Sweden). After the end of World War II, from 1945 to 1950, the current affairs were handled in Copenhagen, although the President was in Wageningen (Netherlands).

In 1950, a Secretary-Treasurer was appointed, and Copenhagen became the location of a real ISTA Secretariat. For the same reason, the Secretariat was moved in 1959 to Wageningen, in 1969 to Ås (Norway) and in 1978 to Zurich-Reckenholz (Switzerland).

In 2000, the Secretariat was established at Bassersdorf (Switzerland), in premises independent of any seed testing station. It is in this new context that the position of Secretary-Treasurer was replaced in 2001 by the position of Secretary General. All these changes are considered to be fundamental to the evolution of the organization and management of ISTA.

The many moves of the ISTA Secretariat were not conducive to a satisfactory archive management. The installation of the office at Bassersdorf allowed this for the first time. Taking care of archive management and preservation is crucial to ISTA in regard to both current affairs and historical knowledge. These are the basis of the ISTA identity and efficiency, and their importance needs some explanations.

## Definitions, procedures and standards

To begin with, some definitions and distinctions are required. Government administrations, private companies, individuals and associations have in common that they all produce archives. In this article 'archives' is used in its broadest sense. According to the International Council on Archives (ICA), 'archives' means all the current and semi-current records and documents, with or without historical value, created, received or collected by a legal entity during its activity. This includes all documents, regardless of date, form or medium. For instance, a mail received by ISTA from the OECD regarding their

relationship belongs physically and intellectually to the ISTA archives.

Each day, every legal entity creates and receives many documents of various kinds on various media: papers, e-mails, computer files, electronic data, tapes etc. A simple document is defined only by its content and information, but in an archive also origin, meaning and context of creation are taken into account.

Of course, not all these documents are intended to be preserved for their potential historical value, beyond their first lives as administrative or financial documents. Sorting, selecting and destroying unnecessary documents (copies, drafts, expired papers etc.) are indeed required procedures for good archive management, developed by professionals. Insufficient or lacking management, generally caused by a lack of time, would highlight the important tasks of the archivist.

The practice of this profession requires specific rules and deontology to be followed (International Code of Deontology by ICA, 1996). The conditions of communicability and preservation must be respected, determined in cooperation with the managers. Furthermore, the application of



Figure 1. Participants of the 8th International Seed Testing Congress in Zurich, 1937. ISTA archives, A622.



professional secrecy is fundamental with regard to all documents of a sensitive or confidential nature. The archivist must also have integrity and objectivity, and avoid any wrong use of archives as historical evidence.

Using specific standards (especially the General International Standard Archival Description (ISAD (G)) and the International Standard Archival Description for Corporate Bodies, Persons and Families (ISAAR (CPF)), the archivist must aim to develop all professional procedures and ensure compliance by others. The task is not only to develop a specific policy on the archives, but also to convince the managers of the producing institution and make them aware of the importance of maintaining current and semi-current records and historical documents.

Why should this be done? Firstly, to permit an easy and logical use of the documents necessary for daily activity, through inventories, management tables or file-naming rules. Secondly, to develop a global policy for managing the entire life cycle of archives safely and confidentially, especially for records with a legal or strategic value. This is getting closer to the concepts of Record Management according to ISO standard 15489.

Of course, historical archives also retain a fundamental value as evidence of the producer's activities. One of the most important missions of the archivist is to inquire and identify the documents produced, and to determine, in collaboration with the executives, the rules of archive management to add value to this evidence.

## Inventories and stocktaking

For archivists to obtain satisfactory knowledge about the producer, its missions and its document production, and also about the location of archives on the premises (offices, repositories, storage rooms, basements etc.), surveys are required. An inventory, whether it is a simple one made during a stocktaking procedure or a more complete one during a classification, is useful as a unique aid to locating documents. Indeed, preservation without any possibility of access is actually meaningless.

In the case of a serious backlog, a stocktaking (or "stock list") is the best way to proceed. The stocktaking, through the inventory, is the basis for a precise reorganization of the archives. If stocktaking has already been done, a complete classification is advised. This is an intellectual and physical organization of the folders belonging to an archive holding (or a part of it) and of the documents inside the folders. An archive holding is defined as a group of heterogeneous documents, structured by their producer in logical order (alphabetical, chronological etc.), according to activity and function. Maintaining this order is of fundamental importance to both producer and archivist, to preserve a good understanding of the original context of production.

Of course, the changing functions of the producer may create a new content or nature of the documents, but the archive holding remains the same.

There is another major principle which must also be respected: the gathering of documents from a single producer. Gathering elements from several provenances, even if they have a similar content, must be absolutely avoided, since it would compromise the integrity and logical order of the holding, as well as sharing. This is precisely the reason why archival work is based on an analysis of producer activities, and not on the organization chart. Classification will therefore include the creation of a filing plan of the producer's activities.

Of course, the professional archivist must be fully conscious of the effect of his work on the documents, and must respect as far as possible their original classification, if this exists. In this context, and to ensure a useful knowledge management, the description of archives in inventories and updates of these are highly recommended, since they allow a good sorting for records at the end. Finally, these procedures save considerable time, productivity and space. Archive management also increases autonomy, and allows good transitions in the case of employee turnover.

To be more specific, the goal of an archival description is to present the most meaningful data on the content of a document or a group of documents. It informs the user, in a standardized way, about the nature, location, action and date of a document.

Because using and preserving archives in a guaranteed context of quality and professional consensus is very important, it is necessary to enforce international rules of archiving. It is especially useful when national and local laws on archives are poorly developed, especially with regard to private institutions.

## Preservation

Parallel to the intellectual management leading to an inventory, the archivist and the executive managers must establish a precise policy for material preservation: choice and maintenance of repository equipment, survey of environmental conditions, selection of packaging materials, restoration or copying of certain documents, and the elaboration of rules for access, transfer and rescue procedures in the case of disaster. Of course, it is important to review the finances available for transferring document content from one medium to another, and to ensure information backup over decades (scanning, printing, computer file migration etc.).

Nevertheless, it should be mentioned that scanning is not a perfect solution for archive preservation, contrary to what is claimed by many commercial companies or computer specialists. Indeed, the cost (e.g. for subcontracting, personnel, equipment or data storage) and impact on the documents could be significant. However, scanning should be considered as a way to protect documents which need to be regularly accessed.

## User training

With regard to communication, there are several important points. All relevant personnel must learn the basic rules of using and preserving archives. Each document is practically unique, and therefore precautions are necessary: good handling, keeping food and drinks off documents, limitation of copying. Each borrower must leave a descriptive paper in the place of each consulted box or folder for the entire duration of the loan. Tracking is also required, to ensure that each document is returned to its right place and to avoid losses. Registration also allows the managers to col-

lect useful statistics and obtain a realistic overview of archive movements.

The benefit of developing actions on archives helps to foster both good use and sufficient understanding of the documents. For example, surveys of storage conditions, reference numbering and sorting make it possible to save time, space, money and energy.

### The ISTA archives

In order to apply all these procedures to the ISTA archives, it is first necessary to understand the nature of the various archive holdings at the ISTA Secretariat. A distinction has to be made between the archives produced by ISTA and those produced by other corporate bodies. This is not an easy task.

The ISTA archives comprise the documents produced by the Association, through its various bodies: Assembly of Ordinary Meetings, Executive Committee (ECOM), President, Technical Committees (TCOMs), Secretary General, Secretariat staff etc. Documents concerning ISTA but produced by Laboratory Members or Personal Members must be separated, because they belong to other corporate bodies, such as governmental agricultural administrations or private seed companies with specific activities and goals.

However, despite this principle, it is often difficult to make this kind of distinction in an organization such as ISTA, whose activity is mostly based on the Members, who work voluntarily, mainly at their places of work or private residences. This is in contrast, for example, to a company which requires its employees to produce, store and preserve on its own premises all the records which are its entire property alone.

Nevertheless, the existence of a permanent Secretariat allows ISTA to concentrate in one single place an important part of its archives, reflecting the nature of the scientific and administrative exchanges between the Secretariat, the ECOM, the TCOMs and other related institutions.

Of course, ISTA can also accept the donation of archive material from other producers, mostly to prevent the loss of material when a laboratory is closed down. Even if ISTA and its Secretariat are not an institution with the goal of preservation,

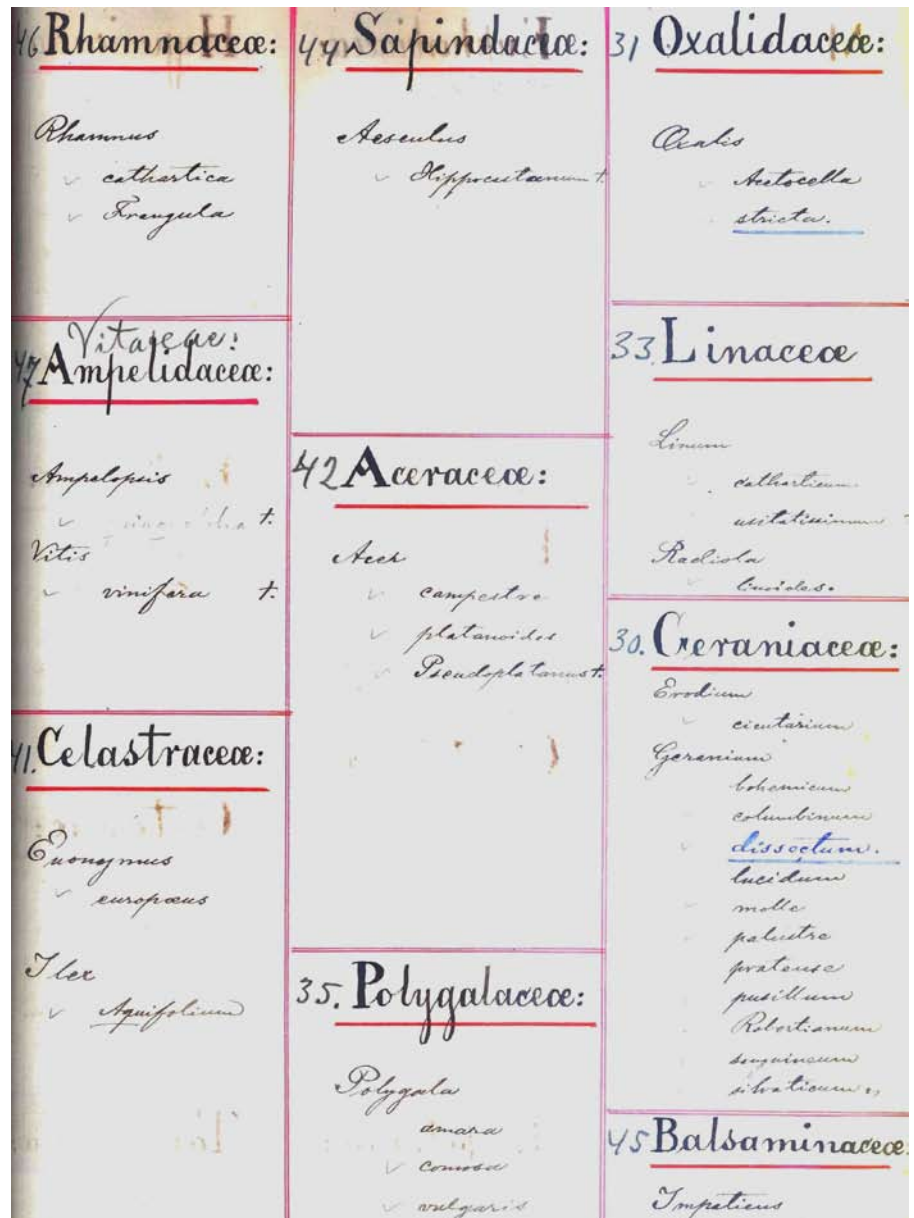


Figure 2. List of Swedish phanerogamous plants by Tom von Post (1902). ISTA archives, A625.

the interest of the executives in the history of seed science and the availability of storage space can allow the preservation and management of several archive holdings at the Secretariat, according to archival management rules. This is precisely the reason why we can find archives of several origins at the Secretariat.

Because of their provenance and nature, several groups of archives, now preserved in a specific repository at the ISTA Secretariat, must be distinguished. To allow a good understanding of the intellectual and physical organization, it is necessary to allocate different temporary reference

numbers to each group. These numbers come in the form of one letter and numbers from 1 to n.

Thus, a first series, from A1 to (currently) A627, comprises ISTA archives. These archives date from 1902 to 2010, but most are from the 1970s to the 2000s. They are mainly collections of ISTA publications and those of other institutions (*News Bulletins, Seed Testing International, Proceedings, Seed Science and Technology, International Rules of Seed Testing*, handbooks, booklets, working sheets etc.) and of course boxes, binders and folders of archives covering all tasks of the Secretariat.



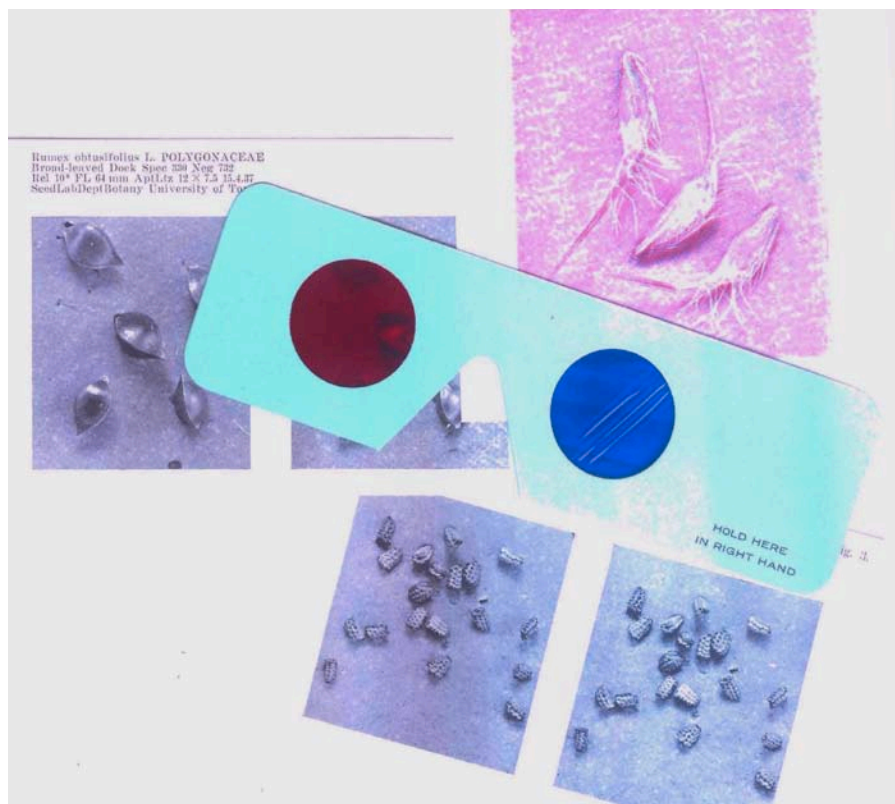
Folders and files from the Administration Department, Accreditation Department, Meeting Organization, Membership or Finances management, the International Rules for Seed Testing, TCOM management or the missions of the Secretary General are preserved there.

A second series, closed, from B1 to B45, is a group of archives received from the Danish State Seed Testing Station and Danish Plant Directorate in Copenhagen, in August 2010, when the Seed Testing Station closed. This series is composed of several parts, which will also have to be considered during the future classification. B1 to B8 is a collection of ISTA Proceedings (1925–1993) collected by the Danish State Seed Testing Station.

On investigation, B9 to B45 (1916–1980) appears to be a subgroup of ISTA archives kept in Denmark since the period of K. Dorph-Petersen. These comprise archives of the ISTA President (mostly correspondence), in collaboration with his secretary, who is also considered to be representative of ISTA, but not as a real Secretary-Treasurer until after World War II. With regard to this subgroup, it must be noted that between 1921 and 1924 these archives correspond to documents produced by the European Seed Testing Association (ESTA), since ESTA did not become ISTA until 1924, but the undisputed connection between these two organizations makes this a uniform subgroup. The same connection could be considered with regard



**Figure 4.** Shelving section of the ISTA archive room after stocktaking in 2011.



**Figure 3.** 3D glasses and specific pictures for a booklet edition (1938). ISTA archives, B23.

to the archives of 1920–1921, containing documents of K. Dorph-Petersen as an influential member of the International Seed Testing Conference, and not as Director of the Danish Seed Testing Station.

The third series (1959–2003), from C1 to C15, is another totally independent archive holding. It was handed over to the ISTA Secretariat in September 2009 by the Forest Research Station of the British Forestry Commission (Surrey, UK), an ISTA Member Laboratory until the end of 2006. Most of these archives cover the activity of this laboratory in several ISTA TCOMs, especially the Forest Tree and Shrub Seed Committee (FTS). This preservation, made possible by the initiative of former FTS Chair Peter Gosling, ensures the survival of these documents.

Finally, the fourth series (1947–1977), also closed and consisting of only one item (D1), was received in April 2011 from the department of Plant Ecology and Crop Biology of the University of Hamburg. This is a collection of pamphlets regarding rules and standards of seed testing in North America, Germany and Thailand between 1947 and 1977.

For completeness it must be mentioned that a part of ISTA archives is preserved at the Danish National Archives in Copenhagen. A delivery record, kept in box A622, informs us that this archive holding is composed of 47 physical units, according to the description on the Danish National Archives web site. These archives date from 1924 to 1973, and cover the most part of ISTA Secretariat activity (correspondence, referee tests, TCOM management, finances, personnel etc.). That these units are now in Copenhagen could be the result of a deposit made in the 1970s, perhaps when the Secretariat was in Norway, but this remains to be confirmed.

### Practical work

My work at the ISTA Secretariat at Bassersdorf, as a trainee archivist, was first to develop contacts with the executive management and staff to obtain a maximum of information on ISTA objectives, procedures and internal organization. Of course, the study of ISTA publications and documentation also helped a lot. In collaboration with Mrs. Patricia Muschick, I then

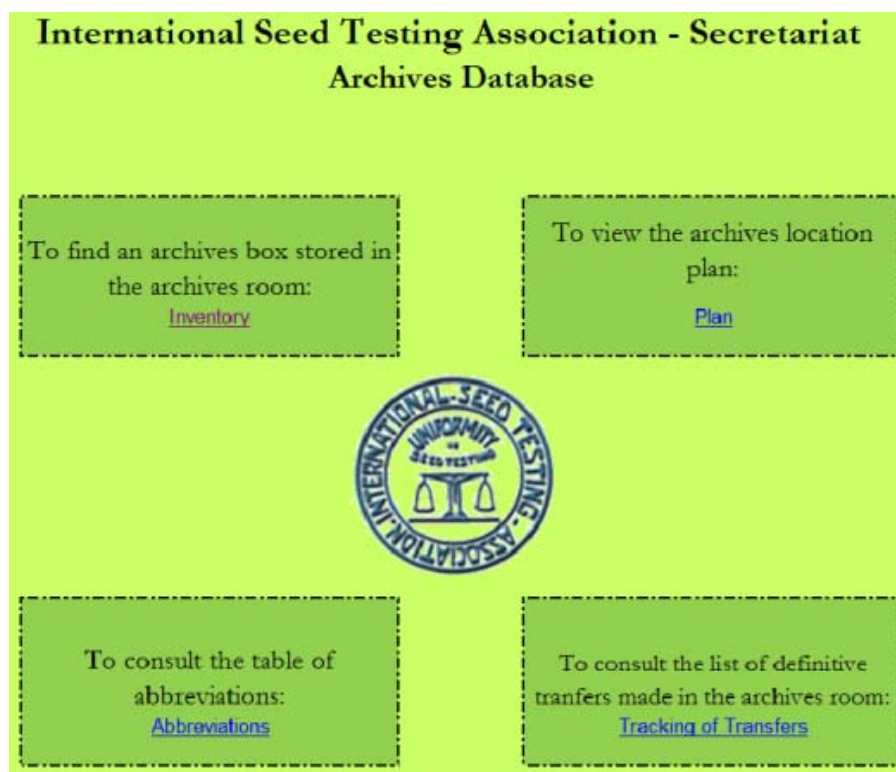


Figure 5. Home page of the archive database of the ISTA Secretariat (2011).

Table 1. Example for an inventory entry for a document unit

| Reference no. | Creator | Title                | Analysis  |
|---------------|---------|----------------------|---|
| A207          | ISTA    | Technical Committees | <b>Proficiency Test</b> , Request on time required to conduct <i>Trifolium incarnatum</i> testing: mail, e-mail (2003). |

aimed to define a storage strategy to preserve the ISTA archives in the best possible conditions. The archive repository, belonging to the private company MBA, from whom ISTA rents several shelving units, was the best place for archive preservation (shelving, temperature, humidity and light quality)(Figure 4).

After cleaning and selection of ISTA publications to be kept for selling or preserving, I decided on the best way to organize the archives in that room and the type of archival boxes required. The packaging of single folders and documents and relocation from one room to another was then carried out, with the former order being maintained, if existing. Then, the creation of logical reference numbers, based on the provenance of the archive holdings, allowed a good labeling in the context of stocktaking.

Of course, the major part of the work was the inventory. This consists in theory of the description of the document units in the physical order as they are presumed to have been lined up. In an Excel file, I described around 700 items (boxes, binders, packages) according to archival standards, specifying their locations, reference numbers and covering dates, the identity of the producer, and of course the analysis of the content of each document unit. This last task consisted of listing the main title, the subject matter, the administrative action and the types of documents included (see Table 1 for an example).

At the beginning of this internship, it was expected to perform a stocktaking of all current and semi-current records stored in the Secretariat offices (mainly the Accreditation Department and Membership Management), but this proved to be impossible because of lack of time. Indeed, the description of archives requires much time to produce a specific inventory which is easily usable and scientifically acceptable. The fact that the archives are in several languages (mainly English, German, French, Danish and Norwegian) leads to the necessity of time-consuming translation. This work at the ISTA Secretariat will therefore have to be continued by other trainee or graduate archivists until the entire classification is finished.

### The future

Finally, the substantial issues of this work are to allow an easier use and knowledge of the archive holdings preserved by the ISTA Secretariat, for both internal activity and external requests (legal, administrative, fiscal and historical). It also gives executives the possibility to have a representative big picture of archives which permits the future pursuance of an increasing management. Furthermore, it could allow a new appreciation of the ISTA heritage which would certainly promote the importance of the Association in both scientific and political circles worldwide. This could perhaps begin with an interesting work by a student of history on the development of ISTA since the 1920s. It could also be realized through exhibitions at the Secretariat, at ISTA meetings or at Member Laboratories. Of course, an online exhibition would also be a good way to present inventories, pictures or even scanned correspondence. All this would make ISTA and its Secretariat a good example to follow not only regarding seed testing, but also on the management and appreciation of archives.

As noted, the ISTA Secretariat became the refuge of several archive holdings from members of the seed testing community. In order to preserve the heritage of seed science and the seed testing stations, each station could, on closure, propose that its historical archives are donated to the ISTA Secretariat. ■



# Report from the ISTA Annual Meeting 2011

The Annual Meeting 2011 was held in Zurich, Switzerland, from 13 to 16 June. Originally the meeting was scheduled to be held in Tsukuba, Japan, but due to the very difficult situation in Japan after 11 March, the ISTA Executive Committee decided to change the venue to Zurich, Switzerland, near the headquarters of the Association.

The venue was the Hotel Novotel Zurich Airport Messe, Glattpark (Zurich). The meeting was attended by 184 delegates from the seed industry and governments, representing 49 countries.

The Welcome Reception on 12 June was opened by Joël Léchappé (France), the President of ISTA. Since we had beautiful summer weather, the participants enjoyed the delicious food and drinks outside on the terrace.

On Monday, 13 June, the Germination Seminar, organized by the ISTA Germination Committee, was held (see report on p. 14).

On the next two days the ISTA Technical Committees (TCOMs) presented their work. On Tuesday evening they took the opportunity to hold their own side meetings. Some of them were open to all delegates, allowing interested people to hear more details about the future plans of the Committees. These meetings are always a great opportunity for TCOM members to meet and discuss their projects.

The Official Dinner took place on Wednesday evening on “top of Zurich” in the Hotel Uto Kulm, with its wonderful view over the city of Zurich. The highlight of this evening was the moving speech of our guest of honour Mr. Junya Endo from the Ministry of Agriculture, Forestry and Fisheries of Japan, who brought sake for the participants from the Japanese region which was affected by the tsunami.

On Thursday the ISTA President Joël Léchappé welcomed all delegates to the Ordinary Meeting. The meeting started with the official address by Mr. Junya Endo, and was followed by a presentation on the development of the seed industry in Japan given by Madoka Koshibe. In his







The view over the Lake of Zurich from the Uetliberg, the venue of the Official Dinner.





presentation, among other things, he spoke about the Japan Seed Trading Association (JASTA) and the nuclear disaster.

