SEED ANALYSIS
A TOOL FOR QUALITY EVALUATION

Dr. Florina Palada, Head of Accreditation and Technical Department and the Executive Committee - International Relations Working Group
Executive Committee – Accreditation Working Group
OUTLINE

- Brief Information about ISTA
- How Seed Science Become ISTA Rules
- How ISTA Rules Are Used; What They Mean
- ISTA Accreditation Programme
ISTA HAS BEEN FACILITATING THE SEED TRADE SINCE 1924

1876 Friedrich Nobbe published his famous Handbook of Seed Science, and the Motto of the Meeting held in Hamburg that year was "uniformity in seed testing", later becoming the ISTA logo.

1924 26 countries participated in the meeting held in Cambridge, and the International Seed Testing Association was founded.

1931 At the request of FIS (ISF), ISTA adopted the first ‘International Rules for Seed Testing’, as well as establishing the ISTA Certificates Scheme.

1950 The ISTA Congress was held in Washington DC, the first outside of Europe, and demonstrated that, after 13 years of interruption by World War II, ISTA was indispensable to seed business.

1995 During the ISTA Congress held in Copenhagen, ISTA Membership was opened to private laboratories and private seed companies.

1996 To ensure harmonised seed testing worldwide, ISTA initiated the Quality Assurance Programme to accredit seed testing laboratories. The first ISTA Member Laboratory was audited under the new set-up in this year.

2004 During the ISTA Congress held in Budapest, it was agreed to consider accreditation as a purely technical task, and the responsibility to give authorisation to issue ISTA International Seed Analysis Certificates was given to the ISTA Executive Committee.
ISTA STRUCTURE

EXECUTIVE COMMITTEE
2016-2019

President
Craig McGill, New Zealand

Vice President
Steve Jones, Canada

Immediate Past President
Joël Léchappé, France

Members-at-large
Mable Simwanza, Zambia
Leena Pietilä, Finland
Berta Killerman, Germany
Masatoshi Sato, Japan
Rita Zecchinelli, Italy
Ignacio Aranciaga, Argentina
Keshavulu Kunusoth, India
Valerie Cockerell, United Kingdom

TECHNICAL COMMITTEES AND ADVISORY GROUPS

ADVANCED TECHNOLOGIES COMMITTEE
BULKING AND SAMPLING COMMITTEE
FLOWER SEED COMMITTEE
FOREST TREE AND SHRUB SEED COMMITTEE
GERMINATION COMMITTEE
GMO COMMITTEE
MOISTURE COMMITTEE
NOMENCLATURE COMMITTEE
PROFICIENCY TEST COMMITTEE
PURITY COMMITTEE
RULES COMMITTEE
SEED HEALTH COMMITTEE
STATISTICS COMMITTEE
SEED STORAGE COMMITTEE
TETRAZOLIUM COMMITTEE
VARIETY COMMITTEE
VIGOUR COMMITTEE
EDITORIAL BOARD (SST)

SEED SCIENCE ADVISORY GROUP
SEED INDUSTRY ADVISORY GROUP
VEGETABLE SEED INDUSTRY ADVISORY GROUP

INTERNATIONALLY RECOGNISED
The World Seed Partnership (WSP) is a joint initiative by four international organizations:

- International Seed Testing Association (ISTA)
- International Seed Federation (ISF)
- Organization for Economic Co-operation and Development (OECD)
- International Union for the Protection of New Varieties of Plants (UPOV)

The mission of the WSP is to provide a focal point for information on internationally harmonized seed systems and to communicate their role in supporting sustainable agriculture.
WORLD SEED PARTNERSHIP - WSP

To find out more about how the partnership can help you, please consult the WSP website (www.worldseedpartnership.org)