Afterwards the changes and the future of the Association were discussed and voted on. The minutes and all other approved documents from the Ordinary Meeting can be found on the ISTA web site ([www.seedtest.org/AM11](http://www.seedtest.org/AM11)).

We would like to thank all speakers and participants for the successful meeting in Zurich, but foremost the Japanese delegation for bringing the spirit of Japan to Switzerland: Mr. Junya Endo, Director of the Intellectual Property Division, Agricultural Production Bureau, Ministry of Agriculture, Forestry and Fisheries of Japan; Mr. Madoka Koshibe, Chairman of the Board of Mikado Kyowa Seed Co. Ltd.; and Mr. Masatoshi Sato, Member-at-Large of the ISTA Executive Committee.

The ISTA Annual Meeting 2011 was a great success due to the active participation of the delegates and lively discussions. Certainly, also, due to the help of the very competent and friendly hotel staff.

The presentations and further information about the Annual Meeting 2011 are available on the ISTA web site at [www.seedtest.org/AM11](http://www.seedtest.org/AM11). ■





Mr. Junya Endo, Director of the Intellectual Property Division, Agricultural production Bureau, Ministry of Agriculture, Japan.



Mr. Madoka Koshibe, Chairman of Mikado Kyowa Seed Co. Ltd.



Dr. Michael Muschick, ISTA Secretary General.



Rules Chair Steve Jones during the voting on the Rules Amendments.



The Membership during voting.





The ISTA Technical Committee Chairs.



ISTA President Joël Léchappé.



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from the ISTA Secretariat (for contact details, see back cover)



# ISTA Germination Seminar

## Zurich, Switzerland, 13 June 2011

S. Ducournau

Chair, ISTA Germination Committee

GEVES

Station Nationale d'Essais de Semences  
49071 Beaucauzé, France  
sylvie.ducournau@geves.fr

The ISTA Germination Seminar was held as the first event of the ISTA Annual Meeting, and was organized by the ISTA Secretariat, the Japanese National Organizing Committee, and of course all the members of the Germination Committee, including our previous Chair, Ronald Don, who was involved in this project since the beginning.

There were 179 participants, scientists and seed laboratory specialists from private, state and public sectors attending the seminar. Fifty-five countries were represented.

Many aspects of germination testing were covered, from academic science to practical aspects covering the biology of germination, statistics and quality assurance.

Mechanisms of physiology of seed germination and dormancy were detailed by Alison Powell, United Kingdom, who has been working for 25 years in research and teaching at the University of Aberdeen. These mechanisms are the basis of the principles of germination tests.

Some examples of species with difficult germination were described first by Karen Hill, manager of the Queensland Seed Technology Laboratory from Australia, and then by Rita Zecchinelli, head of the seed testing laboratory near Milan, Italy. Karen presented interesting methods for improving germination in tropical and subtropical species, and Rita, Chair of the Flower Seed Committee, presented the germination behaviour of many groups of flower species, pointing out improvements that could be made for seedling evaluation. Both showed that, besides the agricultural species well covered by the current Rules, there is a wide field for further studies on flower seeds and tropical and subtropical crops.



Seed health is a very important seed quality characteristic that greatly affects germination capacity and seedling development. Valerie Cockerell, chief officer of the Official Seed Testing Station for Scotland and former Chair of the Seed Health Committee, presented a communication on the influence of seed health on germination quality. She described the effect of diseased seeds on germination and the influence of germination conditions on the amount of infected seedlings.

Stephanie Krämer, senior seed analyst at the Centre for Agricultural Technology Augustenberg at Karlsruhe, Germany, presented the relationship between tetrazolium and germination tests. She showed many examples of species where germination and tetrazolium test results were compared, with good correlations.

Latest developments in seedling evaluation were presented by Sylvie Ducournau, head of the germination laboratory at the French National Seed Testing Station, and Gillian McLaren, seed testing manager and quality manager for the Official Seed Testing Station for Scotland.

Sylvie Ducournau, Chair of the Germination Committee, detailed the changes in coleoptile evaluation of *Zea mays* and in root system evaluation in *Lolium*.

Gillian McLaren presented the recent improvements introduced in the *Handbook on Seedling Evaluation* on cotyledon evaluation. This work was carried out by Takayuki Okuda, member of the Germination Committee, who initially had to present it in Japan.

In the afternoon, two hours were dedicated to the use of calculations and statistical tools for germination testing. This session was led by Jean-Louis Laffont, senior research scientist at Pioneer and Chair of the Statistics Committee, with the help of Kirk Remund, from Monsanto, Vice-Chair of the Statistics Committee. After a presentation of the different tools available for germination results analysis, participants were asked to do some practicals and exercises, using calculation sheets downloaded from the ISTA web site. All the participants became rapidly enthusiastic about statistics for germination, which were presented in a very clear and pleasant manner.





Kirk Remund assisting some of the participants.



Important aspects of quality control in germination testing were presented by Rasha El-Khadem, responsible for all accreditation activities within ISTA, and Anny van Pijlen, from NAK AGRO in the Netherlands, Vice-Chair of the Germination Committee.

They presented various aspects dealing with the checking of equipment and supplies, and also monitoring considerations.

Joël Léchappé, Director of the French National Seed Testing Station and current President of ISTA, presented a communication on evolution in germination testing.

He highlighted the crucial role of germination tests in seed trade throughout the decades. He insisted on the importance of

having simple, reliable and standardized methods on which the seed trade can rely for the safeguard of the germination tests. He also discussed the future needs for flexibility in germination conditions, to ensure the continuance of seed testing, but without decreasing test uniformity.

The last talk of the day was by Bert van Duijn, professor in physiology and chief scientific officer at Fytagoras. Bert van Duijn is also the current Chair of the Advanced Technologies Committee, and as such, he presented new technologies that could be developed for germination testing. He gave interesting examples of applications using spectroscopy, image analysis and hyperspectral analysis and imaging.

All the presentations are available on the ISTA web site (<https://www.seedtest.org/upload/cms/user/Programmeforwebsite1.pdf>). They showed during the seminar that much progress is being made on germination testing, and that this progress is due to the contribution of many ISTA Technical Committees.

Particular thanks are due to the colleagues of the Germination Committee for their input, to the ISTA Secretariat, which made it possible by coordinating all the logistical planning and preparations, and lastly to the lecturers, who contributed with really interesting presentations to ensure the success of the Seminar. ■



The lecturers being thanked by Sylvie Ducornau, Chair of the Germination Committee.



# Auditors' Meeting 2011

R. El-Khadem, M.J. Kelly and B. Opra

ISTA Accreditation Department

The Auditors' Meeting took place on Tuesday, 14 June, from 18:50 to 20:30, after the day's events of the ISTA Annual Meeting.

Nine technical auditors were able to participate, as well as the three system auditors from the ISTA Secretariat, including the head of the Accreditation Department.

## Review of ISTA Certificates issued

There has been some discussion as to what is acceptable as a record for audit purposes regarding ISTA Certificates issued by a laboratory.

For example:

- Accreditation Standard Clause 9.2 does not insist that the record be a photocopy of the exact ISTA Certificate that was issued.
- Are electronic versions of the ISTA Certificates with all required details clearly visible (e.g. signature, stamp) acceptable as records?

At the outcome, the auditors agreed that the laboratories will be asked to have readily available a selection of paper copies of certificates, issued over the past three years.

## Paperless reporting using electronic signatures

The Accreditation Department investigated the possibility of using electronic reports to reduce shipping costs and to deliver reports faster.

Laboratories will from now on be asked during the closing meeting of their audit whether they would accept electronic copies of audit reports. Paper copies will still be provided if this is preferred. Electronic reports would be issued in PDF format with both auditors' signatures.

All agreed that the time and resources saved by electronic reporting would be invaluable.

## Use of personal laptops at audits

The merits were discussed of both system and technical auditors having their own laptops to record the findings to be presented at the close of the audit.

The auditors agreed that both will bring their laptops to save time during the audit.

## Audit timetable/plan revision

An audit timetable has historically been provided to all laboratories prior to an on-site assessment. This document has always dictated the same time format, regardless of a laboratory's scope of accreditation. In order to more realistically approach the order of the day, a much more comprehensive plan, tailored to the individual laboratory, was presented. The aim is to use the laboratory's scope of accreditation as a basis and to consider the commitment of the laboratory staff involved, taking the laboratory's specific circumstances into account (e.g. translation needed? Travel to sampling facility needed?). This plan had actually been put into use as a first trial during a recent audit visit.

The auditors discussed the possibility of a similar plan for future assessments. They were invited to submit their reactions to this draft to the Accreditation Department in the near future.

## ISTA Audit Plan 2011–2012

The audit statistics for 2011 and those forecast for 2012 were presented. The possible occurrence of "repeat audits" for poorly performing laboratories was discussed.

## Proposal for audit findings to be distributed to TCOM Chairs

The Accreditation Department reported that it was proposing to present audit findings to the TCOM Chairs, while protecting the identity of the laboratories.

The laboratories could receive feedback at the Annual Meeting. This will require discussion and planning before it can be implemented.

## GMO workshop for ISTA auditors

The need for a GMO workshop for auditors has been known for some time, and has now been preliminarily scheduled for May or June 2012. With eleven laboratories holding accreditation for GMO testing using the performance-based approach, it is imperative that the auditors have regular theoretical and practical training on the specific requirements to be audited. The minimal requirements must be rigorously defined to provide uniform assessments. Most auditors expressed their interest in attending this workshop next year.

## Open discussion

The conclusion of the agenda allowed the auditors to discuss their particular issues. This is a very helpful session for the auditors to bring troublesome points to light and to "brainstorm" amongst themselves to reach the best solution. The subject matter was mostly technical and included the following topics:

- tolerances vs. level of confidence for germination cabinet temperatures;
- measurement of water-holding capacity;
- conductivity of germination substrate.

## Conclusion

The open discussion was followed by the adjournment of the meeting by Rasha El-Khadem, head of the Accreditation Department, who thanked the auditors for their attendance.

The evening concluded with a delightful dinner at a nearby Italian restaurant which was heartily enjoyed by all.

We hope to see everyone again, especially those who were unable to join us this time around, next year during the 2012 Annual Meeting in the Netherlands! ■

# Changes to the *International Rules for Seed Testing* 2012 Edition

Again this year, a number of changes and amendments to the ISTA *International Rules for Seed Testing* were proposed at the Ordinary Meeting under Agenda point 9. These included final modifications to the Rules Proposals which were discussed and agreed on at the meeting of the Rules Committee the previous day.

Major additions are a test for *Orobanche* seeds in Chapter 4, one revised and two new seed health testing methods, and a new chapter covering seed mixtures.

The Rules Proposal document listing all approved Rules changes for 2012, with the final modifications marked in green, can be downloaded from the ISTA web site at <https://www.seedtest.org/am11>.

## Chapter 1: Certificates

- Reporting the methods for evaluating fresh seeds

## Chapter 2: Sampling

- Addition of *Prunus persica* to Table 2A. Part 2
- More general description of sampling stick, to include sticks which open with a push-pull motion
- Sampling stick partitions obligatory also for diagonally downward use
- Hand sampling: deletion of misleading example genera
- Obtaining the composite sample: clarification

- Sampler not required to dispatch submitted sample
- Separate procedures for obtaining the submitted sample and working sample
- Spoon method for *Arachis*, *Glycine* and *Phaseolus* and *Abies*, *Cedrus* and *Pseudotsuga*
- Hand halving method extended to further species

## Chapter 3: The Purity Analysis

- Addition of *Tripleurospermum* and *Althaea* to Table 3B Part 1
- Deletion of Pure Seed Definition 30
- Editorial changes to many PSDs

## Chapter 4: Determination of Other Seeds by Number

- Inclusion of a test for *Orobanche* spp.
- Reporting of actual sample weight

## Chapter 5: The Germination Test

- Use of vacuum counters clarified
- Reporting the method for evaluating fresh seeds
- New germination method for *Solanum nigrum*

## Chapter 6: The Tetrazolium Test

- Clarification of test definition
- Clarification of premoistening procedure

- Deviations from standard staining temperatures
- Procedures with hard seeds
- Changes to Table 6A for clarification

## Annex to Chapter 7: Seed Health testing Methods

- Revised seed health method 7-003: *Botrytis cinerea* on *Helianthus annuus*
- New seed health method 7-013b: *Ustilago nuda* on *Hordeum vulgare*
- New seed health method 7-027: Osmotic method for *Pyrenophora teres* and *P. graminea* on *Hordeum vulgare*

## Chapter 9: Moisture Content

- Correction to reporting of moisture meter results

## Chapter 11: Testing Coated Seeds

- Merging of Chapter 11 with Annex to Chapter 11

## Chapter 15: Seed Vigour Testing

- New radicle emergence test for *Zea mays*

## Chapter 18: Testing Seed Mixtures

- New Rules Chapter

## *International Rules for Seed Testing*, 2013 Edition Deadline for Rules proposals

All Rules proposals for consideration at the 2012 Annual Meeting in Venlo, the Netherlands, must be submitted by **1 November 2011**. Please send your proposals to:

- ISTA TCOM Co-ordinator, Christof Neuhaus ([tcom@ista.ch](mailto:tcom@ista.ch))
- ISTA Rules Chair, Steve Jones ([Steve.Jones@inspection.gc.ca](mailto:Steve.Jones@inspection.gc.ca))
- ISTA Rules Vice-Chair, Craig McGill ([C.R.McGill@massey.ac.nz](mailto:C.R.McGill@massey.ac.nz))
- ISTA Publications Specialist, Jonathan Taylor ([publications@ista.ch](mailto:publications@ista.ch)).



# Constitution changes

At the ISTA ordinary meeting, four proposals for changes to the ISTA Constitution were submitted for voting. All four proposals were passed by the Voting Delegates.

The changes concern Article VI, V and X of the ISTA Constitution, now reading as follows:

## ARTICLE V

### *Officers*

...

(b) The tenure of office of the President and Vice-President shall be from the adjournment of the ordinary meeting at which they were appointed to the adjournment of the ordinary meeting held in the third year after the ordinary meeting at which they were appointed.

**If the ordinary meeting at which elections are held is not quorate the tenure of the existing Executive Committee will continue until a 'by correspondence' vote can be held to discharge the Executive Committee and to appoint a new Vice-President and new Executive Committee.**

...

## ARTICLE VI

### *Functions of Officers*

...

(b) The Vice-President shall assist the President and, in the event of the inability of the President to serve, shall carry out such duties as pertain to the office of the President. **In the event that a President cannot continue in office for the remainder of his/her term, the Vice-President will be referred to as the President for the remaining period of that Presidency and will also serve for the expected period of his/her own Presidency.**

## ARTICLE X

### *Meetings of the Association*

...

(d) Designated Members designated by forty percent of the Designated Authorities shall constitute a quorum at meetings of the Association. In determining the percentage, fractions less than 0.50 shall be dropped and those 0.50 or greater shall be regarded as a whole number. **If the ordinary meeting is not quorate a 'by correspondence' vote will be held to allow the adoption of ordinary meeting agenda items.**

(e) The agenda for an ordinary meeting of the Association shall include:

- (1) Call to order.
- (2) President's address.
- (3) Roll call of Designated Members entitled to vote.
- (4) **Comments about the minutes of the previous meeting.**
- (5) Report of the Executive Committee.
- (6) Report of the Secretary General.
- (7) Fixation of annual subscriptions.
- (8) Consideration and adoption of reports.
- (9) Announcement of the place and date for the next ordinary meeting of the Association.
- (10) Any other business raised by a Member, of which notice in writing has been received by the Secretary General at least two months prior to the date of the meeting.
- (11) Any other business raised by consent of the Executive Committee.
- (12) President's closing address.
- (13) Adjournment.

And additionally at the ordinary meeting held in the third year after the ordinary meeting at which officers and members-at-large of the Executive Committee were appointed:

(14) Discharge of the Executive Committee

(15) Election of Officers and members-at-large of the Executive Committee.

(16) Installation of new Officers.

**(f) The Executive Committee approved minutes of the ordinary meeting will be published on the ISTA website within two months of the ordinary meeting. If there are no comments requiring amendment to the minutes within the subsequent two month period, the minutes will be considered approved. If there are comments and the comments are accepted by the Executive Committee, then the minutes including the comments will be considered approved and published on the ISTA website. Any comments about the minutes of the previous meeting will be considered at the next ordinary meeting under agenda Article X (e) 4.**

The complete version of the ISTA Constitution can be downloaded from the ISTA web site: [www.seedtest.org/constitution](http://www.seedtest.org/constitution)

## Minutes of the ISTA Ordinary Meeting 2011

The minutes of the ISTA Ordinary Meeting 2011, held in Zurich, Switzerland on June 16, are available on the ISTA web site at [www.seedtest.org/OM11\\_Minutes](http://www.seedtest.org/OM11_Minutes)

# Fit for the future – the new management structure of the ISTA Secretariat

**Michael Muschick**  
ISTA Secretary General

The International Seed Testing Association (ISTA) is an established and internationally recognized international governmental organization. Today, more than 70 countries worldwide have voting rights within the Association, and over 200 scientists and technicians from all over the world are working in the Association's 18 Technical Committees. The primary purpose of the Association is to develop, adopt and publish standard procedures for sampling and testing seeds, and to promote uniform application of these procedures for evaluation of seeds moving in international trade.

The secondary purposes of the Association are actively to promote research in all areas of seed science and technology, including sampling, testing, storing, processing, and distributing seeds, to encourage variety (cultivar) certification, to participate in conferences and training courses aimed at furthering these objectives, and to establish and maintain liaison with other organizations having common or related interests in seed.

All the work and decisions of the Association today are done in the various bodies of the Association: the Ordinary Meeting as the final decision-making body, the Executive Committee, the 18 Technical Committees, and the ISTA Secretariat, run by professionals.

Over the past years, ISTA has gone through a number of important changes to make the Association more efficient and effective to cope with the challenges of today's business. The business areas and services of ISTA have been enlarged, membership meetings now take place annually instead of every three years, international representation has increased, and the developments of modern communication technologies have been fully addressed.

Quite a number of different tasks have been handed over to the ISTA Secretariat, which today is much more involved in, for example, the support of the Technical

Committees, the organization of the Annual Meetings, international representation and the managing of the Accreditation Department.

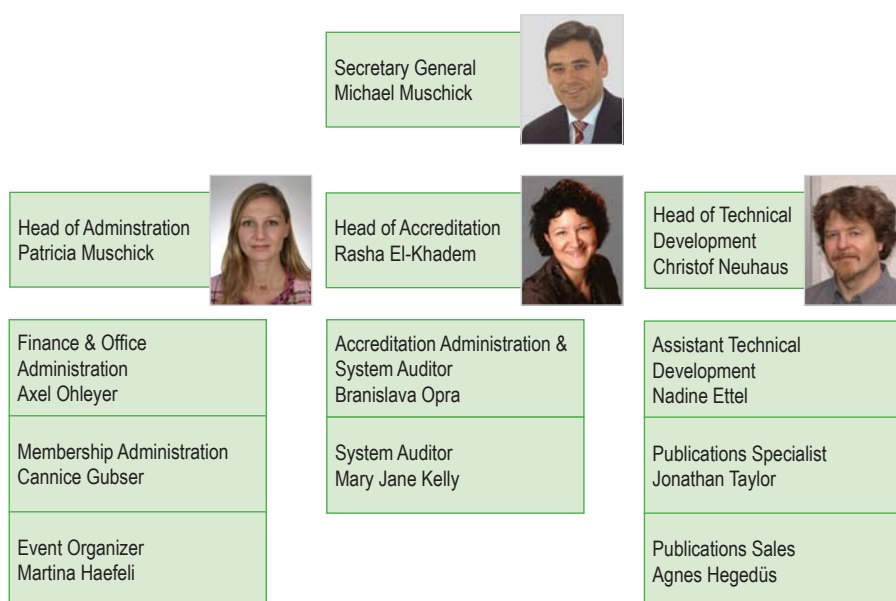
To cope with all these developments and to handle successfully all the different tasks, the overall management structure of the ISTA Secretariat had to be revised. The Secretary General and the ISTA Executive Committee have therefore worked out and established a new management structure with the help of an external consultancy company.

Within the new management structure, three departments have been formed. Each department is led by a head, who supervises a small group of people. The department heads report back to the Secretary General, and actively discuss the further strategy and development of ISTA as a group.

The three departments are the Technical Development Department, led by Dr. Christof Neuhaus, the Administration Department, led by Patricia Muschick, and the Accreditation Department, led by Dr. Rasha El-Khadem.

In a rough overview, the tasks of the departments are the following: the Technical Development Department is responsible for supporting the work of the ISTA Technical Committees, including the work for the GMO proficiency tests and the Seed Health proficiency tests, as well as the production and sales of the ISTA publications. The Administration Department is responsible for the finances of all ISTA activities, the organization of the ISTA Meetings, membership administration and the back office for all ISTA affairs including IT, HR and taxes. The Accreditation Department is responsible for the development of the ISTA Accreditation Standard, the ISTA audit programme, and the proficiency tests as organized by the ISTA Proficiency Test Committee.

With this restructuring, several challenges of the ISTA Secretariat have been addressed, and it is hoped that enhancements will soon be visible. We all feel that ISTA has made a move in the right direction, and that everything has been done to provide the ISTA membership with an improved service. ■





# ISTA Annual Meeting 2012

## 11–14 June 2012, Venlo, Netherlands

The International Seed Testing Association (ISTA) takes pleasure in inviting you to its Annual Meeting to be held in Venlo, Netherlands, from 11-14 June 2012. The National ISTA Designated Authority of the Netherlands is delighted to be hosting the next ISTA Annual Meeting and would like to cordially invite you to the Floriade 2012 in conjunction with the meeting.

The ISTA Annual Meeting provides an excellent opportunity to meet other seed experts and to exchange experiences. The aim of the meeting is to discuss and decide on proposals for changes to the ISTA International Rules of Seed Testing, and business items of the Association, with the international participation of ISTA delegates and representatives from both the seed industry and governments, including experts in seed technology, scientific research and laboratory accreditation.

### Meeting venue

The meeting will take place on the premises of the World Horticultural Expo, Floriade 2012 (<http://www.floriade.com>). This is a large event which is organised

every 10 years. The exhibition covers 66 hectares, and it would take a few days to see everything! Countries from all over the world create country pavilions to show what their horticultural sector has to offer: vegetables, flowers and trees of course, but also landscaping for various purposes. The city of Venlo has prepared itself to welcome you for moments of relaxation. There are brand new meeting facilities and we are glad to have the unique possibility of combining our meeting with visits to the exquisite country pavilions. A cable car of 1.1 km length connects you to the far corners of the garden and to the various meeting places.

### Registration

Registration for the full Annual Meeting includes the ISTA Seminar on 11 June, the technical presentations on 12 and 13 June, and the Ordinary Meeting on 14 June.

Registration is also possible for the ISTA Seminar only. Students may benefit from a reduced fee for the Seminar.

Provision is made for both Members and non-members of ISTA.



All the fees include free admission to the Floriade during the meeting days. The tickets will be distributed upon registration on the spot.

Online registration is now possible at [www.seedtest.org/AM12](http://www.seedtest.org/AM12).

Registration will close on 15 May 2012.

### Registration fees (online registration at [www.seedtest.org/AM12](http://www.seedtest.org/AM12))

| Periods                         | Events                           | EARLY registration<br>(up to 29 Feb 2012) | LATE registration<br>(1 March–15 May 2012) |
|---------------------------------|----------------------------------|---|--|
| <b>ISTA Members</b>             |                                  |   |  |
| 11–14 June                      | Annual Meeting incl. Seminar     | 600 €                                     | 660 €                                      |
| 11 June                         | Seminar only                     | 200 €                                     | 200 €                                      |
| <b>Non-members</b>              |                                  |   |  |
| 11–14 June                      | Annual Meeting incl. Seminar     | 1000 €                                    | 1200 €                                     |
| 11 June                         | Seminar only                     | 250 €                                     | 250 €                                      |
| <b>Students</b>                 |                                  |   |  |
| 11 June                         | Seminar only                     | 40 €                                      | 40 €                                       |
| <b>Accompanying persons</b>     |                                  |   |  |
| 11–14 June                      | Social events, lunches etc. only | 200 €                                     | 200 €                                      |
| <b>Exhibitors (Members)</b>     |                                  |   |  |
| 11–14 June                      | Exhibition booth                 | 2000 €                                    | 2000 €                                     |
| <b>Exhibitors (non-members)</b> |                                  |   |  |
| 11–14 June                      | Exhibition booth                 | 3000 €                                    | 3000 €                                     |



The Netherlands, showing the location of Venlo.

## Accompanying persons

The category ‘accompanying persons’ is applicable only for the spouse, companion and/or children of a delegate. Registration as an accompanying person does NOT include participation in any of the meetings or sessions, but only to social events, lunches and coffee breaks, the Welcome Reception and the Official Dinner.

## Climate

Holland’s climate is rather mild because of the proximity of the sea and the large river system. The weather in June is rather unpredictable. Sunny spells usually alternate with short showers within one day. The temperature is generally around 20 °C (15 to 25 °C) during the day and 10 °C (5 to 15 °C) during the night. So bring a sweater, raincoat and/or umbrella. There is a chance that you won’t need them, but please don’t take that risk.

## Travel information

Venlo is located in the east of the Netherlands. It is surrounded by the international airports of Düsseldorf, Maastricht, Eindhoven and Weeze. The main airport for overseas travellers is Amsterdam Schiphol airport (AMS). Trains depart from Schiphol airport to Eindhoven railway station and from there to Venlo railway station. A shuttle bus is available from Venlo railway station to the Floriade, where the meeting registration and all meetings will take place.

The currency used in the Netherlands is the euro. Cash dispensers (ATMs) are available at all banks, including the airport, and exchange rates are the same everywhere.

## Exhibitors

Reach seed professionals from laboratories and organisations worldwide. Only a limited number of exhibition stands are available.

The exhibitor registration fee includes one booth and one exhibitor for the duration of the Annual Meeting (11–14 June 2012) as well as cocktails, coffees, lunches and official dinner. An additional person to man the booth can register as an accompanying person, with the same benefits.

For detailed information about exhibition spaces, please contact Mr. Marcel Toonen (m.toonen@naktuinbouw.nl).

## Sponsors

There are also possibilities to sponsor the ISTA Annual Meeting 2012, with a variety of sponsoring packages to choose from.

For detailed information about sponsoring, please contact Mr. Marcel Toonen (m.toonen@naktuinbouw.nl). ■

# Preliminary programme

## Sunday 10 June 2012

Registration of participants

19:00 **Welcome Reception**

## Monday 11 June 2012

08:00–18:00 Registration of participants at conference venue

08:30–18:00 **ISTA Seminar “New developments and technologies in seed testing”**

**Chair: Bert van Duijn (Netherlands)**

Session 1: Vision and image analysis

Session 2: (New) Sensor applications in seed testing and developments in seed technology

Session 3: Discussion/panel session: New technologies and ISTA rules, needs and implementation barriers

Session 4: Molecular technologies in seed testing

## Tuesday, 12 June 2012

08:00–18:00 Registration of participants at conference venue

08:30–18:00 **Presentations of ISTA’s technical work**

08:30 Opening by the ISTA President, Joël Léchappé (France)

08:30–10:00 **Session 1:**

a. Report of the Purity Committee

Chair: Adriel Garay (United States)

b. Report of the Germination Committee

Chair: Sylvie Ducournau (France)

c. Report of the Moisture Committee

Chair: Craig McGill (New Zealand)

10:00–10:30 Coffee break





## ISTA Annual Meeting 2012

- 10:30–12:30 **Session 2:**
- Report of the Tetrazolium Committee  
Chair: Stefanie Krämer (Germany)
  - Report of the Vigour Committee  
Chair: Alison Powell (United Kingdom)
  - Report of the Seed Health Committee  
Chair: Theresa Aveling (South Africa)
  - Report of the Variety Committee  
Chair: Berta Killermann (Germany)
- 12:30–13:30 Lunch break
- 13:30–14:00 e. Report of the GMO Committee  
Chair: Christoph Haldemann (Switzerland)
- 14:00–15:00 **Session 3:**
- Report of the Flower Seed Committee  
Chair: Rita Zecchinelli (Italy)
  - Report of the Forest Tree and Shrub Seed Committee  
Chair: Fabio Gorian (Italy)
- 15:00–15:30 **Session 4:**
- Report of the Editorial Board of Seed Science & Technology  
Chair: (tbc)
- 15:30–16:00 Official photo session followed by coffee break
- 16:00–18:30 Time allocated for meetings of ISTA Committees
- Wednesday, 13 June 2012**
- 08:00–18:00 Registration of participants at conference venue
- 08:30–18:30 Presentation of ISTA's Technical Work** (continued)
- 08:30 Opening by the ISTA President
- 08:30–10:00 **Session 5:**
- Report of the Bulking and Sampling Committee  
Chair: Leena Pietilä (Finland)
  - Report of the Statistics Committee  
Chair: Jean-Louis Laffont (France)
  - Report of the Nomenclature Committee  
Chair: John Wiersema (United States)
- 10:00–10:30 Coffee break
- 10:30–11:30 **Session 5 (continued):**
- Report of the Seed Storage Committee  
Chair: Hugh Pritchard (United Kingdom)
  - Report of the Committee on Advanced Technologies  
Chair: Bert van Duijn (Netherlands)
- 11:30–12:30 **Session 6:**
- Report of the Proficiency Test Committee  
Chair: Günter Müller (Germany)
  - Report of the Audit Programme  
Rasha El-Khadem (ISTA Secretariat)
- 12:30–13:30 Lunch break

- 13:30–15:30 **Session 7:**
- Meeting of the Rules Committee  
Chair: Steve Jones (Canada)
- 15:30–16:00 Coffee break
- 16:00–18:00 **Session 7 (continued):**
- Meeting of the Rules Committee  
Chair: Steve Jones (Canada)
- 19:00 Official Dinner

### Thursday, 14 June 2012

- 09:00–17:30 **ISTA Ordinary Meeting**
- 09:00–10:00 Welcome by the ISTA President
- Presentation on the development of the seed industry in the Netherlands
- 10:00–10:30 Coffee break
- 10:30–12:30
- Call to order
  - President's address
  - Roll call of Designated Members entitled to vote
  - Comments about the minutes of the previous ordinary meeting
  - Report of the Executive Committee
  - Report of the Secretary General
- 12:30–13:30 Lunch break
- 13:30–14:30
- Fixation of annual subscriptions
  - Consideration and adoption of reports
  - Announcement of the place and date of the next ordinary meeting of the Association
- 15:00–15:30 Coffee break
- 15:30–17:30
- Any other business raised by a Member, of which notice in writing has been received by the Secretary General two months prior to the date of the meeting
  - Any other business raised by consent of the Executive Committee
  - President's closing address
  - Adjournment

# 30th ISTA Congress Seed Symposium Antalya, Turkey, 12–14 June 2013

Alison A. Powell

ISTA Executive Committee Member, ISTA Seed Vigour Committee Chair and Seed Symposium Convenor

The 30th ISTA Seed Symposium, to be held in Antalya, Turkey from 12 to 14 June 2013, will cover a wide range of seed related topics including:

- Genetic conservation;
- Seed pathology;
- Habitat regeneration;
- Seed germination and dormancy;
- Seed quality and plant breeding;
- Application of molecular markers;
- Seed quality evaluation;
- Seed physiology and stress responses.

The overall theme of the symposium will be:

**Evaluation of seed quality: a key step in exploiting the benefits of plant breeding and genetic conservation**

The symposium will be made up of five oral sessions (see below), and two poster sessions, each of two hours, covering the same topics. Each oral session will be chaired by a lead speaker who is well known in the field of seed science and technology.

## Role of quality evaluation in seed production

**Chair and lead speaker: Francisco Krzyzanowski, Brazil**

Multiplication of new cultivars; maintenance of genetic purity; environmental and maternal effects on quality; production

and processing; conventional and organic seed production; epidemiology and modelling; seed treatments.

## Physiological, biochemical and molecular markers of seed quality

**Chair and lead speaker: Françoise Corbineau, France**

Stress and desiccation tolerance, genomics, proteomics, development and maturation, regulation and induction of dormancy, germination; seed longevity; disease resistance.

## Advanced methods in seed quality evaluation

**Chair and lead speaker: Beni Kaufman, United States**

Automatic and computer based methods; image analysis; DNA-based methods; variety identification; purity analysis; seed pathology; germination.

## Seed storage for commercial use and genetic conservation

**Chair and lead speaker: Robin Probert, United Kingdom**

Seed collection and handling effects on germination and longevity; seed moisture content and water activity; storage conditions in relation to quality; orthodox and recalcitrant seeds, identification of quality traits in non-crop species.

## Evaluation and improvement of physiological quality

**Chair and lead speaker: Alison Powell, United Kingdom**

Evaluation of germination and vigour; seed quality in relation to field establishment, transplant production, land reclamation and regeneration; response to stress (e.g. pathogens, drought, salinity, soil contaminants).

## Paper submission

Intending participants are encouraged to present oral and poster papers dealing with a range of topics under the above theme. The research reported in offered papers can cover both the scientific basis of aspects of seed quality and its technological application in seed testing. In all sessions, we welcome papers on tropical and temperate crop species, wild species, flowers, trees and shrubs including species with potential for use in plant breeding and in habitat regeneration.

## Call for papers:

1st call for papers: **May 2012**

2nd call for papers: **August 2012**

Deadline for paper submission:

**26 October 2012**



**30th ISTA Congress, Antalya, Turkey, 12–18 June 2013**



# Perspectives on horticultural, forestry and agricultural seed storage: analysis of the ISTA laboratories

H.W. Pritchard<sup>1,14</sup>, S. Ajayi<sup>3</sup>, S. Ashmore<sup>4</sup>, P. Berjak<sup>5</sup>, R. Blanco<sup>6</sup>, C. de la Cuadra<sup>7</sup>, I. Ferraz<sup>8</sup>, M.E. Gonzalez-Benito<sup>9</sup>, F. Gorian<sup>10</sup>, H. Msanga<sup>11</sup>, P. Leon-Lobos<sup>12</sup>, I. Martin<sup>7</sup>, D. Mycock<sup>13</sup>, M. Sacandé<sup>2</sup>, N. Sershen<sup>5</sup>, X.-Y. Yang<sup>14</sup>

<sup>1</sup>Chair, <sup>13</sup>Vice-Chair and <sup>2-5, 7-9, 12, 14</sup>Members, ISTA Seed Storage Committee

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<sup>4</sup>Griffith University, Queensland, Australia

<sup>5</sup>University of KwaZulu Natal, Durban, South Africa

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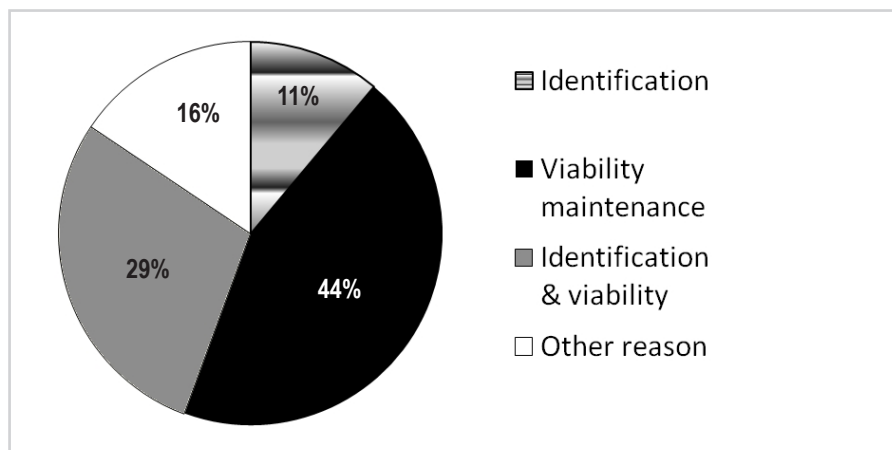
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<sup>12</sup>INIA, Vicuña, Chile

<sup>13</sup>University of the Witwatersrand, South Africa

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**Figure 1.** Purposes for storing seeds based on the 45 respondents. Identification of the seed species and maintenance of seed quality, especially in case of dispute resolution, were the main reasons given.

In the triennial period 2007–2010, the Seed Storage Committee carried out an assessment of the current standards and conditions used for seed storage by ISTA members, as a forerunner to the development of appropriate seed storage guidelines. Information was gathered by means of a questionnaire, composed of 13 main questions on seed handling procedures and seed lot details, with subsidiary queries, and a section inviting laboratory staff to raise key issues.

The main objectives of the Seed Storage Committee are 1. to characterise and maximise seed storage of horticultural, crop and forestry species, and their wild relatives, so that their sustainable use in trade is enhanced, and 2. to develop and amend guidelines on the storage of seeds. The questionnaire responses provide some pointers to the sorts of information that could be valuably provided in a seed storage ‘guideline’.

The main findings reported here came from 45 replies, including 34 from ISTA-accredited laboratories; the remaining respondents included governmental organisations and seed companies. The respondents were based in 28 countries (Table 1). This self-selecting sample of laboratories from across the world is felt to provide a reasonable representation of the

current situation with respect to seed storage at ISTA laboratories. Some non-ISTA laboratory members of the Committee also provided information, but this was not included in the analysis.

## Analysis and discussion

### Main purposes for storing seeds

The main reasons for storing seeds in the ISTA laboratories are 1. the identification of the seed lot (reference), and 2. the maintenance of seed viability (Fig. 1). Only 11% of respondents gave identification as the sole aim for holding seed samples. Forty per cent held seeds for the maintenance of viability and as a reference, whilst for 44% the primary aim was to maintain seed quality. When these latter respondents were combined with those storing seed for both identification and viability retention purposes (i.e. 29%), nearly three quarters (73%) of respondents had an interest in maintaining seed quality. Of this combined group, eight (23%) stated the legal and rules requirements (national, international, sector-based etc.) for doing so, in terms of disputes. A small number of respondents (16%) gave no reason, or mentioned the importance of having a sample for seed weight and purity analysis.

### Diversity of collections stored

Laboratories are storing a wide range of diversity, as over 150 genera were named in the replies. The top 30 genera are shown in Table 2, with the top five mentioned being *Brassica*, *Helianthus*, *Lycopersicon*, *Medicago* and *Triticum*. The majority of seed lots held are of agricultural species, although tree seeds feature strongly, but horticultural species less so.

**Table 1.** Countries from which replies were received

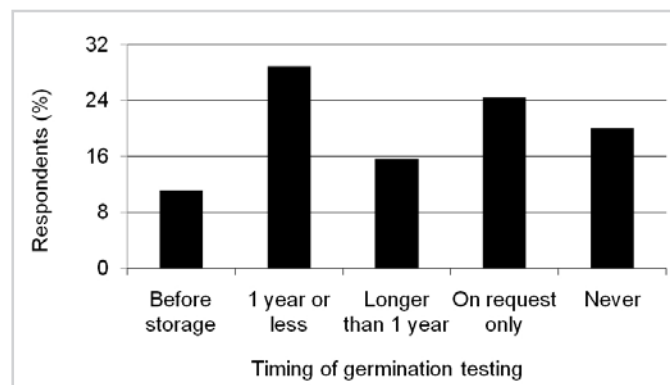
|                |  |
|----------------|--|
| Austria        | Latvia   |
| Belgium        | Nepal  |
| Bolivia        | Netherlands  |
| Canada         | New Zealand  |
| Cyprus         | Pakistan   |
| Czech Republic | Philippines  |
| Denmark        | Russia   |
| Germany        | Slovakia   |
| Greece         | Spain  |
| India          | Sweden   |
| France         | Separate Customs Territory of Taiwan, Penghu, Kinmen & Matsu |
| Ghana          | USA  |
| Hungary        |  |
| Italy          |  |
| Japan          |  |
| Kenya          |  |

Overall, the laboratories surveyed handle an average of 259 species (36 respondents). In addition, the laboratories have about 14 000 (36 respondents) or 7400 (35 respondents) seed lots per laboratory. This would mean that, in total, about 500 000 and 250 000 samples, respectively, are held in these 36 or 35 laboratories, the difference being that there was one facility with about 250 000 samples.

For each seed lot held, the average number of seeds was given as varying between 2000 and 600 000 000 (i.e. a 30-tonne batch). Within this range of numbers of seeds per lot, there were two lots that were clear outliers, one with 12 000 000 and one with 600 000 000 seeds per lot. Excluding these two outliers, which are presumed to be at the upper end of seed handling, the average number of seeds per lot is about 15 700. This means that over 116 000 000 seeds are stored by the 'average' ISTA laboratory, or about 20 billion seeds across all ISTA laboratories.

### Quality assessment – germination testing

Quality assessment of the seed lots through germination testing (Fig. 2) was mentioned by 80% of the respondents, although this included 24% who said they conducted tests only on request. Of those undertaking germination tests, 29% did so at yearly intervals (mainly) or more frequently (unusually). Some samples were checked every few months, e.g. bean, squashes, onion, corn and cotton. Sixteen percent of respondents checked germinability at intervals greater than annually, sometimes only every five years. Eleven percent of respondents said that the germination test was carried out before seed storage, and often not thereafter.



**Figure 2.** Timing or frequency of intervals between stored seed germination testing (42 respondents).

**Table 2.** Top 30 genera being stored in ISTA laboratories and affiliated facilities based on the responses to the questionnaire. The top five are shown in bold.

|                        |                  |                            |                  |                        |
|------------------------|------------------|----------------------------|------------------|------------------------|
| <i>Allium</i>          | <i>Cucurbita</i> | <b><i>Helianthus</i></b>   | <i>Oryza</i>     | <i>Secale</i>          |
| <i>Avena</i>           | <i>Dactylis</i>  | <i>Hordeum</i>             | <i>Phaseolus</i> | <i>Solanum</i>         |
| <i>Beta</i>            | <i>Daucus</i>    | <i>Lactuca</i>             | <i>Phleum</i>    | <i>Trifolium</i>       |
| <b><i>Brassica</i></b> | <i>Festuca</i>   | <i>Lolium</i>              | <i>Pisum</i>     | <b><i>Triticum</i></b> |
| <i>Capsicum</i>        | <i>glycine</i>   | <b><i>Lycopersicon</i></b> | <i>Poa</i>       | <i>Vicia</i>           |
| <i>Cucumis</i>         | <i>Gossypium</i> | <b><i>Medicago</i></b>     | <i>Raphanus</i>  | <i>Zea</i>             |

### Length of storage

Whilst retention of seed viability was a key objective, the time horizon was generally short. Twenty-six of 43 respondents (60%) indicated that the main objective was storage for one year. The other 17 aimed to store over the medium term of under 10 years, generally between 2 and 5 years. Exceptionally, four of the 43 respondents (9%) also had long-term stores (over 10 years) in support of plant conservation, including species of possible value to future plant-breeding programmes. Such work contributes to the Convention on Biological Diversity's Aichi Biodiversity Targets (<http://www.cbd.int/sp/targets/>). Of greatest relevance are:

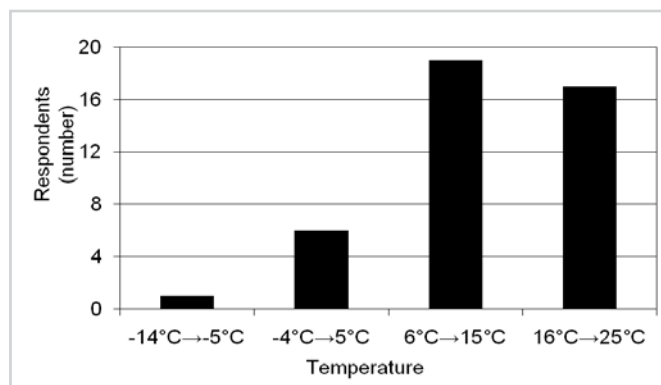
**Target 12:** by 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

**Target 13:** by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically and culturally valuable species, is maintained, and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.

### Storage conditions

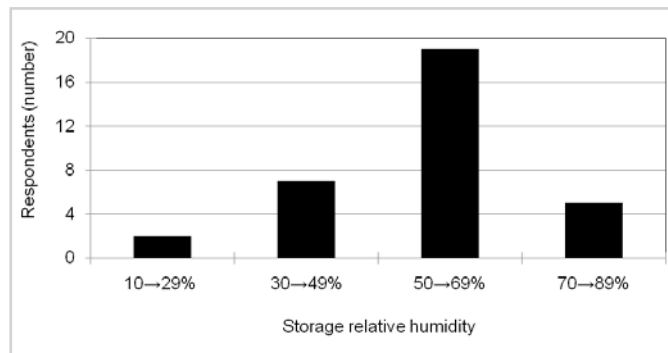
The storage conditions varied considerably between laboratories, and reflected the main purpose of storage. Respondents often gave a range of temperatures, from which we estimated the mid-temperature value and fed this into the determination of average storage temperatures used across the laboratories. For the long-term stores, the average storage temperature was  $-16\text{ }^{\circ}\text{C}$ . These laboratories also had other storage rooms operating at temperatures between  $-1$  and  $19\text{ }^{\circ}\text{C}$ ; the warmer end of this scale applies mostly to labs involved in within-season germination (or viability) testing for the commercial trade. In cases where there were two storage temperatures mentioned, we used the lower temperature facility in the calculation of average storage room conditions. Across 43 laboratories (two respondents did not provide information), the average temperature was  $13.2 \pm 6.9\text{ }^{\circ}\text{C}$  (SD)(Fig. 3). One facility dealing with large-scale seed handling stated the use of seven storage areas with temperatures between  $12$  and  $20\text{ }^{\circ}\text{C}$ .

Fifteen respondents mentioned the use of holding rooms, with relative humidity (RH) varying from about 10% to a maximum of 80%. These were mainly laboratory areas, although some are clearly drying rooms. Seeds at the upper end of this

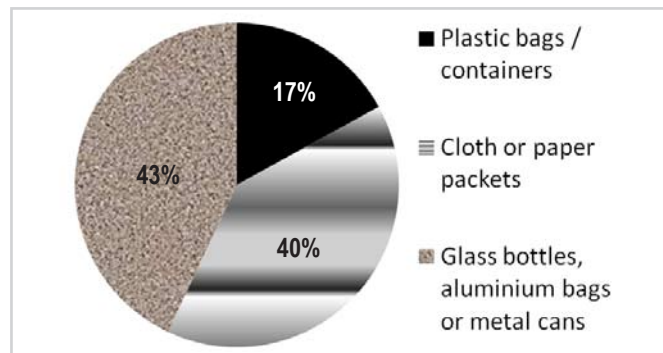


**Figure 3.** Distribution of temperature conditions, in  $10\text{ }^{\circ}\text{C}$  ranges, for the storage rooms (43 respondents).





**Figure 4.** Distribution of relative humidity conditions of storage rooms (33 respondents)



**Figure 5.** Proportional use of types of storage container reported by the laboratories. Generally, it would be expected that the initial moisture level of the seeds would be maintained better in glass bottles, aluminium bags or metal cans than in plastic bags or containers, with cloth and paper bags being the least suitable.

range will have a reduced life span; indeed, seed longevity is at its lowest at c.85–90% RH (Roberts and Ellis, 1989; Pritchard and Dickie, 2003). The average prestorage room RH was  $40.5 \pm 23.6\%$  (SD), following the same analysis method as that used to estimate storage temperature. Such a wide range of RH conditions is indicative of the lack of guidelines for seed handling.

Thirty three respondents provided information on the relative humidity of the storage room, from which mid-values have been estimated. The number of laboratories using various RH conditions for the storage facility is shown in Figure 4. The mode is 50–69%, and the average  $53.2 \pm 15.1\%$  (SD).

Seed moisture content was not routinely or widely determined, being measured by just under half of the respondents (i.e. 20). They indicated average seed moisture contents of  $10.3 \pm 3.3\%$  (SD). On the basis that the average storage room was at c.53% RH, this moisture content is approximately what is expected for a seed with a mid-range oil content, e.g. lettuce (32% oil); we might call this the ‘average’ seed.

**Packaging**

Forty percent of respondents indicated that they use cloth bags or paper packets (sometimes in a plastic container) to store seeds (Fig. 5). Seventeen percent use plastic bags or containers. The remaining respondents gave the use of glass, aluminium bags or metal cans, which tend to be the materials favoured by gene banks engaged in the longer-term storage of seeds, including for conservation purposes (Gomez-Campo, 2002; Manger *et al.*, 2003).

As cloth and paper are highly permeable to water vapour, the seeds will equilibrate quite rapidly to the prevailing humidity conditions (i.e. 53% RH, as stated above). The consequences of high humidity and high average moisture content (i.e. 10.3%) on the retention of viability can be estimated through the seed viability equations (see section ‘Predicted seed longevity’ below).

**Perceptions and concerns**

In the final part of the questionnaire, staff had the opportunity to raise the issues that were most important to them. The analysis above clearly indicates significant risks to viability loss because of the storage conditions generally in use. This concern is reflected in the comments raised by respondents (Table 3) as the most frequent question related to preferred conditions for storage on a species by species basis, including the matter of recalcitrant seeds (13 respondents). Moreover, respondents expressed concern about choosing appropriate storage containers and, related to this, how to control pests. Finally, some guidance was requested on seed store management (design, data, logistics, etc).

**Predicted seed longevity**

We decided here to briefly highlight some of the risks to seed quality when seeds are stored under the average storage conditions from the analysis of ISTA laboratory practice (i.e. approximately 10.3% moisture content and 13.2 °C). For some seeds, the dependency of viability on moisture, temperature and time has been detailed and related through the seed viability constants. Readers are directed to other sources of information for a full explanation of the history and use of the constants and their predictive value (Roberts and Ellis, 1989; Pritchard and Dickie, 2003). In brief, the constants are highly applicable to conditions used in the ISTA laboratories, as analysed above. In addition to the relationships and interplay between temperature, moisture and time, seed half-life (50% viability; P50), is a function of the initial quality of the seed. It is difficult for the farmer or seed collector to judge the initial seed quality, other than by the gross appearance of maturity of the seed harvest. However, it is possible to describe mathematically this internal feature of ‘initial quality’ (or *K*) by back extrapolation of seed survival curves (ageing curves) to

**Table 3.** The main issues raised by ISTA laboratories with respect to seed storage

| Guidance needed on:  | Number of mentions |
|--|--------------------|
| The ‘optimum’ conditions (temperature and RH) to store seeds for each species for >12 months | 13                 |
| The most appropriate storage containers  | 6                  |
| How best to manage the store   | 3                  |
| The areas of the world most risky for 12 months storage                                      | 2                  |
| How to control insects or bugs   | 2                  |

the estimated start of ageing.  $K_i$  is known to vary considerably between seed lots. For example, in one study,  $K_i$  varied from 1.1 to 3.5 probits (0 probit = 50% germination/viability) for 18 crops, including six cereals, four legumes and four oil crops (Nagel and Börner, 2010). The average  $K_i$  for these seedlots was 2.1 probits, or 98% viability. For purposes of illustration, we used this value of  $K_i$  with the viability constants to estimate the effects of 10.3% moisture content and 13.2 °C storage conditions on the longevity of three species from the top five genera of interest to ISTA laboratories (Table 4).

These results are illustrative only for the average conditions for storage based on the replies to the questionnaires; and a more thorough estimate of seed longevity of many of the species of interest to ISTA would be valuable. Nonetheless, if we accept that a fall in seed viability from 98% to 84.1% is likely to be significant and readily observable, the results suggest that such a fall in seed quality could be obvious within one year for *Helianthus annuus* and, possibly, *Brassica napus* seeds, but that this is rather unlikely for *Triticum aestivum*. By comparison, the long-term storage of *Helianthus annuus* and *Triticum aestivum* seeds kept in paper bags in a room operating at  $20.3 \pm 2.38$  °C and  $50.5 \pm 6.3\%$  RH, yielded longer half-lives of 4.3 years and 7.2 years respectively (Nagel and Börner, 2010). This provides us with two cautions: 1. of assigning too much accuracy to the viability constants when they have been generated from work at relatively few storage conditions or on few seed lots; 2. of expecting all seed lots of the same species from different seasons to store equally well because  $K_i$  may well vary.

Achieving greater life spans for seeds in ISTA laboratories can be quite easily remedied by lowering the storage temperature by a few degrees, lowering the seed moisture content by a few percent, or both (Roberts and Ellis, 1989; Pritchard and Dickie, 2003).

**Table 4.** Predicted longevity of seeds of three species assuming storage at 10.3% moisture content and 13.2 °C to reflect ‘average’ ISTA laboratory storage conditions. The viability constants (not shown here) were extracted from the Seed Information Database (<http://data.kew.org/sid/>).

| Species                  | Time for viability to fall from 98 to 84.1% in days (and years) | Time to reach half viability (50%) from 98% in days (and years) |
|--------------------------|---|---|
| <i>Brassica napus</i>    | 400 (1.10)  | 822 (2.25)  |
| <i>Helianthus annuus</i> | 102 (0.28)  | 210 (0.58)  |
| <i>Triticum aestivum</i> | 929 (2.55)  | 1909 (5.23)   |

## Concluding remarks

The responses to this consultation have provided invaluable insight into the concerns of the ISTA laboratory technologists with respect to optimal conditions (packaging, temperature and moisture) for seed storage to meet the legal requirements of maintaining seed quality for at least one year. Some preliminary guidance on storage has been provided here. However, the Seed Storage Committee’s objectives for 2010–2013 include the production of a seed storage guideline or handbook as a reference source. This needs to be supported by wider education programmes. A start has been made with a three-day workshop on ‘Water activity measurement applied to seed testing’, held in October 2010. The workshop brought together laboratory specialists and lecturers interested in seed moisture testing and was held under the auspices of the ISTA Moisture, Forest Tree and Shrub Seed, and Seed Storage Committees. For a report see <https://www.seedtest.org/en/report-on-ista-workshop-water-activity-measurement-applied-to-seed-testing--content---1--1330--668.html>. There will be further discussion of the role of moisture in seed survival at the ‘Desiccation Workshop’ in South Africa early in 2012.

## Acknowledgements

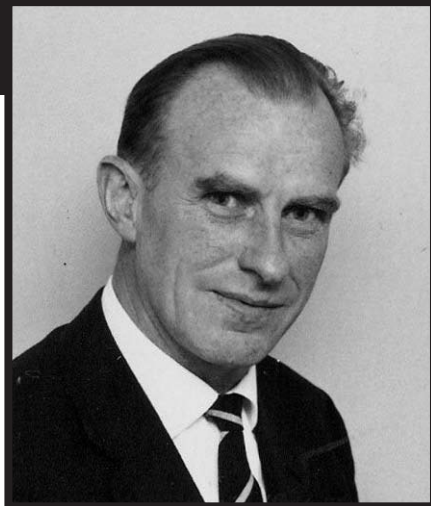
H.W.P. finalised this article during a stay at the laboratory of Xiang-yun Yang, Kunming Institute of Botany, and acknowledges support from the Chinese Academy of Sciences for a ‘Visiting Professorship for Senior International Scientists’ (Grant 2010T2S04). We are grateful for constructive comments on this article from Alison Powell (ECOM, ISTA).

## References

- Gomez-Campo, C. (2002). Long term seed preservation: the risk of selecting inadequate containers is very high. *Monographs ETSIA Universidad Politecnica de Madrid*, **163**, 1–10.
- Manger, K.R., Adams, J., Probert, R.J. (2003). Selecting seed containers for the Millennium Seed Bank Project. In: *Seed Conservation – Turning Science into Practice* (eds. R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard, R.J. Probert). Royal Botanic Gardens, Kew, pp 637–652.
- Nagel, M., Börner, A. (2010). The longevity of crop seeds stored under ambient conditions. *Seed Science Research*, **20**, 1–12.
- Pritchard, H.W., Dickie, J.B. (2003). Predicting seed longevity: the use and abuse of seed viability equations. In: *Seed Conservation – Turning Science into Practice* (eds. R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard, R.J. Probert). Royal Botanic Gardens, Kew, pp 653–721.
- Roberts, E.H., Ellis, R.H. (1989). Water and seed survival. *Annals of Botany*, **63**, 39–52.



# In memory of Peter Norup Pedersen (31 October 1917–13 July 2011)



Valmuevej 3  
Slagslunde  
DK-3660 Stenløse, Denmark

The former director of the Danish State Seed Testing Station (Statsfrøkontrol- len), Associate Professor Peter Norup Pedersen, Ph.D. died in July, 2011, at the age of 93.

Peter Norup Pedersen was born on a farm in Jutland, Denmark. After some years of practical agricultural training, he studied at the Agricultural University in Copenhagen. In 1945 he became an agronomist, obtained his Ph.D. in Plant Husbandry in 1951, and visited the famous Rothamsted Experimental Station in Hertfordshire, England, in 1952.

From 1945 to 1946 he worked as scientific assistant at a pest infestation laboratory, and from 1946 to 1949 at the Danish State Seed Testing Station. In the period 1951–62 he was Associate Professor in the Department of Plant Husbandry at the Agricultural University, Copenhagen, where he, among other things, taught seed morphology and performed research on barley loose smut (*Ustilago nuda*), describing a routine method of testing seed barley for this fungus. He also studied pollen spreading in *Secale cereale*, and foot rot attack in cereals.

From 1962 to 1981, Norup was director of the Danish State Seed Testing Station, and in the same period chairman of a Danish committee on import and export of seeds. Other committee work included nomenclature of plants and seed certification.

Director Norup Pedersen participated personally with enthusiasm in the work of ISTA, and supported other staff members spending time on ISTA work as well. He was a member of the ISTA Executive Committee from 1973 to 1977, and as Chair of the ISTA Referee Testing Committee from 1968 to 1977 worked very intensively on improving the referee testing programme.

Although these activities required a lot of work, the main part of Norup's great working capacity at the seed testing station was dedicated to both daily and long-term planning. In 1962 the facilities at Thorvaldsensvej 57, Frederiksberg were insufficient, and the seed testing activities were going on at three different addresses. In the following years Norup and members of the staff did a lot of planning of the new seed testing station, and the new building in Sorgenfri was completed in 1969–70. It was at that time one of the biggest and most modern seed testing stations in the world.

The Danish State Seed Testing Station was founded in 1871 (the second oldest in the world), and the 100 years' anniversary was properly celebrated, including publication of the book 'Statsfrøkontrol- len 1871–1971'. In preparation of this and other publications, Norup was an esteemed writer and a critical and inspiring reader, aiming that all publications from the institute were as clear and well written as possible. It was a training I personally appreciated very much.

In 1973, the Danish Seed Testing Station hosted the ISTA Workshop on Purity and Germination. Norup also put a lot of effort in preparation of this event, aiming that the participants should have an unforgettable visit to Denmark.

Around 1980, a lot of time and money was spent on planning of the use of data processing in the administration of the seed testing activities. Norup was also heavily involved in the detailed work in this internationally pioneering project.

On Norup's retirement in 1981, his farewell present from the staff was an old stone trough, which was an expression of thanks for his thorough leadership and his interest and care for the welfare of the personnel of the seed testing station.

The stone trough was placed at his cottage at 'Øllemosen', near Fuglebjerg, Western Zealand.

The family had owned this place for many years, and Norup enjoyed the practical work restoring the old half-timbered house and creating a beautiful garden with a great number of flowers and bushes.

Director Norup lived here for many years together with his wife Anna, before moving to a home for the elderly in Fuglebjerg a few years ago. Norup's wife passed away some years ago, and he is survived by a son and three grandchildren.

Director Peter Norup Pedersen will be remembered with respect and honour by the many people he met in his long life of 93 years.

On behalf of colleagues and friends

Hans Arne Jensen, former ISTA Member

# The 1st Meeting of the Directors of Seed Testing Stations in Graz, 1875

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In August 1869, Friedrich Nobbe founded seed testing by publishing his “Statute”, describing basic principles of the aims and implications of seed testing: seed lot homogeneity, sampling, size of submitted samples, determination of purity and germination, and financial and organizational matters (Steiner and Kruse, 2007). Not long after, at the 6th Migratory Meeting of German Agricultural Chemists, Physiologists and Directors of Experimental Stations, Nobbe introduced his concept of seed testing, the establishment of which was endorsed by the Meeting (Mayer and Rost, 1870). In 1872, the 7th Meeting introduced a stand-alone section for agricultural experimentation under Nobbe’s leadership (Henneberg, Nobbe and Wolff, 1872). During these years, Nobbe published various papers in the journal *Landwirtschaftliche Versuchs-Stationen*, e.g. studies on the testing of timothy and red clover seed, the effect of threshing on seed germination in cereals, and also general directions for seed testing. In 1874, he advertised the first seed reference sample collection available for sale, comprising seeds of 180 species of weeds, 20 species of clover and 50 species of grasses. Eventually, Nobbe envisaged convening a meeting on seed testing.

## The Meeting in Graz, Austria, 1875

Six years after founding seed testing, Nobbe organized the 1st Meeting of the Directors of Seed Testing Stations in Graz on 20 and 21 September 1875. This took place in the university building, in conjunction with the 48th Meeting of the Society of German Researchers and Physicians. Nobbe (1875) published the agenda in advance, and a concomitant exhibition of seed cleaning machinery was announced

(Anon., 1875). A summary report of the Meeting was presented by the *Landwirtschaftliche Presse* (1875). The full proceedings were published by Eidam (1876a, b), and the technical part is also contained in Nobbe’s *Handbook of Seed Science* (1876; Fig. 1).

All these and related publications are in German; please remember that up to the 1st World War, German was the language of science, and even more so the language of seed science. Hence, in English hitherto only Wold (1975) reported in brief on some basics of the Meeting, and referred only to a part of Nobbe’s text. Steiner (2000a) presented a review on the occasion of the 125th anniversary of the Meeting, but again in German. Therefore, the essentials of the Meeting are given here, because it was the first fundamental step for promoting and disseminating seed testing, and because it pointed ahead to the next step, 30 years later in 1906, namely the 1st International Conference on Seed Testing in Hamburg, Germany (Steiner and Kruse, 2006).

## The participants of the Meeting

In those days, there were 19 seed testing stations in operation: two in Belgium (Gembloux and Ghent, founded in 1875), one in Denmark (Copenhagen, 1870) 12 in Germany (Tharandt, 1869; Darmstadt, Ebendorf, Hildesheim and Münster, 1871; Karlsruhe and Munich, 1872; Kiel and Rufach [now Rouffach, France], 1874; and Breslau [now Wrocław, Poland], Königsberg [now Kaliningrad, Russia] and Rostock, 1875), two in Austria-Hungary (Graz, 1872; Tabor, 1874), one in Russia (Riga, now Latvia, 1872) and one in the USA (Middletown, Connecticut, 1875). Incidentally, 19 more stations were founded in the two years following the Graz Meeting, and at the end of the century there were 113 stations in 19 countries worldwide (Rostrup, 1896).

There were 31 participants at the Meeting. Five were directors of seed testing stations: E. Eidam (Breslau), G. Hennings (Kiel), L. Just (Karlsruhe), F. Nobbe

(Tharandt), and G. Wilhelm (Graz). In addition, nine directors of experimental stations attended, two of them active in seed testing: J. König (Münster) and R. Alberti (Hildesheim). Hohenheim, which was in the process of establishing a seed testing station, was represented by director E. von Wolff, and the future head of this station (1878), O. von Kirchner, also attended.

Two more participants later established seed testing stations: W. Hoffmeister, at Insterburg (1877), and R. Ulbricht, at Ungarisch-Altenburg (1878). Four experimental stations were represented by members. Among these was F. von Soxhlet of Vienna, who later played a key role in seed production and plant breeding as Professor for Agricultural Chemistry at the Technical University Munich and Director of the Bavarian Central Experimental Station. Six more participants came from academies, and there were four delegates from the civil service (Fig. 2).

Of the above-mentioned participants, four were high-ranking personalities from the host province of Styria. Baron



Figure 1. First page of Friedrich Nobbe’s Handbook of Seed Science of 1876.



| Präsenzliste:  |  |
|--|--|
| R. Alberti, Vorstand der Versuchs-Station Hildesheim.  |  |
| Heinrich Graf Attems, Begründer der Samencultur-Station zu St. Peter bei Graz.                         |  |
| Prof. Dr. H. Birner, Versuchs-Station Regenwalde.  |  |
| Dr. J. Breitenlohner, Privatdocent a. d. Hochschule f. Bodencultur, Wien.                              |  |
| Dr. Th. Dietrich, Vertreter der Versuchs-Station Alt-Morschen, Preuss. Prov. Hessen-Nassau.            |  |
| Edgar Freiherr von Ecker-Eckhofen, Graz.   |  |
| Dr. Ed. Eidam, Assistent am Physiolog. Laboratorium d. Univ. Breslau.                                  |  |
| Dr. J. Fittbogen, Vorstand der Versuchs-Station Dahme.   |  |
| Dr. M. Fleischer, Vorstand der Versuchs-Station Bonn.  |  |
| Dr. Grönland, Assistent der Versuchs-Station Dahme.  |  |
| Dr. W. von Hamm, K. K. Ministerialrath, Wien.  |  |
| G. Hennings, Assistent am botanischen Institut der Universität Kiel.                                   |  |
| Dr. W. Hoffmeister, Vorstand der Vers.-Station Insterburg.   |  |
| Prof. Dr. L. Just, Samencontrol-Station Carlsruhe.   |  |
| Dr. Kellner, Assistent der V.-St. Proskau.   |  |
| Dr. Kirchner, Akademie Proskau.  |  |
| Dr. J. König, Vorstand der Vers.-St. Münster.  |  |
| Dr. U. Kreisler, Vorstand der Vers.-St. Poppelsdorf.   |  |
| Prof. Dr. Krocke, Akademie Proskau.  |  |
| Prof.-Dr. G. Kühn, Vorstand der Vers.-Station Möckern b. Leipzig.                                      |  |
| Dr. G. Marek, Privatdocent a. d. Hochschule f. Bodencultur, Wien.                                      |  |
| Prof. Dr. F. Nobbe, Vorstand der physiol. Versuchs- u. Samencontrol-Station Tharand.                   |  |
| C. Sikorá, Director der landw. Lehranstalt Feldberg.   |  |
| Dr. Soxhlet, Assistent der Versuchs-Station Wien.  |  |
| H. Stierner, Steuer-Inspector, Tapiau, Ostpreussen.  |  |
| Prof. Dr. R. Ulbricht, Akademie Ungarisch-Altenburg.   |  |
| Baron v. Washington, erster Vicepräsident der K. K. Steyr. Landwirthschaftsgesellschaft, Schloss Töls. |  |
| Dr. Eugen Wildt, Vorstand der Vers.-Stat. Kuschen, Posen.  |  |
| Prof. Dr. G. Wilhelm, Graz.  |  |
| Dr. von Wittenburg, Königl. Landrath, Neustadt a. S., Preussen.  |  |
| Prof. Dr. E. von Wolff, Vorstand der Vers.-Station Hohenheim.  |  |

Figure 2. List of participants at the Graz Meeting 1875.

Maximilian von Washington, of English ancestry born in Bavaria, was a trend-setting leader in Austrian agriculture. He was First Vice-President of the Imperial and Royal Styrian Agricultural Society. Heinrich Count Attems was the founder of the Seed Production Station, St. Peter, near Graz, and as President of the Imperial and Royal Styrian Horticultural Society he was decisively involved in founding the School for Seed, Vegetable and Fruit Production. Landowner Baron Edgar von Ecker-Eckhofen, born in Bavaria and trained at the Royal Agricultural and Silvicultural Academy Hohenheim, was a leading figure in the agricultural interest group system, and one of the founders of the renowned Pomological Experimental and Seed Control Station at Graz in 1892. Last but not least, Friedrich Wilhelm, born in Vienna and also a graduate with distinction from the Hohenheim Academy in 1856, was Professor for Agronomy at the famous Joanneum at Graz, and an early promoter of higher education.

This detailed description of the attendants is to show that this was a meeting of notable experts in seed testing and neighbouring fields of those days.

### Opening and introductory lecture

The Meeting was opened by Nobbe. First, Baron von Washington welcomed the participants with best wishes for progress. Thereafter, Nobbe was elected President and Eidam Secretary of the Meeting.

In his introductory lecture, Nobbe also welcomed the audience, and expressed his gratitude to Baron von Washington and the Imperial and Royal Styrian Agricultural Society for their support. He also thanked Prof. Wilhelm and Secretary Müller of this Society for staging the exhibition of cleaning machinery.

Nobbe went on to address the following concerns: seed testing stations must be free in the extent of testing, research and organizational matters as to their individual situations. However, with regard to the

methods of testing, the undisputable aim must be the best possible uniformity. There must be no disadvantage to the seed trade. Therefore, the simplest and most economical methods must be used, as long as the reliability of the results was guaranteed. The great problems, grass seed mixtures and clover seed lots, ought to be tackled and that of dodder solved in the field. Nobbe demonstrated by calculation that the monetary loss caused by impurities in red clover seed alone amounted to a sum which exceeded by far the total expenses for seed testing.

He then carried straight on to the agenda. The proposals for discussion and voting had been distributed by Nobbe in advance. However, under "motive" he explained the basics of each item once again.

### "A. Regarding the method of testing seed samples"

The following is taken from the proceedings, and shows the directions, as approved by the audience, only in a highly condensed form. The "motives" documented along with the directions are not discussed here. However, the individual items are complete, in order to show the full coverage, and the original numbering and lettering of the items has been retained.

1. For proper testing, a minimum of 50 g of small seeds, such as bent grass and white clover, 100 g of medium-sized seeds, such as red clover and lentils, and 250 g of cereals and pulses must be submitted.
2. For random sampling, depending on the nature of seed (free flowing or chaffy), it is recommended to use a) a trier for clover, b) a trier for grain, or c) sampling by hand.
3. For sample reduction, the spoon method is recommended, with 4–5 random withdrawals from the spread submitted sample.
4. The size of the working sample depends on seed size. Prescribed in detail for many species, the sample size ranges from 50 g for peas, beans, maize, acorns and beechnuts to 2 g for bent grass. In clovers and linseed, the total submitted sample, 25 g or 30 g, respectively, must be tested for dodder.
5. Trueness to species is tested by botanical characteristics. Prerequisites are competence and a reference sample

collection. The use of a microscope is permitted. Testing of grass seed mixtures must be refused. Trueness to variety shall be determined by growing out tests.

6. "Foreign matter" is determined by separation of the working sample into "true seeds", including intact, broken with embryo, and not normally developed seeds, and "foreign matter", including other seeds, broken seeds without embryo and inert matter. The use of sieves and blowing devices is recommended, although separation must be done grain by grain. Magnifiers are endorsed.
7. a) For determination of germination, 2 x 200 seeds or, for grasses, 3 x 200 seeds are tested. If the difference between the tests exceeds 10%, the test must be repeated.  
b) Presoaking seeds in water for 24 hours is recommended.  
c) As substrates, Nobbe's Germination Apparatus (unvarnished ceramic), paper, soil or sand shall be used. Parallel tests shall be run using different substrates.  
d) A temperature level of 18–19 °C shall be maintained; in *Cucurbitaceae*, maize, tomato, tobacco and others this shall be 20–25 °C.  
e) Germination duration including presoaking is prescribed for species. It is shortest (10 days) in clovers, cereals and crucifers, and longest (21 days) in firs. Fresh seeds must be counted separately as possibly germinable. Chemical and physical germination stimulation shall not be applied.  
f) Seeds of woody plants germinating only after 1 to 2 years shall be presoaked for 2–3 days and kept on substrate for 4 weeks. Then, after cutting, four fractions shall be reported: 1. germinating seeds; 2. probably later germinating seeds; 3. decayed seeds; and 4. empty seeds.  
g) One third of the seeds of *Papilionaceae* remaining hard after 10 days are added to the germination percentage; however, the percentage must be declared.
8. The "utility value" is the percentage calculated on the basis of purity and germination (annotation: today "pure life seed percentage").

The keeping of records is at the discretion of the station, as long as the following is documented:

1. Serial number of test.
2. Date of submission and name of sender.
3. Botanical or declared name of seed.
4. Source, price for 50 kg, utility value.
5. Mass of submitted sample.
6. Mass of working sample.
7. Mass of true and pure seeds.
8. Mass of 1000 seeds, number of seeds per kilogram, specific mass, dimensional mass.
9. Mass of foreign matter.
10. Percentage of foreign matter.
11. Number of dodder seeds and dodder seeds per kilogram
12. Date of presoaking.
13. Date of germination testing.
14. Substrates used.
15. Dates of serial germination determinations and number of respectively removed seedlings.
16. Final count of normal seedlings.
17. Number of hard seeds.
18. Number of normal seedlings plus 1/3 of hard seeds.
19. Utility value.
20. General remarks.

The certificate shall show:

1. serial number of sample;
2. correct botanical name;
3. 1000-seed mass;
4. percentage of foreign matter;
5. if so, number of dodder seeds per kilogram;
6. germination energy;
7. germination percentage and duration of test;
8. utility value;
9. general remarks.

Addendum:

A. The type of foreign matter is specified as broken seed, sand, chaff or weed seeds (i.e. other seeds). Conspicuous fractions are determined by mass. Weed seed identification is only done on request.

B. 1000-seed mass is considered to be an indication of seed quality.

C. The methods for determination of specific mass and dimensional mass are specified.

D. A difference of 5% in utility value is considered tolerable.

## "B. The formal organization of seed testing."

The following summarizes the items as listed in the proceedings.

1. Tariffs were discussed and target rates announced. Translated into modern-day amounts, based on the wages of skilled craftsmen then and now, a purity determination, for example, without further specification of "foreign matter" in grass and clover seeds including dodder determination, was priced at 100 €; the same without dodder determination in ryegrass, clover, legumes, alder and birch 80 €, and in cereals, maize, crucifers, pulses, conifers, acorns and beechnuts 20 €; germination determination was priced at 40 €; 1000-seed mass 20 €; foreign matter by number 100–500 €, depending on the sample quality. Cost-covering seed testing was not considered to be feasible, hence public interest calls for subsidies by associations or the state to secure independence in testing. Concerns about takeovers by private industry were raised.

2. When seed testing for customers, sampling must take place in the presence of witnesses, and the source, price and utility value of the lot must be disclosed.

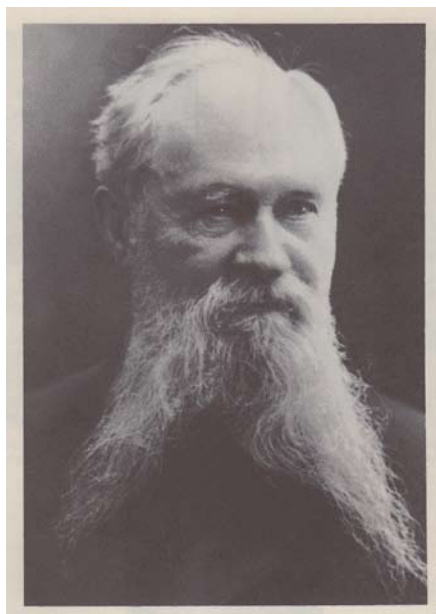
3. In order to promote seed trade, under certain circumstances reductions in tariffs are possible for a) sponsors, b) co-operatives, c) firms with express warranty, and d) customers of these firms.

4. Details of contracts between seed firms and seed testing stations were outlined, relating to: a) warranty, b) link-up in testing, c) tariff reduction, d) time limits, e) handling of information, and f) public announcement of the contract.

5. A restriction in the number of stations permitted to contract with firms was refused, in order to avoid monopolies.

(Note: point 6 is missing)

7. The activity of a seed testing station is not bound to seed testing, but its major task is the promotion of seed trade, by a) research in seed science, b) continuing education and information, c) allocation of reference collections, d) recommendation of machinery tested, e) support of co-operatives, and f) the promotion of seed production.



**Figure 3.** Portrait of Friedrich Nobbe (1830–1922) advanced in years; for other portraits see Steiner (2000c) and Steiner and Kruse (2007).

### Impact of the Meeting

In closing the Meeting, Nobbe emphasized the strict observation henceforward of the jointly approved methods, and the continuation of efforts for improvement. The next meetings were in 1876 in Hamburg (uniformity in seed testing), 1877 in Munich (comparative testing), 1878 in Kassel and 1882 in Salzburg. Step by step, method validation was developed (Steiner, Kruse and Leist 2008). On the basis of the Graz rulings, improved and extended “Methods for Seed Testing” were approved in 1891 in Halle (Steffeck 1892). In 1893, the first autonomous “Permanent Committee for Seed Testing” was formed within the Association of Agricultural Experimental Stations of the German Empire (L.V.S.); today its name is “Seed Group” within the Association of German Research and Testing Stations (VDLUFA). In 1899, this Committee approved revised rules, now mandatory for seed testing (Anon., 1900; Steiner, 2000b). In 1890 in Copenhagen and in 1892 in Gothenburg, the Nordic countries also developed rules inspired by and in close contact with the German activities (Wold, 1975). Thus, at the 1st International Conference for Seed Testing

in Hamburg in 1906, four different sets of rules for seed testing were presented: I. the Association of Agricultural Experimental Stations in the German Empire (L.V.S.); II. the Association of Agricultural Experimental Stations in Russian Poland (R.P.); III. the Seed Testing Stations Established by Governmental Support of the Nordic Empires Denmark, Norway and Sweden (N.R.); and IV. the Association of American Agricultural Colleges and Experimental Stations (Widén, 1906; Steiner and Kruse, 2006).

In the USA, organized seed testing began at the turn of the century. The Association of Official Seed Analysts (AOSA) was founded in 1908, and the first AOSA rules appeared in 1917. A direct path can hence be traced from Graz to Hamburg, and from Hamburg to the first International Rules for Seed Testing in Wageningen in 1931 (Steiner 2000b, c).

After Nobbe’s beginning in 1869, all seed testing has its roots in Graz in 1875 (Fig. 3). The procedure to introduce method proposals, along with explanations, prior discussion and subsequent voting, was exemplified in Graz. The essential principles and subjects of seed testing were identified in Graz. Only one subject, nowadays important, seems to be missing: seed health testing. However, this subject was well observed, because at that time seed health testing was done along with germination testing (Nobbe 1876).

Finally, as in Graz, even today, seed testing, seed research and advisory services are considered to belong inalienably together.

### References

- Anonymous (1875). Ausstellung von Maschinen und Geräthen zur Samen-Reinigung in Graz. *Landwirtschaftliche Versuchs-Stationen* **18**, 403–404.
- Anonymous (1900). Technische Vorschriften des Verbandes Landwirtschaftlicher Versuchs-Stationen im Deutschen Reich für die Samenprüfungen. *Landwirtschaftliche Versuchs-Stationen* **54**, 91–100.
- Eidam, E. (1876a). Verhandlungen der ersten Versammlung der Vorstände von Samencontrol-Stationen zu Graz am 20. und 21. September 1875. *Landwirtschaftliche Versuchs-Stationen* **19**, 64–78; (1876b) ditto printed as brochure of 16 pages by Breitkopf and Hertel, Leipzig.

- Henneberg, W., Nobbe, F. and Wolff, E. (1872). Wanderversammlung Deutscher Agriculturnchemiker etc. betreffend. *Landwirtschaftliche Versuchs-Stationen* **15**, 320.
- Landwirtschaftliche Presse (1875). Die Zusammenkunft der Vorstände von Samencontrol-Anstalten zu Graz. *Landwirtschaftliche Versuchs-Stationen* **18**, 477–478.
- Mayer, A. and Rost, A. (1870). Verhandlungen der VI. Wanderversammlung Deutscher Agriculturnchemiker, Physiologen und Vorstände der Versuchs-Stationen zu Halle a/S. *Landwirtschaftliche Versuchs-Stationen* **13**, 1–62.
- Nobbe, F. (1875). Vorschläge zu den Verhandlungsgegenständen der ersten Versammlung der Vorstände von Samencontrol-Stationen zu Graz. *Landwirtschaftliche Versuchs-Stationen* **18**, 401–404.
- Nobbe, F. (1876). *Handbuch der Samenkunde*. Verlag von Wiegand, Hempel und Parey, Berlin.
- Rostrup, O. (1896). Dansk Frøkontrol 1871–1896 samt en kort Oversigt over Udlandets Frøkontrol. Det Nordiske Forlag, Copenhagen.
- Steffeck, Dr. (1891). Verhandlungen der Vorstände von Samencontrol-Stationen zu Halle 1891. *Landwirtschaftliche Versuchs-Stationen* **40**, 69–75.
- Steiner, A.M. (2000a). 125 Jahre Vorschriften zur Saatgutuntersuchung – die erste Versammlung der Vorstände von Samencontrol-Stationen zu Graz 1875. Bericht über die 51. Arbeitstagung 2000 der Vereinigung österreichischer Pflanzenzüchter, BAL Gumpenstein, 21.–23. November, 77–83.
- Steiner, A.M. (2000b). 100 Jahre Technische Vorschriften des Verbandes Landwirtschaftlicher Versuchs-Stationen im Deutschen Reich für die Samenprüfungen. *VDLUFA-Schriftenreihe* **55**, 100–105.
- Steiner, A.M. (2000c). Landmarks of seed testing – ISTA for future. *ISTA News Bulletin* **121**, 9–12.
- Steiner, A.M. and Kruse, M. (2006). Centennial – The 1st International Conference for Seed Testing 1906 in Hamburg, Germany. *Seed Testing International*, **132**, 19–21.
- Steiner, A.M. and Kruse, M. (2007). Nobbe’s “Statute concerning the Testing of Agricultural Seeds” of August 1869. *Seed Testing International*, **134**, 11–13.
- Steiner, A.M., Kruse, M. and Leist, N. (2008). ISTA method validation 2007: a historical retrospect. *Seed Testing International*, **136**, 3–33.
- Widén, J. (1906). *Technische Vorschriften für die Wertbestimmung bei Saatwaren*. Printed as manuscript of 48 pages by Lütcke & Wulff, Hamburg.
- Wold, A. (1975). Background and history of the International Seed Testing Association. *Seed Science and Technology*, **3**, 33–55. ■



# ISTA membership changes

Status 1 September 2011

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# New faces at the ISTA Secretariat

**Martina Haefeli****Event Organizer**

Martina Haefeli is from Switzerland and studied International Business Management at the Haute-Alsace University Mulhouse-Colmar in France, the Baden-Wuerttemberg Cooperative State University Lörrach in Germany, the University of Applied Sciences of Northwestern Switzerland and the University of California Santa Barbara in the United States.

Beside her studies she worked at the Swiss National Science Foundation in the domains of project administration, financial control of international projects, meeting organization and assistance of the deputy director.

She gained further practical experience in event management in Berlin, and in customer relations and knowledge management at Ernst & Young in Shanghai.

During her last internship at Ernst & Young, she wrote her Bachelor's thesis in the field of market, customer and competition behaviour in China compared to Switzerland.

Martina Haefeli joined the ISTA Secretariat in July 2011; her main area of responsibility is the organization of meetings, workshops and congresses.

**Axel Ohleyer****Finance and Office Administrator**

Axel Ohleyer, a German who grew up in Belgium and France and studied and worked in England and in the USA, has 11 years of experience in the banking sector.

After obtaining a Bachelor's degree in Business & Administration, specialization Finance at the Northeastern University, Boston, USA, he started working for the State Street Bank in 1998 in Boston. After a year in London, with 20 other expatriates he successfully opened a subsidiary of the State Street Bank in Zurich. By the end of 2004, 120 employees were working for SSB Zurich.

After 3 years of accounting, 5 years of performance and analytics, and 3 years of investment controlling, Axel Ohleyer decided in 2009 to refocus his professional career. It was important for him to see a meaning in his work, and to stand behind the product and the mission of the company.

Therefore he worked temporarily at Green Cross as a project leader in finance. This commitment to highly qualified applicants was funded by SECO and was organized by the FAU (professional association for work and the environment).

Since 2005, he is also doing voluntary work for the WWF.

He is fully dedicated to help ISTA become an internationally well-known non-profit organization.

Axel Ohleyer joined the ISTA Secretariat mid-July 2011; his main area of responsibility is the administration of finances.



# Today's ISTA Proficiency Test Programme, a corner stone for Accreditation

R. El-Khadem

Head, ISTA Accreditation Department

The vision of the International Seed Testing Association is Uniformity in Seed Quality Evaluation Worldwide. The Association communicates this clearly and has put "Uniformity in Seed Testing" in the center of its logo, visible for all. Whereas the vision is formulated in a succinct manner and as an easy structured declaration, its accomplishment requires the input of the entire Association and the implementation of a broad range of activities.

In 1931, seven years after the foundation of the Association, the first International Rules for Seed Testing (ISTA Rules) were approved. With the publishing of the ISTA Rules, important steps were taken to define and agree on sampling and testing procedures as well as reporting guidelines (Anon, 1931). As an international organisation with member laboratories all over the world, speaking different languages and working with equipment and supplies from different sources, the complexity in achieving uniformity in seed testing is obvious. Words and signs could be interpreted differently depending on the meaning in different countries and cultures. An important goal has always been therefore to publish the ISTA Rules in a way that ensures that they are understood worldwide rather than producing ISTA Rules with perfect, classically correct English sentences.

Checking whether laboratories obtain uniformity in test results was always one of the aims of the Association and it was able to measure this uniformity by sending seed samples of equal quality to different laboratories for testing. This has a long history within the Association as early reports indicate that comparative tests were already set in 1929 (Dorph-Petersen, 1931). In one of the publications from ISTA on the subject, there was a discussion as to where this testing programme should be called "referee testing" or "comparative tests" (Justice, 1957). The Chairman of the Rules Committee, who was at that time in charge of presenting details on the organisation of the comparative tests stated, that as a result

of the discussion, the desirable wording should be "comparative test". Frequently the results of all reporting laboratories were used to calculate the mean and the median, which acted as the reference result and he suggested that the word "referee" would in English give the wrong message. It would imply that someone was acting as a judge on the performance of participants rather than comparing performance of participants to assess uniformity. However, in subsequent reports published in the years 1960 - 2002, the Association used the term "referee testing" (Justice, 1960; Ednie, 2001).

From the outset the programme was designed in a way to have the testing organised on an Association-wide basis, as well as a region-wide basis from 1957 - 1974 (Justice, 1960; Schoorel, 1960; Pedersen, 1975). In the report given by the Rules Committee in 1957, explanations on the causes of variation observed during the evaluation of the data were given. The choice of testing methods was in some cases identified as source. Also the important influence of analysts was recognised with a need for clear definitions in the ISTA Rules and training of analysts. The Chair of the Rules Committee, Dr. Justice, stated in his report: "This suggests that in our pursuit of uniformity we should look to our analysts at least as much as to our equipment" (Justice, 1957).

The reporting of the identified root causes of variation continued in the subsequent Reports. Differences of methodology are mentioned several times as influencing factor as is the use of substrates not listed in the ISTA Rules. In recognition of this the results of regional referee tests were the basis for publishing recommended methods for the germination tests of different species. These recommendations included e.g. temperature regimes, substrates, pre-treatment conditions, the time for the first and final counts as well as the requirement for light (Doyle, 1965).

In 1975, the Referee Testing Committee instigated major changes that significantly influenced the programme (Pedersen, 1975). The committee published results of a questionnaire giving details of the numbers of ISTA Certificates issued, and tests performed per species by member countries. Details of the most frequently exported and imported species by member countries were also given. The committee proposed changes for the future organisation of tests. These included a distinction between obligatory and voluntary participation in ISTA referee tests depending on how familiar a laboratory was with the testing of particular species. Suggestions were also made regarding changes in the way results were evaluated with average reference results only being calculated after the elimination of results exceeding the limits of the tolerances described in the Handbook of Tolerances (Miles, 1963).

Some of the implemented changes were reported in the 1974 - 1977 report of the Referee Testing Committee. The participation in tests became obligatory for laboratories wishing to issue ISTA Certificates. Members of the committee raised concerns as to whether the results achieved were worth the efforts if there was no follow-up when results of a laboratory were outside a certain tolerance (Pedersen, 1978). In 1987, the committee raised the concern that a small number of laboratories authorised to issue ISTA Certificates had difficulties in obtaining acceptable test results and as a consequent it was debated if the authorisation of such laboratories should be withdrawn (Scott, 1987).

Until 1987 one of the goals of the programme was to give single laboratories the best possibility to compare their results with those obtained by other laboratories on identical material. The terms of reference for 1992 established an extension to the programme with regards to its objectives within the Association. The monitoring of laboratories authorised to issue ISTA Certificates, was added as goal and there is the

first mention of a mini-referee programme for candidate laboratories seeking authorisation to issue ISTA Certificates. Within the mini-referee programme the test results of the candidate laboratories are compared to already authorised laboratories that had experience in seed testing.

Following a decision of the ISTA Executive Committee, the name of the "ISTA Referee Test" was changed to "ISTA Proficiency Test" in 2002. Similarly the ISTA "Referee Test Committee" was renamed as the "Proficiency Test Committee". One of the reasons for this change was that the term "Proficiency Test" was the commonly used name at that time in the ISO Guide 43. Another reason was that ISTA used its programme to identify true laboratory competency using a rating system. The change in naming was effective as of 1<sup>st</sup> of January 2003 (Ashton, 2002). Concurrently, the ISTA Executive Committee decided to apply the Method Validation process for all seed quality testing methods. This came into force two years after being introduced by the ISTA Seed Health Committee. With the full implementation of the ISTA Method Validation Programme, any new seed testing method to be included in the ISTA Rules had to be validated to ensure that it was accurate and delivered reproducible and repeatable test results. Validation is achieved by organising comparative inter-laboratory test rounds. With the validation, the method itself gets recognised as valid test method and can be subject to a vote to be included in the ISTA Rules.

Different laboratories using the approved and published ISTA test methods, should obtain statistically similar test results under the condition that. This can only be achieved the laboratory has a high level of competency and experience to perform

the test in accordance to the ISTA Rules. Measuring the competency or proficiency of a testing laboratory, is performed using the ISTA Proficiency Test Programme. The current ISTA Proficiency Test Programme does not give recommendations as to which method shall be used to obtain more uniform test results. Within the ISTA Proficiency Testing Programme, the calculation of the "true value" for a germination test is based on the results of accredited laboratories that have demonstrated their competency for the particular crop group, after elimination of outliers. The results are not reported in a way that would identify any differences in performance using different ISTA methods, temperature ranges or pre-treatments. The reason for this is the assumption that test results are uniform once a method has been approved through the validation process and that accredited laboratories are competent in applying the method appropriately.

In reviewing the publications related to ISTA's Proficiency Test Programme, it becomes obvious that the Association has had discussions regarding the terminologies to be used. Today the term "Proficiency Test" is used for approved or validated test methods, whenever a true value can be calculated as a result of a statistical analysis. In contrast the term "Comparative Test" is used whenever the true value is not known and its goal is to measure repeatability and reproducibility of the test method. Within the ISTA Validation Programme, samples are distributed to laboratories for comparative testing. The results obtained from different laboratories are assumed to be equal and it is assumed that they will be part of the evaluation process.

## References

- Anon (1931). International Rules for Seed Testing. *Proceedings of the International Seed Testing Association*, **18**, 313–385.
- Justice, O.L. (1957). Report of the Rules Committee on Comparative Testing. *Proceedings of the International Seed Testing Association*, **22**, 500–512.
- Ashton, D. (2002). Name change from "Referee" to "Proficiency". *ISTA News Bulletin*, **124**, 22.
- Dorph-Petersen, K. (1931). Report of the Activities of the International Seed Testing Association during the years 1928–1931. *Proceedings of the International Seed Testing Association*, **18**, 55–73.
- Doyle, E.J. (1965). Report of Referee Testing on a Regional Basis 1962–1965. *Proceedings of the International Seed Testing Association*, **30**, 427–435.
- Ednie, A.B. (2001). Report of the Referee Committee 1998–2001. *Seed Science and Technology*, **29**, 211–220.
- Justice, O.L. (1960). Report of Referee Testing on a Regional Basis. *Proceedings of the International Seed Testing Association*, **25**, 636–648.
- Miles, S.R. (1963). Handbook of tolerances and of measures of precision for seed testing. *Proceedings of the International Seed Testing Association*, **28**.
- Pedersen, P.N. (1975). Report of the referee testing committee, 1971–1974. *Seed Science and Technology*, **3**, 280–337.
- Pedersen, P.N. (1978). Report of the Referee Testing Committee 1974–1977. *Seed Science and Technology*, **6**, 399–409.
- Procedure approved by the ISTA Executive Committee (2006). ISTA Method Validation for Seed Testing, Version 1.0.
- Schoorel, A.F. (1960) Referee-Testing on Association-Wide Basis 1954-1955-1956-1957-1958. *Proceedings of the International Seed Testing Association*, **25**, 649–673.
- Scott, D.J. (1987). Report of the Referee Testing Committee 1983–1986. *Seed Science and Technology*, **15**, 539–553.

# Results of Seed Health Proficiency Test Round 08-SH *H.vul.*, Detection of *Ustilago nuda* on *Hordeum vulgare*

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## Introduction

The aim of Proficiency Test Round 08-SH *H. vul.* was to check the ability of laboratories to identify the presence of the fungus *Ustilago nuda* in barley embryos, and quantify the number of infected embryos. This was the second proficiency test for *U. nuda*. The first test, a pilot study, was organised in 2000. Both tests were organised by the Official Seed Testing Station (OSTS) for Scotland, at Science and Advice for Scottish Agriculture (SASA), Edinburgh. The results of the pilot study showed very large variations between laboratories. Variation was so wide that a meaningful statistical analysis was not worthwhile. Also, there was no basis for agreeing to a set of reference laboratories to allow comparison of their mean results to those of individual laboratory results. There were a number of possible reasons for the wide variation in results, including laboratories not following the method but applying their own modifications, inexperience with the test method, or insufficiently trained analysts. By the time of the 2008 Proficiency test (PT), the *Ustilago nuda* Working Group within the Seed Health Committee had responded to requests for changes to the method, and 16 ISTA-accredited laboratories included Method 7-013 within their scope of accreditation, providing a potential pool of 16 reference laboratories.

## Materials and methods

### Seed lots

The organisers agreed to infection levels of 1%, 1.5% and 4%, on the basis that these would be sufficient to pick up differences between laboratories, and to

determine a laboratory's competence to identify embryos infected with *U. nuda*, with less than 1% infection considered to be uninformative.

The OSTS identified three naturally infected and two healthy seed lots from commercial samples tested at the laboratory. Dilution of infected seed lots (1 and 3) with the healthy lots achieved seed lots with the agreed target infection levels. Seed lots were mixed by passing the seed through a Boerner divider three times prior to sample preparation.

### Sample preparation

Thirty laboratories, including 16 accredited (for whom participation was mandatory) and 14 volunteer laboratories, expressed interest in taking part.

A total of 112 subsamples of 120 g each were prepared according to the ISTA Proficiency Test Sample Preparation Instruction. All subsamples were randomly numbered.

One volunteer laboratory withdrew prior to samples being sent, and five laboratories did not respond to communications regarding phytosanitary/import requirements. Samples could therefore not be sent. In total, samples were sent to 24 laboratories (14 accredited and 10 volunteer).

### Testing

The organising laboratory tested 10 randomly chosen subsamples from each seed lot for assessment of heterogeneity.

Each laboratory received nine blind-coded subsamples of 120 g, three from each seed lot. The laboratories were asked to extract embryos from the whole subsamples according to ISTA method 7-013, then select at random 1000 embryos and examine them for *U. nuda* infection. For each subsample the number of infected embryos per 1000 examined was recorded.

### Statistical analysis

For the assessment of heterogeneity in subsample testing by the organising

laboratory, the binomial dispersion test was used. This compares the variability in counts of infected embryos between subsamples with that expected if the disease were distributed uniformly amongst subsamples.

The results for accredited laboratories were analysed using a logistic regression model for binomial response data (McCullagh and Nelder, 1989) with GenStat. Overdispersion was estimated from the residual deviance. Means and variances estimated from these models were then used to calculate Z-scores as for ISTA proficiency tests (PT-G-01, the ISTA Proficiency Test Programme V3.2).

## Results

### Heterogeneity

The binomial dispersion test indicated that the levels of dispersion for seed lots 2 and 3 were consistent with a uniform distribution of disease over the subsamples (Table 1). However, lot 1 had three times the expected level of dispersion. This was considered unacceptable. Rather than find a new seed lot, seed lot 1 was re-mixed using the Boerner divider, and a further 10 random subsamples were chosen and tested. After re-mixing, the dispersion factor was acceptable for the PT.

### Analysis

Results were received from 21 laboratories (13 accredited and 8 volunteer) – see Table 2 and Figure 1.

A logistic regression on accredited laboratories revealed problems (large outliers or out of line overall) for laboratories 1, 3, 12, and 23 (Fig. 2). It was decided to remove these laboratories, with the remaining 9 laboratories used as a 'core' set for calculation of means and standard deviations for Z-scores.

Logistic regressions on this 'core' set of laboratories for each seed lot separately showed the degree of over-dispersion (within-sample/lab variability, or repeatability) was sufficiently similar between samples to allow taking one value from a



combined analysis for use in the Z-scores. The over-dispersion factor was estimated at 4.374, indicating that the within-sample/lab standard deviation was 2.09 times greater than would have been expected for binomially distributed data. The mean proportions of infected seed were 3.952%, 1.681% and 1.281% for the three samples respectively over the 8 'core' laboratories.

The Z-scores were calculated using the standard formula in the ISTA Proficiency Test Programme. The standard errors in this formula were calculated using the formula for the standard error of a binomial proportion estimate inflated by the dispersion index. This standard error is based on the number of embryos examined and the mean for the sample.

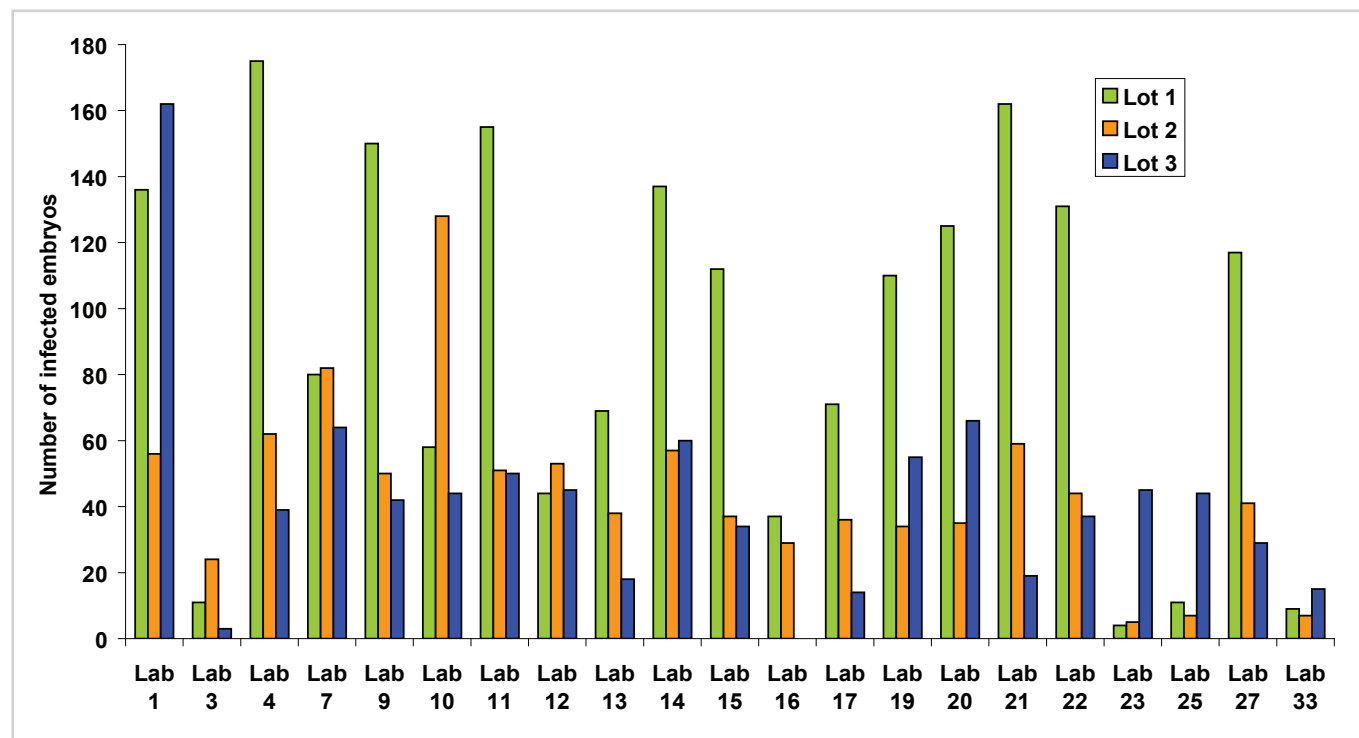
Note that this formulation only considers repeatability and ignores reproducibility. In fact, there was some evidence for differences in performance between the core laboratories. A standard error formulation

**Table 1.** Heterogeneity: results of binomial dispersion test for *Ustilago nuda*

| Seed lot       | Mean no. of infected embryos (10 subsamples) | Ratio of actual variance over expected variance (dispersion) | P-value for dispersion test |
|----------------|--|--|-----------------------------|
| Lot 1          | 43.2   | 3.05   | 0.0012                      |
| Lot 1 re-mixed | 43.4   | 0.76   | 0.653                       |
| Lot 2          | 16.4   | 1.28   | 0.246                       |
| Lot 3          | 11.9   | 1.61   | 0.105                       |

**Table 2.** Mean proportion of embryos infected and range of infection

| Laboratory grouping                                   | Mean proportion infected (and range of infection)(%) |                  |                  |
|---|--|------------------|------------------|
|   | Lot 1  | Lot 2            | Lot 3            |
| 'Core' accredited laboratories                        | 3.95 (2.30–5.83)                                     | 1.68 (1.17–2.73) | 1.28 (0.47–2.20) |
| All accredited laboratories                           | 3.24 (0.20–5.83)                                     | 1.52 (0.17–2.73) | 1.54 (0.10–5.40) |
| Volunteer laboratories                                | 2.68 (0.30–5.17)                                     | 1.43 (0.23–4.27) | 1.20 (0–1.93)    |
| Heterogeneity samples tested by organising laboratory | 4.34 (3.5–5.2)                                       | 1.64 (1.1–2.5)   | 1.19 (0.6–1.8)   |



**Figure 1.** Number of infected embryos found in 3000 embryos examined per lot (all laboratories).

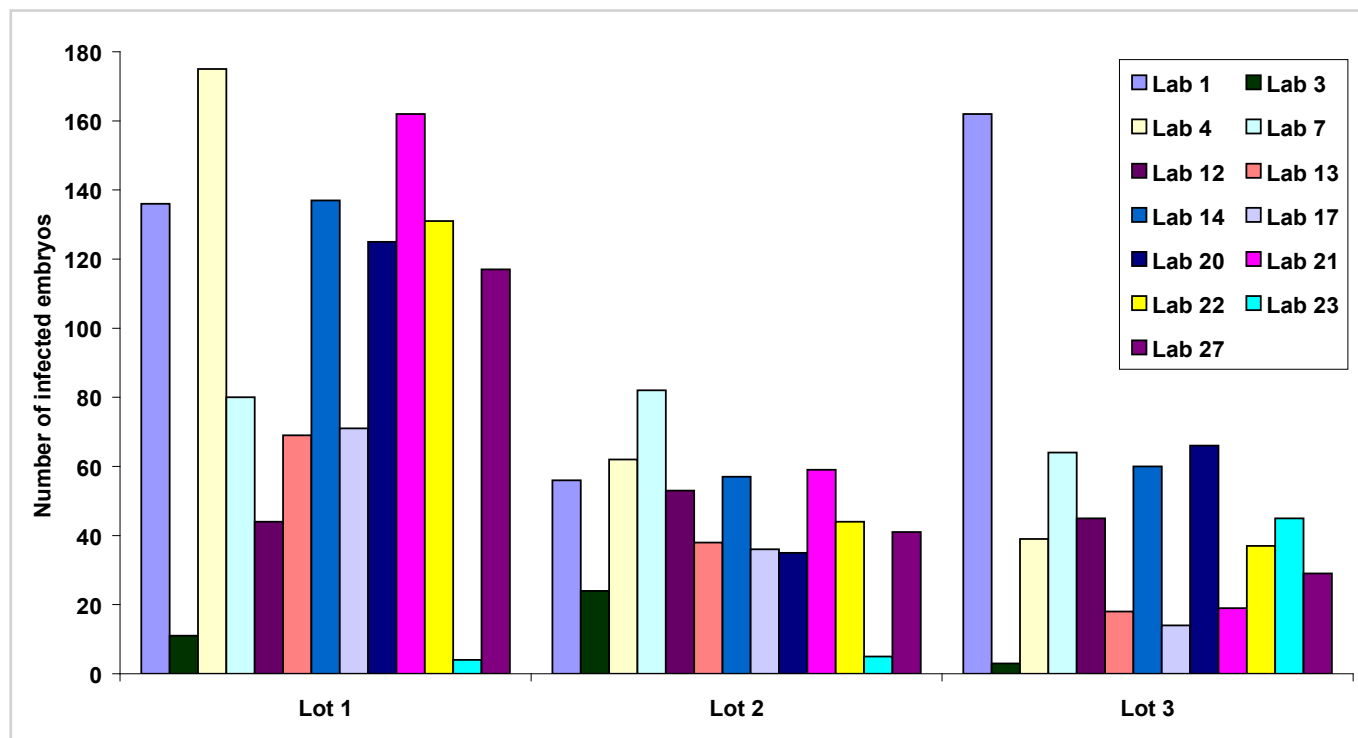


Figure 2. Number of infected embryos found in 3000 embryos examined per lot (accredited laboratories only).

that included reproducibility would be larger, and thus the Z-scores would be smaller. It would be necessary to use more sophisticated methods to estimate reproducibility, such as generalised linear mixed models. However, given that this was an early-stage proficiency test, it was considered beneficial not to incorporate the between-laboratory variance; this would tend to hide problems within the 'core' set.

#### Assessment of laboratory scores

To provide an assessment of laboratory results per lot, Z-scores between 2 and -2 are acceptable, those larger than 2.68 or less than -2.68 are classified as 'unsatisfactory', and those larger than 2 or less than -2 are classified as 'possible problem' (Fig. 3).

Eight laboratories (L3, L10, L12, L13, L16, L23, L25 and L33) underestimated the number of infected embryos in seed lot 1, and one laboratory (L4), overestimated the number of embryos. Of these laboratories, six (L3, L12, L16, L23, L25 and L33), were

classified as having unsatisfactory results, and three (L4, L10 and L13) were classified as having a 'possible problem'. For seed lot 2, three laboratories (L23, L25 and L33) underestimated and one (L10) overestimated the number of infected embryos. The results of all four laboratories were classified as unsatisfactory. Laboratories L16 and L3 underestimated the number of infected embryos, and L1 overestimated the number of infected embryos present in seed lot 3. L1 and L16 were considered as unsatisfactory, with L3 as a 'possible problem'.

#### Discussion

This was the first ISTA PT for *Ustilago nuda* since the accreditation of laboratories for Method 7-013. The proficiency test showed large variations in results between accredited laboratories, with a wide range of results for each seed lot (Table 2). Inconsistency with the other laboratories led to the exclusion of four accredited laboratories,

and the remaining accredited laboratories provided a 'core' set on which further analyses were performed to determine Z-score values. However, even within this core set of laboratories, there was larger variation than expected between laboratory results.

The overall mean proportion of infection was lower for accredited and volunteer laboratories than for the 'core' accredited laboratories. This was reflected in the Z-score analysis, which showed for lots 1 and 2 a tendency to underestimate. With Z-scores of less than -2, eight laboratories underestimated the number of infected embryos in lot 1 and three laboratories and two laboratories underestimated infection for lots 2 and 3 respectively. Five laboratories underestimated infection in two of the three lots tested.

Underestimation suggests that identification of *Ustilago nuda* mycelium within the embryo is causing difficulties. Possible reasons are lack of training and experience, or improper use of the method. Although one

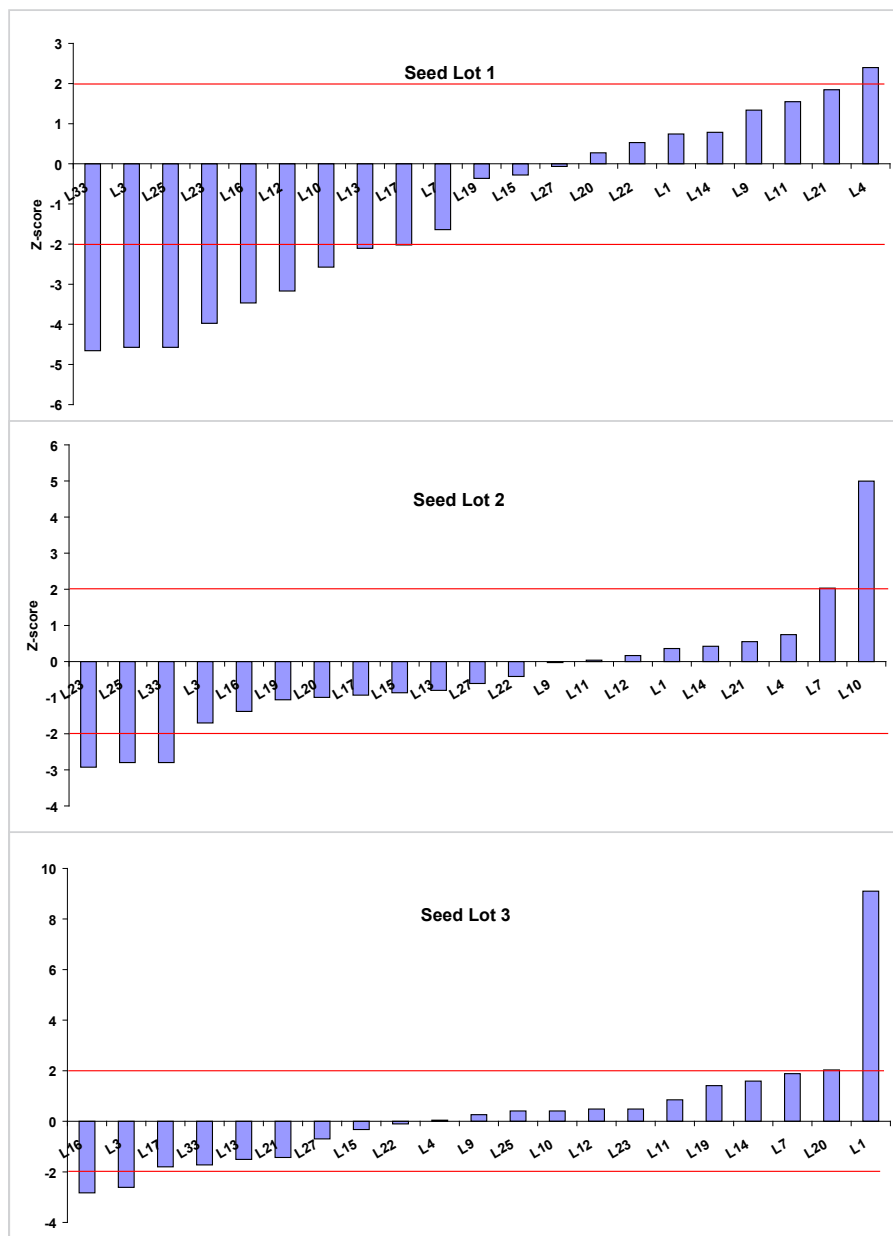
accredited laboratory did comment on their difficulty in discriminating mycelium within the scutellum, after staining the embryos with a solution of lactic acid plus methyl blue a second examination revealed additional infected embryos. A volunteer laboratory also commented on their difficulty in identifying the mycelium, and thought that staining might aid identification.

Three laboratories commented on their difficulty in extracting embryos from Lot 3, although a fourth laboratory suggested that soaking for 24 hours in sodium hydroxide leads to overdigestion of samples. Both scenarios potentially lead to damaged embryos, increasing the difficulty in finding infected embryos.

Overestimation of infected embryos was less likely in this PT, although two laboratories produced unsatisfactory results, one in Lot 2 and one for Lot 3, due to overestimation of the number of infected embryos.

## Conclusions

- Variability between accredited laboratories is high, with only eight of the 13 laboratories able to discriminate between the infection level in Lot 1 and the infection levels in Lots 2 and 3.
- Large effect: tendency for a significant number of laboratories to underestimate infection levels.
- Reproducibility between ‘core’ laboratories not good.
- Repeatability not good compared to ‘perfection’ (after accounting for sampling variation).
- ISTA SHC to look at future training need of ISTA-accredited laboratories.
- Consideration from ISTA SHC to provide optional staining of embryos in Method 7-013.
- More PTs required for *U. nuda* detection and identification (Method 7-013).



**Figure 3.** Laboratory Z-scores for seed lots 1, 2 and 3. Laboratories results between the red lines are acceptable.

## References

ISTA (2008). 7-013: Detection of *Ustilago nuda* on *Hordeum vulgare* (barley). Annex to Chapter 7: Seed Health Testing Methods, International Rules for seed Testing, ISTA, Basserdorf, Switzerland.

McCullagh, P. and Nelder, J.A. (1989). *Generalized Linear Models* (2nd Ed.). Monographs on Statistics and applied Probability. Chapman and Hall/CRC



# Laboratory accreditation changes

Status 1 September 2011

## Re-accreditations

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### New accreditations

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## Call for registration: 16th ISTA GMO Proficiency Test on maize (*Zea mays*)

The 16th ISTA GMO Proficiency Test will focus on the detection and/or the quantification of transgenic events in a defined number of maize seed samples.

The ISTA Proficiency Test on GMO Testing is open not only to laboratories involved in GM seed testing, but also to laboratories involved in food and feed GM testing.

Your laboratory can select the appropriate method to detect the presence or absence of GM seeds and to quantify their presence in samples of conventional seeds.

Since GMO testing has been included in the ISTA Accreditation Programme, the participation in the ISTA Proficiency Tests on GMO Testing is compulsory for those ISTA member laboratories which have GMO testing methods in their scope of accreditation.

Laboratories interested in participating should please send a completed registration form to the ISTA Secretariat in the next weeks.

The registration form, a detailed announcement and the proceeding deadlines can be found on the ISTA web site under the following link:

[www.seedtest.org/GMOPT](http://www.seedtest.org/GMOPT)

For further information please contact the ISTA Secretariat:

E-mail: [tcom.admin@ista.ch](mailto:tcom.admin@ista.ch)

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# Towards automated single counts of radicle emergence to predict seed and seedling vigour

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The radicle emergence test for *Zea mays* is an ISTA-validated vigour test (Matthews *et al.*, 2011b) which was accepted into the ISTA Rules at the Annual Meeting in Zurich in June 2011. This article will:

- briefly describe the background to the radicle emergence test;
- provide evidence in support of the potential widespread use of radicle emergence as a vigour test for many species;
- consider how this test can make use of automated methods;
- compare this approach to other automated methods for seed quality evaluation and improvement.

## Germination progress curves, mean germination time and seed ageing

Germination curves, produced following regular counts of germination (radicle emergence) during a germination test, are

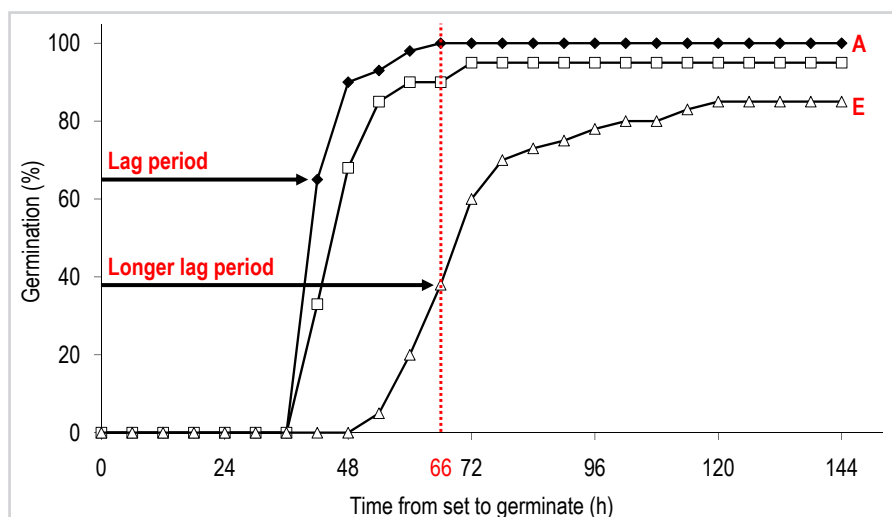
**Table 1.** Significance of correlation coefficients between mean germination time (MGT) and A) rate of emergence (field or glasshouse transplants), B) final emergence and C) germination (%) after accelerated ageing (AA) or controlled deterioration (CD). Numbers in parentheses indicate the number of lots from which the correlation was calculated

| Species       | A: Rate of emergence | B: Final emergence (%) | C: germination (%) after AA or CD test | Source |
|---------------|----------------------|------------------------|--|--------|
| Maize         | *                    | ** (9)                 | * (9)                                  | 1      |
| Cotton        | ND                   | *** (13)               | *** (13)                               | 2      |
| Pepper        | ***                  | * (11)                 | ** (5)                                 | 3      |
| Watermelon    | **                   | *** (10)               | *** (10)                               | 4      |
| Melon         | **                   | *** (10)               | *** (10)                               | 4      |
| Cucumber      | **                   | *** (9)                | *** (9)                                | 4      |
| Oil seed rape | ***                  | ** (11)                | ND                                     | 5      |
| Viola         | ***                  | *** (9)                | *** (9)                                | 6      |

ND: not determined

Significances: \*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001

Source: 1. Matthews *et al.*, 2011a; 2. S. Matthews, B. Ross and P. Steele (Cotton Seed Distributors, Australia) unpublished data; 3. Demir *et al.*, 2008; 4. Mavi *et al.*, 2010; 5. McLaren *et al.*, 2010; 6. Demir *et al.*, 2011



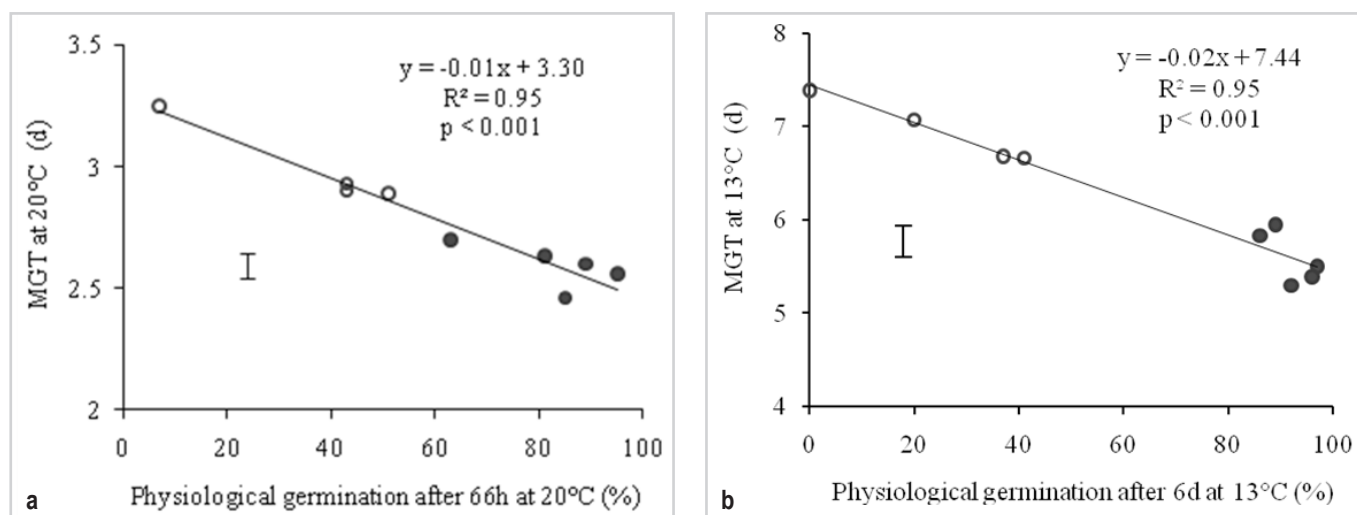
**Figure 1.** Germination progress curves at 20 °C for commercial seed lots of maize differing in vigour and field emergence. The vertical line at 66 h indicates the appropriate time for a single count of germination (radicle emergence).

familiar to most seed scientists. Such curves differ between seed lots, even amongst those having high standard (normal) germination, as seen for three commercial seed lots of maize (Fig. 1). The regular germination counts can also be expressed as the mean germination time (MGT) (Ellis and Roberts, 1980). The MGT describes the average

time for a seed to germinate, or the delay (lag period) from the start of imbibition to radicle emergence. In Figure 1, seed lot E has the longest average delay (high MGT), is the latest to start to germinate and has the greatest spread of germination over time.

The differences seen in the germination curves described by the MGT have been related to the seed vigour of maize, expressed as both the rate and final level of emergence (Khajeh Hosseini *et al.*, 2009; Matthews *et al.*, 2011a). For example, in Figure 1, lot A with a small MGT (lag period) emerged rapidly with a high final emergence, while lot E with a larger MGT emerged more slowly to a lower final emergence. This relationship between MGT and emergence performance is also significant in a wider range of species, from cotton to viola (Table 1, columns A and B). Thus, where germination was slower (high MGT), the rate of emergence was also slower and emergence was lower, i.e. the seed lot had low vigour.





**Figure 2.** Relationships between physiological germination (radicle emergence) made after 66 h at 20 °C (a) and 6 d at 13 °C (b) and mean germination time at the same temperatures for nine seed lots of maize. Open circles are for four seed lots significantly lower in germination than the five highest germinating lots at each temperature, as determined by LSD ( $P < 0.05$ ) following ANOVA of arc-sine transformed percentages. Vertical bars are the LSDs for MGT following ANOVA. Each point is a mean of 4 replicates of 25 seeds (taken from Matthews *et al.*, 2011a).

The major cause of differences in vigour is seed ageing, leading to seed deterioration. One of the first effects of ageing is an increase in MGT (Guy and Black, 1998; Bailly *et al.*, 2002). Thus, ageing and the resultant seed deterioration would result in the curve for lot A becoming similar to the curve of lot E (Fig. 1). Differences in the initial level of deterioration or ageing of seed lots can be identified by two of the ISTA-validated vigour tests, accelerated ageing (AA) for *Glycine max* and controlled deterioration (CD) for *Brassica* spp. (ISTA 2011). The levels of deterioration in commercial seed lots, measured using these ageing tests, have been consistently and significantly correlated with MGT in a large number of species (Table 1, column C). The more deteriorated the seed lots, the higher the MGT, that is, the greater the lag period from the start of imbibition and radicle emergence. This association between deterioration and the length of the lag period has been explained by the need for more time for metabolic repair in the more deteriorated seeds before germination processes can begin (Matthews and Khajeh Hosseini, 2007; Matthews *et al.*, 2011a).

Thus, the germination progress curves and MGT describe the extent of deterioration in a seed lot, and hence seed vigour.

### Single counts of radicle emergence, MGT and vigour

The periodic counting of radicle emergence to produce germination progress curves and allow calculation of MGT is time consuming. However, automated methods to generate germination progress curves have been developed that involve image analysis for a time series of photographs. These are entered into a computer for storage and curve fitting (Ducournau *et al.*, 2005; Joosen *et al.*, 2010). Instead of producing a germination progress curve, a simpler approach would be to use single early counts of radicle emergence to predict MGT, and hence vigour. This was the approach behind the new radicle emergence test for maize. Close relationships were seen in maize between MGT and single counts after 66 h at 20 °C and after 6 d at 13 °C (Fig. 2), and between these single counts and emergence (Matthews, *et al.*, 2011b). These close relationships formed the basis of the new vigour test.

Evidence suggests that the relationships described for maize are common to a wide range of species. MGT has been shown to relate to the rate and final emergence in other species (Table 1, columns A and B), and the differences in the MGT, or lag period, relate to the extent of deterioration in

the seed (Table 1, column C), as in maize. Furthermore, a single count is highly predictive of MGT since, as indicated by the  $R^2$  calculations (Table 2), more than 90% of the variability in MGT was accounted for by regression on a single count for seven out of ten regressions.

Single counts of radicle emergence are also closely related to emergence performance, i.e. to seed vigour (Table 3), in the field (maize, cotton, oil seed rape, watermelon, melon, cucumber) and in seedling transplant production (viola). In canola, 2 d radicle emergence was significantly correlated with relative seedling size ( $r = 0.84$ ,  $p < 0.001$ ; calculated from data in Buckley and Huang, 2011).

MGT reflects the relative level of deterioration of a seed lot, as do the AA and CD tests. The close relationship between MGT and these tests (Table 1, column C), and between MGT and single counts (Table 2), highlights the possibility that single counts of germination could provide an alternative, more rapid test of seed vigour than existing vigour tests. For example, counts of radicle emergence in maize between 2 and 3 days of the standard germination test would be a more efficient use of time and space than a 10 d cold test that would be done in addition to a standard germination test (Matthews *et al.*, 2011a,

**Table 2.** Regression ( $R^2$ ) values and significances between single counts of radicle emergence and mean germination time (MGT) for seed lots of 8 cultivated species with high standard germination (%)

| Species    | Lots (n) | $R^2$ with single counts (time of count and germination temperature) | Standard germination (%) | Source |
|------------|----------|--|--------------------------|--------|
| Maize      | 7        | 0.98 (66 h, 20 °C);<br>0.95 (6 d, 13 °C)                             | >90                      | 1      |
|            | 9        | 0.95 (66 h, 20 °C);<br>0.95 (6 d, 13 °C)                             | >90                      | 2      |
| Cotton     | 13       | 0.96 (3 d, 18 °C)  | >82                      | 3      |
| Watermelon | 10       | 0.83 (68 h, 25 °C)   | >98                      | 4      |
| Melon      | 10       | 0.60 (44 h, 25 °C)   | >98                      | 4      |
| Cucumber   | 9        | 0.97 (48 h, 25 °C)   | >98                      | 4      |
| Radish     | 9        | 0.94 (48 h, 20 °C)   | >80                      | 5      |
| Viola      | 9        | 0.85 (48 h, 20 °C)   | >82                      | 6      |

Significances:  $R^2$  all at  $P < 0.001$  except cucumber where  $P < 0.01$   
Sources: 1. Khajeh Hosseini *et al.*, 2009; 2. Matthews *et al.*, 2011a; 3. S. Matthews, B. Ross and P. Steele (Cotton Seed Distributors, Australia), unpublished data; 4. Mavi *et al.*, 2010; 5. K. Mavi (University of Mustafa Kemal, Turkey), unpublished data; 6. Demir *et al.*, 2011

b, c). Similarly, in the ornamental viola, a 2 d count of radicle emergence during a standard germination test can identify low-vigour lots as effectively as the saturated salt accelerated ageing test (SSAA) (Demir *et al.*, 2011). Again, this would be much quicker (2 d) than the 17-day SSAA test which would be done in addition to the standard germination test.

### Seedling vigour and MGT

The contrasted germination progress curves for maize (Fig. 1) have an impact not only on emergence, but also on seedling size. Thus, there are clear differences in seedling size and uniformity of lots A and E after 14 d in rolled towels at 13 °C (Fig. 3). Lot A, with a lower MGT (from counts of 2 mm radicles), produced larger and more uniform seedlings than lot E. The same applies when an earlier criterion of germination, the first appearance of the radicle, which we have termed mean just germination time (MJGT), is used (Fig. 3). Differences in seedling growth therefore relate back to the timing of the earliest stages of germination. Differences in the length of time from radicle emergence to the measurement of seedlings seem to be the determinant of size. This general proposition was suggested by Ellis (1992) and is supported by observations on peppers (Demir *et al.*, 2008), *Brassica* spp. (Powell *et al.*, 1991) and onions (Wheeler

**Table 3.** Significance of correlations between single counts of radicle emergence and final emergence for seed lots of 8 cultivated species with high standard germination (%)

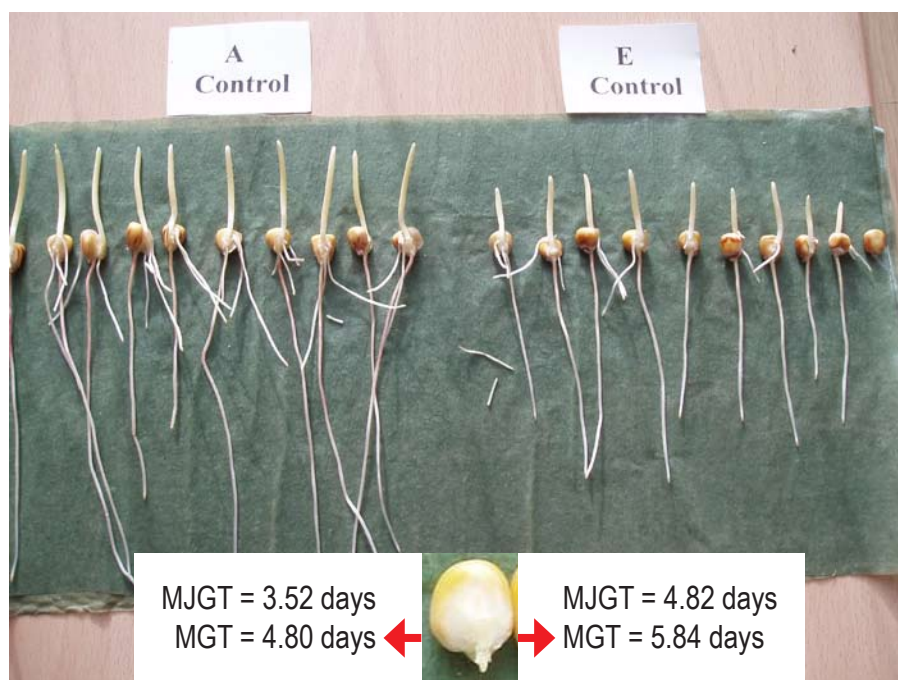
| Species       | Lots (n) | Time of count and temperature | Significance | Source |
|---------------|----------|-------------------------------|--------------|--------|
| Maize         | 9        | 66 h, 20 °C                   | *            | 1      |
|               | 9        | 6 d, 13 °C                    | **           | 1      |
| Cotton        | 13       | 3 d, 18 °C                    | ***          | 2      |
| Watermelon    | 10       | 68 h, 25 °C                   | *            | 3      |
| Melon         | 10       | 44 h, 25 °C                   | *            | 3      |
| Cucumber      | 9        | 48 h, 25 °C                   | **           | 3      |
| Oil seed rape | 11       | 30 h, 20 °C                   | **           | 4      |
| Canola        | 19       | 2 d, 20-30 °C                 | ***          | 5      |
| Viola         | 9        | 2 d, 20 °C                    | **           | 6      |

Significances: \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$   
Sources: 1. Matthews *et al.*, 2011a; 2. S. Matthews, B. Ross and P. Steele (Cotton Seed Distributors, Australia), unpublished data; 3. Calculated by Mavi from data in Mavi *et al.*, 2010; 4. McLaren *et al.*, 2010; 5. Calculated from data on seedling growth and 2 d radicle emergence in Buckley and Huang, 2011; 6. Demir *et al.*, 2011

and Ellis, 1991), as well as maize (Khajeh Hosseini *et al.*, 2009) and canola (Buckley and Huang, 2011). In addition, the greater spread of germination over time of lower-vigour lots (e.g. E in Figure 1) results in greater variation in seedling size, as seen in Figure 3. This is particularly important in the production of uniform transplants of vegetable and ornamental species.

### Development of automated methods

Computer-aided image analysis has been the most popular approach to automated germination and vigour testing (Dell'Aquila, 2007, 2009). Changes in seed dimensions and shape during imbibition have been investigated to try and identify germinable seeds before radicle protrusion



**Figure 3.** Seedling growth after 14 d at 13 °C of two commercial maize seed lots contrasted in the rate of germination, as indicated by MGT and the earlier stage of mean just germination time (MJGT).

(Dell'Aquila, 2003). The more direct approach of using image analysis to identify and count seeds at the time of radicle protrusion has been developed to the point of routine use in research laboratories to generate germination progress curves (Ducournau *et al.*, 2005; Joosen *et al.*, 2010).

However, the work described above on the general applicability of single counts of radicle emergence to predict vigour suggests that these automated methods could be used more simply. Our suggestion would be to identify appropriate times for single counts of radicle emergence and use a single photographic image to determine radicle emergence, and hence vigour. In many laboratories involved in routine testing, this could also be done manually to identify lots that would have a high MGT and the germination progress curve of a low-vigour lot.

A further use of image analysis in vigour testing has been on seedlings using a scanner image-capturing technique (Sako *et al.*, 2001). This type of approach has been applied to ornamentals and vegetables to give vigour scores to transplant seedlings (Geneve and Kester, 2001). The influence of the timing of radicle emergence on seedling size and uniformity described earlier raises the possibility of obtaining information on seedling quality from much earlier counts of radicle emergence.

Computer-aided use of X-rays for non-destructive sorting is coming into routine use for tomatoes. Seeds containing embryos that are morphologically malformed or reduced in size can be identified and discarded to improve the quality and uniformity of seedling transplants (Van der Burg *et al.*, 1994). The same method can also provide automated tests of the seed quality that results from differences observed in embryo morphology.

A physiologically based non-destructive method proposed for improving germination and vigour is chlorophyll fluorescence (CF) sorting. This has been under development since the 1990s, and aims to remove low-quality seeds that contain higher levels of chlorophyll. Equipment to assess CF is being sold for both sorting and quality testing. There are, however, few scientific papers that convincingly support this approach. The earliest publication (Jalink *et al.*, 1998) used a seed lot of white cabbage

described by the authors as 'specially selected', since it showed a wide distribution of chlorophyll fluorescence signals and may have been harvested at an immature stage. A further seed lot of white cabbage described in two later publications (Jalink *et al.*, 1999a, b) had a normal seedling germination count before sorting of only 64.5%. This lot was effectively sorted into groups ranging from 5% normal germination with low vigour (high CF) to 87.5% normal germination with high vigour (low CF). In other work on white cabbage, the CF values of a low-germinating (77%) lot increased after artificial ageing, and the values for aged and unaged seeds correlated with both germination and vigour (Dell'Aquila *et al.*, 2002). None of the three white cabbage lots used in work on CF sorting (Jalink *et al.*, 1999a, b; Dell'Aquila *et al.*, 2002) were typical commercial seed lots. Furthermore, it would have been interesting to compare the results of CF sorting with conventional processing methods such as air separation, size and colour sorting. Conventional methods might remove smaller, immature seeds as effectively as CF sorting.

The use of CF sorting of tomato and cereals has not always been convincingly effective. When a seed lot of tomato was sorted into six groups using CF, only the group with the highest signal (3.4% of the seeds) had a significantly slower and lower (75%) germination than the unsorted seed (Jalink, 1999a). In three lots of barley, CF sorting failed to produce groups that differed significantly in total (normal plus abnormal) germination (Konstantinova *et al.*, 2002). For three other lots, the authors claimed that the total germination percentages of the groups having medium or low CF values were higher than the non-sorted grains. However, the maximum increase was only 6%. Further data, for one lot only, showed a significant increase in the normal germination of grain with medium and low CF values and a decrease for grain with high CF values (Konstantinova *et al.*, 2002). Removing the high CF grains (30% of the lot), referred to by the authors as immature seeds, would improve the germination level. In paddy rice, removal of lower germinating immature seeds (13.9% of the lot) with high CF values improved germination from 90 to 97.5% (Van der Burg, 2009). Again, for these cereal examples,

comparisons with other ways of removing immature, smaller seeds would have been useful and appropriate.

The identification of radicle emergence by CF is also under investigation as a possible automated approach to germination testing (Van der Burg, 2009). Published work on many more commercially available seed lots and comparisons with existing procedures would help to confirm the general applicability of CF. This is also the case for other proposed methods and equipment that are promoted, and in some cases sold, for seed quality evaluation and improvement.

## Concluding comments

- Mean germination time (MGT), calculated from many counts of germination, is the average delay or lag period from the start of imbibition to radicle emergence and describes the germination curve. MGT is highly indicative of the emergence (rate and final level) as well as seedling size and variation of commercial seed lots (Table 1, columns A and B).
- Single counts of early radicle emergence relate closely to MGT and emergence performance in a range of species. A single early count of the radicle emergence forms the basis of the new radicle emergence vigour test for maize.
- There is clear evidence that early counts of radicle emergence can be used to predict vigour differences in a wide range of species. Comparative testing is under way to extend the validation of this test to other species in addition to maize.
- Single counts of radicle emergence could be incorporated into routine germination testing and hence assess germination and vigour within one test.
- An objective of recent research in seed technology has been the development of rapid automated tests of germination and vigour (Dell'Aquila, 2007, 2009), but none have, so far, been rigorously evaluated on commercial seed.
- Development of radicle emergence as a vigour test will encourage the focused application of automated counting at an appropriate time without the need to determine the complete time course of germination.



- Much of the work on automated methods for testing germination and vigour involves complex procedures and expensive equipment. These automated methods remain to be tested on commercial seeds.
- In this review, we advocate a simpler approach, based on deterioration and its repair, for testing a wide range of species. This approach is the basis of the new vigour test for maize. As we have shown, such an approach could provide quicker, repeatable test methods for routine use on commercial seeds, with little further development or expense.

## Acknowledgements

We are grateful to members of the Vigour Committee and their colleagues in their laboratories for all their work relating to the radicle emergence test on maize and other species.

## References

- Bailly, C., Bogatek-Leszczynska, R., Côme, D. and Corbineau, F. (2002). Changes in activities of antioxidant enzymes and lipoxygenase during growth of sunflower seedlings from seeds of different vigour. *Seed Science Research*, **12**, 47–55.
- Buckley, W.T. and Huang, J. (2011). An ethanol-based vigour assay for canola. *Seed Science and Technology*, **39**, 510–526.
- Dell'Aquila, A. (2003). Image analysis as a tool to study deteriorated cabbage (*Brassica oleracea* L.) seed imbibition under salt stress conditions. *Seed Science and Technology*, **31**, 619–628.
- Dell'Aquila, A. (2007). Towards new computer imaging techniques applied to seed quality testing and sorting. *Seed Science and Technology*, **35**, 519–538.
- Dell'Aquila, A. (2009). Development of novel techniques in conditioning, testing and sorting seed physiological quality. *Seed Science and Technology*, **37**, 608–624.
- Dell'Aquila, A., Van der Schoor, R. and Jalink, H. (2002). Application of chlorophyll fluorescence in sorting controlled deteriorated white cabbage (*Brassica oleracea* L.) seeds. *Seed Science and Technology*, **30**, 689–695.
- Demir, I., Ermis, S., Mavi, K. and Matthews, S. (2008). Mean germination time of pepper seed lots (*Capsicum annum* L.) predicts size and uniformity of seedlings in germination tests and transplant modules. *Seed Science and Technology*, **36**, 21–31.
- Demir, I., Celikkol, T., Sari Kumis, G. and Eksi, C. (2011). Vigor tests to estimate seedling emergence potential and longevity in *Viola* seed lots. *Horticultural Science*, **46**, 402–405.
- Ducournau, S., Feutry, A., Plainchault, P., Revellon, P. and Vigouroux, B. (2005). Using computer vision to monitor germination time course of sunflower (*Helianthus annuus* L.) seeds. *Seed Science and Technology*, **33**, 329–340.
- Ellis, R.H. (1992). Seed and seedling vigour in relation to crop growth and yield. *Plant Growth Regulation*, **11**, 249–255.
- Ellis, R.H. and Roberts, E.H. (1980). Towards a rational basis for testing seed quality. In *Seed Production* (ed. P.D. Hebblethwaite) p. 605, Butterworths, London.
- Geneve, R.L. and Kester, S.T. (2001). Evaluation of seedling size following germination using computer aided analysis of digital images from a flat bed scanner. *Horticultural Science*, **36**, 1117–1120.
- Guy, P.A. and Black, M. (1998). Germination-related proteins in wheat revealed by differences in seed vigour. *Seed Science Research*, **8**, 99–111.
- ISTA (2011). *International Rules for Seed Testing*. International Seed Testing Association, Bassersdorf.
- Jalink, H., Van der Schoor, R., Frandas, A. and Van Pijlen, J.G. (1998). Chlorophyll fluorescence of *Brassica oleracea* seeds as a non-destructive marker for seed maturity and seed performance. *Seed Science Research*, **8**, 437–443.
- Jalink, H., Van der Schoor, R., Birnbaum, Y.E. and Bino, R.J. (1999a). Seed chlorophyll content as an indicator for seed maturity and quality. *Acta Horticulturae*, **504**, 219–227.
- Jalink, H., Van der Schoor, R., Birnbaum, Y.E. and Bino, R.J. (1999b). Chlorophyll fluorescence as a non-destructive marker for seed maturity and seed performance. In *Proceedings of the 1999 World Seed Conference*, pp. 145–149. International Seed Testing Association, Zurich.
- Joosen, R.V.L., Kodde, J., Willems, L.A.J., Ligtink, W. and Hilhorst, H.W.M. (2010). The germinator automated germination scoring system. *Seed Testing International*, **140**, 4–8.
- Khajeh Hosseini, M., Lomholt, A. and Matthews, S. (2009). Mean germination time in the laboratory estimates the relative vigour and field performance of commercial seed lots of maize (*Zea mays* L.). *Seed Science and Technology*, **37**, 446–456.
- Konstantina, P., Van der Schoor, R., Van den Bulk, R. and Jalink, H. (2002). Chlorophyll fluorescence sorting as a method for improvement of barley (*Hordeum vulgare* L.) seed health and germination. *Seed Science and Technology*, **30**, 411–421.
- Matthews, S. and Khajeh Hosseini, S. (2007). Length of the lag period of germination and metabolic repair explain vigour differences in seed lots of maize (*Zea mays*). *Seed Science and Technology*, **35**, 200–212.
- Matthews, S., Beltrami, E., El-Khadem, R., Khajeh Hosseini, M., Nasehzadeh, M. and Urso, G. (2011a). Evidence that time for repair during early germination leads to vigour differences in maize. *Seed Science and Technology*, **39**, 501–509.
- Matthews, S., Wagner, M.-H., Ratzenboeck, A., Khajeh Hosseini, M., Casarini, E., El-Khadem, R., Yakhliif, M. and Powell, A.A. (2011b). Early counts of radicle emergence during germination as a repeatable and reproducible vigour test for maize. *Seed Testing International*, **141**, 39–45.
- Matthews, S., Noli, E., Demir, I., Khajeh Hosseini, M. and Wagner, M.-H. (2011c). Evaluation of seed quality: from physiology to international standardisation. *Seed Science Research*, (in press).
- McLaren, G., Cockerell, V. and Matthews, S. (2010). Early counts of physiological germination in seed lots of oilseed rape relate to percentage normal seedlings and field emergence. In *Seed Symposium Abstracts*, 29th ISTA Congress, Cologne, Germany, pp. 63, International Seed Testing Association, Bassersdorf.
- Mavi, K., Demir, I. and Matthews, S. (2010). Mean germination time estimates the relative emergence of seed lots of three cucurbit crops under stress conditions. *Seed Science and Technology*, **38**, 14–25.
- Powell, A.A., Thornton, J.M. and Mitchell, J.A. (1991). Vigour differences in *Brassica* seed and their significance to emergence and seedling variability. *Journal of Agricultural Science*, **116**, 369–373.
- Sako, Y., McDonald, M.R., Fujimura, K., Evans, A.F. and Bennett, M.A. (2001). A system for automated seed vigour assessments. *Seed Science and Technology*, **29**, 625–636.
- Van der Burg, J. (2009). Raising seed quality: what is in the pipeline? In *Responding to the challenges of a changing world: the role of new plant varieties and high quality seed in agriculture*. Proceedings of the Second World Seed Conference, pp. 177–184. Rome, UPOV, Geneva.
- Van der Burg, W.J., Aarste, J.W., van Zwol, R.A., Jalink, R.A. and Bino, R.J. (1994). Predicting tomato seedling morphology by X-ray analysis of seeds. *Journal of the American Society of Horticultural Science*, **119**, 258–263.
- Wheeler, T.R. and Ellis, R.H. (1991). Seed quality, cotyledon elongation at sub-optimal temperatures and the yield of onion. *Seed Science Research*, **1**, 157–167.

# Computer vision for monitoring seed germination from dry state to young seedlings

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Seedling establishment is a crucial stage for plant production. High throughput phenotyping of a large number of seed and seedling traits becomes a great challenge to contribute to a better understanding of the mechanisms which lead to the establishment of a vigorous crop stand. Seed vigour and seedling establishment have, in several species, been related to the time course of germination, as determined by periodic counts of radicle protrusion (Matthews and Powell, 2011). However, the production of time course curves for seed lots is difficult and time consuming. An automated system using computer vision is a more efficient alternative. In this paper we describe such a system, which is capable of generating the time courses for large numbers of seeds, and illustrate its application to compare breeding lines and seed lots of a number of species.

## Germination monitoring by computer vision

The French Seed Testing Station has been involved for many years in research programmes based on image analysis. For germination testing, a prototype was developed on sunflower (Ducournau *et al.*, 2004, 2005) to provide full informative data, which can be difficult and time-consuming to record on individual seeds. Since then, this prototype has been improved in order to analyse more species and more seeds per species. Now, three vision machines (Fig. 1) have been developed with Jacobsen tables which allow seed germination with continuous watering and at accurately controlled temperatures between 10 and 30 °C ( $\pm 0.5$  °C). Four calibrated



Figure 1. Automated germination tools.

cameras (PixeLINK® PL-A662 1.3 MP) are placed on each table to analyse large samples (up to 400 seeds per camera), and image analysis was improved to record germination parameters of individual seeds (4 replicates of 50 or 100 seeds per lot for one curve). The automated devices are driven by in-house developed software which is sequenced to a predetermined frequency (usually every two hours at 20 °C) as follows: switching on the light (6 × 36 W cold white light), opening the cover, taking and saving a picture of the seeds for each camera, switching off the light and closing the cover. The software also names and stores images from each camera in separate directories according to the species name, in order to ensure complete traceability of the experiments. Experiments were performed, using a range of magnifications, to test and validate the system with various species, from small seeds such as oilseed rape or tomato to large seeds such as sunflower or maize (Table 1).

Image analysis is performed with ImageJ software in order to separate seeds from the background, and to measure and record selected data such as area, X and Y position of the inertia centre and curve length. After calibration, the initial seed mass can be deduced from the measurement of its surface or volume (Demilly *et al.*, 2007; Casco and Dias, 2008). It was also demonstrated that the increase in seed surface and volume observed in legume seeds is correlated with seed imbibition, i.e. the increase in seed water content (Demilly *et al.*, 2007). The automated device allows separation of radicle protrusion (germination *sensu stricto*) from elongation, using inertia centre changes and axis length after each single seed germination is completed. Thus, initial seed mass, imbibition, germination *sensu stricto* and embryonic axis elongation are automatically measured for each seed by image analysis, and constitute a database within each camera's directory. Data are then pooled and analysed with

**Table 1.** Species frequently phenotyped for their germination traits

| Species                        | Total images since 2005 | Sample size (single seeds) |
|--------------------------------|-------------------------|----------------------------|
| <i>Brassica napus</i>          | 9684                    | 68150                      |
| <i>Medicago truncatula</i>     | 5170                    | 27825                      |
| <i>Lycopersicon esculentum</i> | 4577                    | 18380                      |
| <i>Brassica rapa</i>           | 2403                    | 12865                      |
| <i>Medicago sativa</i>         | 1748                    | 11240                      |
| <i>Helianthus annuus</i>       | 3850                    | 10810                      |
| <i>Allium cepa</i>             | 1740                    | 9625                       |
| <i>Zea mays</i>                | 2770                    | 9235                       |

**Table 2.** Coefficient of determination between vigour tests and emergence results of five seed lots sown in the early spring, 7 April 2006 (\*significant  $p < 0.05$ )

| Vigour test   | Correlation to mean emergence ( $R^2$ ) |
|---|---|
| Accelerated ageing                                  | 0.543                                   |
| Conductivity  | 0.457                                   |
| Cold test   | 0.619                                   |
| Mean just germination time at 13 °C (manual counts) | 0.690*                                  |
| Mean germination time at 20 °C (vision machine)     | 0.664*                                  |

Excel® software, which creates a file for each date, camera (i.e. replicate) and sample, using appropriate plug-ins. A second file joins the various replicates from the same sample, and a metafile summarizes the whole experiment by cumulating data for the various samples and replicates.

**Vigour testing for seed technology**

In a comparative vigour testing method ring test in maize, prepared for the 2nd ISTA Vigour Testing Workshop in 2006, mean germination time (MGT) was the best indicator of field emergence (Table 2). The MGT was obtained for five samples, both automatically at 20 °C and using data obtained by manual counts at 13 °C. Both were significantly correlated with field emergence at an early sowing, while the commonly used cold test was not (Wagner *et al.*, 2007). Following international collaborative tests (Matthews *et al.*, 2011), a vigour test for maize using radicle emergence has been introduced into the ISTA Rules.

Another example of the use of the automated system is the priming of vegetable seeds. The automated germination time courses obtained clearly separated the effect of priming the samples (Fig. 2), with the exception of the slowest germinating seed lot, from which the primed sample had an MGT included in the range of unprimed samples from the same variety. Automated time courses have also shown that some cultivars can germinate very rapidly and homogeneously without any priming; but seed priming can still gain one day in germination time (Wagner *et al.*, 2010).

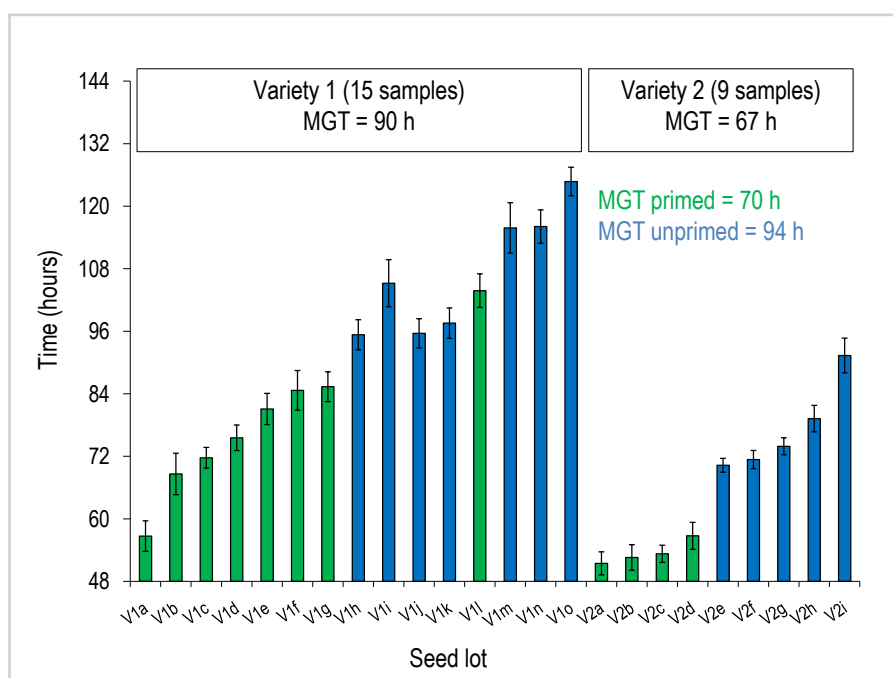
**Phenotyping for seed science**

Each automated germination device can analyse up to 1600 individual seeds simultaneously. Accurate and consistent data provided by image analysis can be used for modelling plant emergence or contributing to genetic studies. Germination high-throughput phenotyping has become a great challenge for seed biologists since the automation of genetic tools (Joosen *et al.*, 2010). In collaboration with an INRA research team (Brunel *et al.*, 2009; Dias *et al.*, 2011), the germination of a model legume species, *Medicago truncatula*, was studied for 178 recombinant inbred lines (RIL) at two temperatures. The RIL populations came from crosses between Jemalong A17 (genetically mapped) and two ecotypes,

DZA 315.16 (RIL4) and F83005.5 (RIL5). The ability to obtain information on imbibition, radicle protrusion (Fig. 3) and early seedling growth on the same seeds using computer vision allowed some distinct quantitative trait loci (QTL) to be identified for the three stages of seed germination, and their location to be found on the RIL consensus genetic map (Dias *et al.*, 2011).

**Seed phenotyping platform**

The automated system for germination is part of the seed phenotyping platform located in Angers. Several species have been validated, the most important being sunflower, cabbage, tomato, oilseed rape, maize and *Medicago truncatula* (Table 1). More than 170 000 seeds have been analysed since



**Figure 2.** Mean germination times obtained at 20 °C for 24 tomato seed lots with primed samples (green bars) within two varieties (left: V1; right: V2).



2005, at first for research programmes, but during recent years, seed companies have become interested in using germination time courses for ranking seed lots.

In addition to these computer vision tools dedicated to germination traits, a series of non-invasive characteristics are currently measured using X-rays (Belin *et al.*, 2011), chlorophyll fluorescence sorting, and image analysis for morphological dimensions.

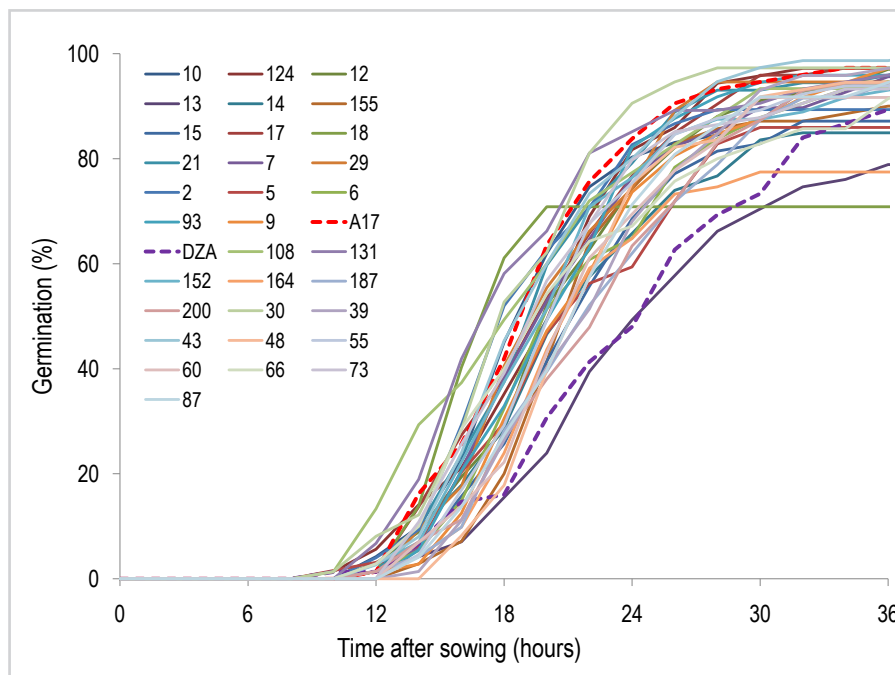
All these tools give a large range of possibilities to phenotype seeds from the dry state to young seedlings. The platform is open to seed researchers and seed companies.

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## References

- Belin, E., Rousseau, D., Léchappé, J., Langlois-Meurinne, M. and Dürr, C. (2011). Rate-distortion tradeoff to optimize high-throughput phenotyping systems. Application to X-ray images of seeds. *Computers and Electronics in Agriculture*, **77**, 188–194.
- Brunel, B., Teulat-Merah, M.-H., Wagner, T., Huguet, J.M., Prosperi, Dürr, C. (2009). Using a model-based framework for analysing genetic diversity during germination and heterotrophic growth of *Medicago truncatula*. *Annals of Botany*, **103**, 1103–1117.
- Casco, H. and Dias, L.H. (2008). Estimating seed mass and volume from linear dimensions of seeds. *Seed Science and Technology*, **36**, 230–236.
- Dias, P., Brunel, S., Dürr, C., Demilly, D., Wagner, M.-H., Teulah-Mérah, B. (2011). QTL analysis of seed germination and pre-emergence growth at extreme temperatures in *Medicago truncatula*. *Theoretical and Applied Genetics*, **122**, 429–444.
- Ducournau, S., Feutry, A., Plainchault, P., Revillon, P., Vigouroux, B., Wagner, M.-H. (2004). An image acquisition system for automated monitoring of the germination rate of sunflower seeds. *Computers and Electronics in Agriculture*, **44**, 189–202.
- Ducournau, S., Feutry, A., Plainchault, P., Revillon, P., Vigouroux, B., Wagner, M.-H. (2005). Using artificial vision to monitor germination time course of sunflower (*Helianthus annuus* L.) seeds. *Seed Science and Technology*, **33**, 329–340.
- Demilly, D., Wagner, M.-H., Brunel, S., Dürr, C. (2007). Using computer vision to analyse the relationship between physical characteristics of *Medicago truncatula* seeds and their germination and root elongation. 28th ISTA Congress, 5–11 May 2007, Iguazu Falls, Brazil.
- Joosen, R.V.L., Kodde, J., Willems, L.A.J., Ligterink, W., van der Plas, L.H.W., Hilhorst, H.W.M. (2010). GERMINATOR: a software package for high-throughput scoring and curve fitting of *Arabidopsis* seed germination. *Plant Journal*, **62**, 148–159.
- Matthews, S. and Hosseini, M. (2006). Mean germination time as an indicator of emergence performance in soil of seed lots of maize (*Zea mays* L.). *Seed Science and Technology*, **34** (2), 339–347.
- Matthews, S. and Powell, A.A. (2011). Towards automated single counts of radicle emergence to predict seed and seedling vigour. *Seed Testing International*, **142**, 31–35.
- Matthews, S., Wagner, M.-H., Ratzenboeck, A., Khajeh Hosseini, M., Casarini, E., El-Khadem, R., Yakhlifi, M. and Powell, A.A. (2011). Early counts of radicle emergence during germination as a repeatable and reproducible vigour test for maize. *Seed Testing International*, **141**, 39–45.
- Wagner M.-H., Matthews, S., Feutry, A., Demilly, D., Ducournau, S. (2007). Germination rate monitoring, a useful way for seed vigour testing on maize (*Zea mays* L.). 28th ISTA Seed Symposium, 5–11 May 2007, Iguazu Falls, Brazil.
- Wagner, M.-H., Demilly, D., Ducournau, S., Belin, E., Léchappé, J., Dürr, C. (2010). High throughput phenotyping of seeds from dry state to young seedlings. AGRO2010, The Scientific International Week around Agronomy, 29 August–03 September 2010, Montpellier, France.



**Figure 3.** Automated germination time courses obtained at 20 °C for 35 recombinant lines of the *Medicago truncatula* population RIL4 (dotted lines: parents A17 Jemalong and DZA 315.16).

# ISTA Biotechnology Trait Detection Workshop

## Shanghai, China, 5–9 December 2011

The National Center of Molecular Characterization of GMOs (NCMCG) at the Shanghai Jiao Tong University, China, will host an ISTA Workshop on Biotechnology Trait Detection Methods and Theory.

**The workshop will cover:** sampling principles, testing plan design, assessment of GMO content, SeedCalc, uncertainty theory of PCR methodologies; testing through-put and turnaround time, challenges specific to GMO testing; hands-on practice of samples processing; qualitative and qPCR testing and analyses.

### Location

Shanghai Jiao Tong University, Shanghai, China

### Organizers and lecturers

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### Sponsors

Pioneer Hi Bred  
Monsanto  
KBio science

### Registration

Chinese registrants please use:  
<http://zhanglab.sjtu.edu.cn/ista2011/>  
International registrants, please use:  
<http://seedtest.org/GMO-REG>

**Registration will be limited to 25 participants**

### Registration deadline

Friday, 4 November 2011

### Registration fee

ISTA Members: USD 600  
Non-members: USD 750  
Fee includes instructive materials, manuals and proceedings; coffee breaks, lunches and official dinner; half a day tour to Shanghai including visit to Chenghuang Temple, YU Park and a boat ride on the Huangpu River.

### Accommodation

Shanghai Jiao Tong University Academic Activities Center  
<http://academic.sjtu.edu.cn/index.php?controller=Hotel&action=Introduction>  
Standard room rate: approx. CNY 400 (about USD 62)  
Reservations can be made online, or, with the assistance of:  
Dr. Liato Yang  
800 Dongchuan Road  
School of Life Science and Biotechnology  
Shanghai Jiao Tong University  
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# ISTA Workshop on Quality Assurance in Seed Testing

## Shanghai, China, 5–9 December 2011

The National Center of Molecular Characterization of GMOs (NCMCG) in Shanghai Jiao Tong University, China, will host an ISTA Workshop on Quality Assurance in Seed Testing.

### Location

Shanghai Jiao Tong University, Shanghai, China

### Organizers

Prof. Dr. Dabing Zhang  
School of Life Science & Biotechnology  
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Dr. Litao Yang  
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Ms. Martina Haefeli  
ISTA Event Organizer  
meetings@ista.ch

### Lecturers

Rasha El-Khadem (Head of ISTA Accreditation Department)  
Ronald Don (ISTA Technical Auditor)

### Aim of the workshop

Presentation and discussion of basic principles of quality management, and the needs of laboratories to comply with the ISTA Accreditation Standard and prepare for attaining and maintaining ISTA accreditation. Successful participants will be able to:

- know about the ISTA Accreditation Scheme;
- understand the requirements of the Accreditation Standard;
- evaluate the situation of their laboratory with regard to conformity with the ISTA Accreditation Standard;
- document the quality management system for their laboratory in a manual and related documents;
- implement a quality management system;
- implement the checks required for laboratory equipment.

### Workshop content

The theoretical background will be given through lectures. Participants will be actively involved through group work, discussions and presentations. The ISTA Accreditation Standard will be used during the group work.

### Target group

Quality managers, laboratory managers and seed testing analysts, with or without experience in quality management.

**Please note:** This workshop does not focus on technical aspects of quality assurance.

### Preliminary programme

- Introduction to ISTA and the ISTA Accreditation Scheme
- The quality management system and quality documentation
- Quality management in seed testing, technical aspects: how to check the seed dividing process – how to perform balance checks – checking moisture-proof containers – how to perform germination substrate checks – monitoring of temperature-controlled equipment
- How to use tolerance tables and other statistical tools
- The Internal Audit Programme (establishing the audit check list and performing the audits)
- Corrective and preventive actions: principles and documentation
- The Management Review
- ISTA Certificates and how to issue them
- The ISTA Proficiency Test Programme
- Interpretation of the ISTA Accreditation Standard
- Excursion to an ISTA accredited laboratory
- Workshop dinner

### Accommodation

Shanghai Jiao Tong University Academic Activities Center  
<http://academic.sjtu.edu.cn/index.php?controller=Hotel&action=Introduction>

Standard room rate: approx. CNY 400 (about USD 62)

Reservations can be made online, or, with the assistance of:

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Shanghai 200240, China

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E-mail: [yyltt@gmail.com](mailto:yyltt@gmail.com)

### Registration fee

ISTA Members: USD 450

Non-members: USD 600

Fee includes instructive materials, manuals and proceedings; coffee breaks, lunches and official dinner.

**Please note:** for cancellations made before 4 November 2011, registration fees are refundable less a USD 50 administration fee.

For cancellations made after 4 November 2011, registration fees are non-refundable.

### Registration deadline

Friday, 4 November 2011

**Registration will be limited to 25 participants**

### Registration

[www.seedtest.org/QA\\_China](http://www.seedtest.org/QA_China)



# ISTA Workshop on Quality Assurance in Seed Testing Bangalore, India, 8–12 August 2011

Ronald Don<sup>1</sup> and Rasha El-Khadem<sup>2</sup>

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The ISTA-accredited seed testing laboratory of Indo-American Hybrid Seeds Pvt., Ltd., in Bangalore, India, organised an ISTA Quality Assurance Workshop in August 2011. The interest to attend the workshop was overwhelming, and 36 participants from 11 countries of Asia, Africa and Europe attended the five-day workshop. The participants represented quality assurance departments of the seed industry, universities and government agencies.

The aim of the event was to present and discuss the basic principles of quality management. It focused on the needs of seed testing laboratories that wish to comply with the ISTA Accreditation Standard, and was designed to be suitable both for those preparing to attain ISTA accreditation and for those aiming to maintain it.

The workshop was held in Bangalore in a hotel with suitable facilities, and started with an introduction of all participants and their expectations of the workshop. The lectures were given by Rasha El-Khadem, Head of the ISTA Accreditation Department, and Ronald Don, an ISTA technical auditor and a former Chair of the ISTA Germination Committee.



Presentations on the first two days dealt with document control and management of equipment. This was followed by more detailed presentations about how to check whether riffle seed dividers or hand dividing leads to the suitable division of a composite sample.

Several possibilities were presented on how to check whether containers are moisture proof, and therefore suitable to hold samples intended for the moisture determination analysis. The determination of the water-holding capacity of germination substrate was explained, and information on germination substrate checks in general was provided.

The group visited the hosting laboratory, and each participant was able to undertake four practical exercises: water-holding capacity and pH measurement of germination paper; riffle/soil divider check and verification; check on hand dividing; and check of suitability of moisture-proof containers.

Some of the lectures and presentations were followed by group work. Detailed explanations were given about the purity analysis and determination of other seed. Participants practiced their knowledge by filling in work cards using data provided for both tests.

The interest in the storage of seed samples was very high, and many questions were addressed and answered. A demonstration was given on how to use the Viability Equation Calculator (available as a download from the Royal Botanical Gardens Kew web site) to:

- predict storage time;
- predict final viability;
- estimate moisture content to give viability at known temperature;
- estimate temperature to give viability at known moisture content.





The participants at the Bangalore Botanical Gardens.

Participants were encouraged to use statistical and calculation tools that are freely available for download from the ISTA web site in the Germination toolbox, and details were given on how to use them for:

- rounding results;
- checking replicate tolerances;
- ascertaining confidence limits for germination results;
- deciding on the result to report when germination retests have been carried out;
- calculating moisture content results;
- calculating the water holding capacity of germination media.

ISTA's Accreditation Scheme and the ISTA Proficiency Test Programme were presented, and participants gained experience of completing ISTA Orange Certificates. Detailed information was also given on conducting internal audits. The requirements of the ISTA Accreditation Standard were discussed, and a demonstration was given on how to create an internal audit checklist. The demonstration SOP "*Sample Mixing, Calibration of Seed Dividers and Operation of the Seed Divider Register*" was used to develop a checklist for the calibration of a soil/riffle divider. Participants working in groups had to perform this internal audit, while the auditees (i.e. the lecturers) performed the practical divider check. All auditors also had to conduct a closing meeting presenting their audit findings

to the auditees, and were thereafter given feedback on the audit they performed.

The raw data generated during the practical exercises in the host laboratory was evaluated and discussed with the participants. The variation observed especially in regards to hand division and the check of the riffle/soil divider was much lower than expected by all, which motivated the entire group. The results of the moisture-proof containers were evaluated after the staff of the host laboratory had provided the weights of the seed stored for three days in the containers under varying conditions of relative humidity and temperature.

The botanical garden in Bangalore celebrated its annual Independence Day Horticultural Show, and the participants enjoyed visiting the exhibition where our hosts had won a first prize for their amazing floral





landscaping display, featuring *Coleus*, *Geranium*, *Petunia* and *Zinnia* plants. The Labagh Glass House was a good background for a group picture. Admiring the beautifully arranged plants and their colourful flowers, India's agricultural potential became obvious.

The workshop dinner was held in the famous Bangalore Club with its magnificent grounds. Once a haven and reserve for aristocratic British colonials (Winston

Churchill was once a member), the club is now open to Indians and offers an ideal venue for corporate events.

Around 30% of the participants had never before participated in an ISTA workshop. Sharing experience with participants from other seed testing stations was found to be valuable. The ISTA Secretariat received feedback forms of over 94% of the participants, containing very positive com-

ments, and confirming that most of the expectations were fulfilled.

Our sincere thanks are due to the laboratory staff of Indo-American Hybrid Seeds Pvt., Ltd. for the success of the workshop. They had put so much effort into organising the Workshop, and provided continuous support. Their contribution was very much appreciated by the lecturers and participants. ■

**President's Report** (continued from page 3)

pertinent, this approach could be extended to many kind of tests.

Reducing costs or adapting the tests to customer needs, while retaining accuracy, may be a difficult challenge. But it may be a chance to safeguard quality control and even the regulatory schemes, such as certification schemes.

These approaches (performance-based approach, or flexibility adapted to the objectives of the tests) and the first discussions started in Zurich confirmed that this will need a full debate within the Membership. It will also require close collaboration with the other international organizations, the OECD, the ISF, the EU Commission, the national regulation bodies, the seed industry and the Member Laboratories.

Thank you for your work and support for ISTA. ■

## ISTA Working Sheets on Tetratzolium Testing, Supplements 2011

By the ISTA Tetratzolium Committee;  
editors N. Leist, S. Krämer and A. Jonitz,  
illustrator J. Pfäfflin

The Tetratzolium Working Sheets Volumes I and II include detailed and standardized descriptions to conduct and evaluate tetratzolium tests for the determination of viability in agricultural, vegetable, horticultural and forest seed. These new sets of working sheets, available separately, cover 43 agricultural and 15 forest species and genera.

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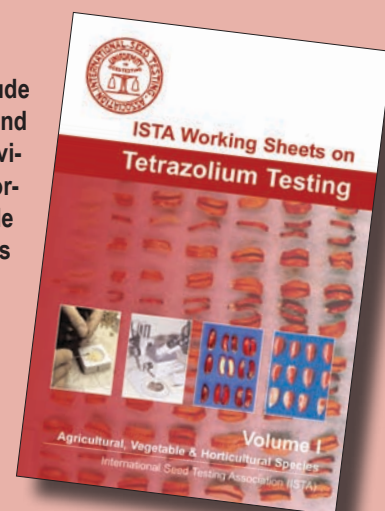
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|      | 2–11 November  | <b>ILAC General Assembly</b>   | Bangkok, Thailand             | <a href="http://www.ilac.org/events.html">www.ilac.org/events.html</a>                                     |
|      | 14–18 November | <b>APSA Annual Meeting</b>   | Kobe, Japan                   | <a href="http://www.apsaseed.org">www.apsaseed.org</a>   |
|      | 5–9 December   | <b>ISTA Workshop on Biotechnology Trait Detection</b>  | Shanghai, China               | <a href="http://www.seedtest.org/gmo">www.seedtest.org/gmo</a>   |
|      | 5–9 December   | <b>ISTA Workshop on Quality Assurance in Seed Testing</b>  | Shanghai, China               | <a href="http://www.seedtest.org/qa_china">www.seedtest.org/qa_china</a>                                   |
|      | 6–9 December   | <b>ASTA 66th Corn &amp; Sorghum Seed Research Conference — 41st Soybean Seed Research Conference — Seed Expo</b> | Chicago, USA                  | <a href="http://www.amseed.com/eventDetailLarge.asp?id=443">www.amseed.com/eventDetailLarge.asp?id=443</a> |
| 2012 | 7–10 March     | <b>AFSTA Congress</b>  | Lilongwe, Malawi              | <a href="http://www.afsta.org">www.afsta.org</a>   |
|      | 19–23 March    | <b>IPPC Commission on Phytosanitary Measures – 6th Session</b>   | Rome, Italy                   | <a href="http://www.ippc.int">www.ippc.int</a>   |
|      | 28–31 May      | <b>ISF World Seed Congress</b>   | Rio de Janeiro, Brazil        | <a href="http://www.worldseed.org/isf/congress.html">www.worldseed.org/isf/congress.html</a>               |
|      | 6–9 June       | <b>ISTA Workshop on Flower Seed Testing</b>  | Roelofarendsveen, Netherlands | <a href="http://www.seedtest.org/am12">www.seedtest.org/am12</a>   |
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