The launch of its website has been done at the occasion of the ISF World Seed Congress 2017, which took place in Budapest, Hungary, from May 22 to 25, 2017.
UNIFORMITY IN SEED TESTING

https://www.youtube.com/results?search_query=UNIFORMITY+IN+SEED+TESTING

VIDEO 1
ISTA OBJECTIVES

(1) develop, adopt and publish STANDARD PROCEDURES
for sampling and testing seeds and
promote uniform application of these procedures,
for evaluation of seeds moving in international trade

(2) PROMOTE RESEARCH
in all areas of seed science and technology
A GLOBAL MEMBERSHIP

78

COUNTRIES / DISTINCT ECONOMIES

HAVING AT LEAST ONE MEMBER
MEMBERSHIP CATEGORIES

222
MEMBER LABORATORIES

134
ACCREDITED LABORATORIES

58
ASSOCIATE MEMBERS

34
PERSONAL MEMBERS

05
INDUSTRY MEMBERS
LABORATORY MEMBERSHIP

Europe: 97
Australia/Oceania: 10
Asia Pacific: 67
Africa: 16
South America, AR, BO, BR, CL, UR, CO, PY: 13
North America: 19
MEMBERSHIP CATEGORIES

SOUTH AMERICA

14 MEMBER LABORATORIES

6 ACCREDITED LABORATORIES
2 ACCREDITED IN BRAZIL

6 ASSOCIATE MEMBERS

2 PERSONAL MEMBERS

4 DESIGNATED AUTHORITIES
ISTA’S COMMUNITY OF EXPERTS

https://www.youtube.com/watch?v=eXfnM30R8C8

Video 2
FROM SEED SCIENCE TO RULES FOR SEED TESTING: THE ROLE OF ISTA

- Method proposal
- Species proposal
- Submission and Information to ISTA Technical Committee
- Method Validation Study
- Evaluation and Approval by ISTA Technical Committee
- ISTA Rules proposal
- Approval by ISTA Executive Committee
- Approval by ISTA Ordinary Meeting
- New ISTA Rules
ACCEPTANCE OF RULES PROPOSALS

- Designated members vote on Rules proposals at ISTA Annual Meeting (June)

- Validated methods included in Rules after agreement by ISTA members

- New ISTA Rules implemented January each year
HOW ARE ISTA RULES USED?

Provide validated, standardised methods for testing aspects of seed quality
  ➢ guidance for seed companies and end-users of seed

ISTA methods must be used if ISTA Orange or Blue International Certificate are to be issued
  ➢ allows trade in seed
  ➢ provides guarantees to exporters and importers
WHAT DO WE WANT FROM OUR SEED?

Uniform, successful establishment
WHAT DO WE WANT FROM OUR SEED?

Uniform, successful establishment
WHAT WE DO NOT WANT TO SEE?

Weedy crops
WHAT WE DO NOT WANT TO SEE?

- Diseased crops
- Uneven maturity
SEED QUALITY, WHAT DOES IT MEANS?

- Required variety

- Physical purity – freedom from weeds, other seed and inert matter

- Good plant establishment

- Freedom from disease
WHAT DO ISTA TEST RESULTS TELL YOU?

Physical characteristics of the seed lot
- Purity, other seeds content, moisture content

Genetic purity
- Variety and GMO testing

Seed health
- Pests
- Diseases

Physiological characteristics of the seed
- Germination, viability (tetrazolium, vigour)
VARIETY TESTING
Chapter 8 ISTA Rules

Two aspects:

➢ Identity of the variety: is it the required species or variety?

➢ Varietal purity
  • Open pollinated, F1 hybrids
  • Presence of GM in conventional lots and vice versa
TRADITIONAL METHODS FOR VARIETY TESTING

Morphological methods

Seeds

In laboratory and glasshouse

In the field
VARIETY TESTING

- Protein reserves; electrophoresis
- Molecular markers: DNA extraction; PCR
- Microsatellites: Simple Sequence Repeats (SSR)
DNA BASED METHODS

This method is best used to verify varieties in a comparative manner, i.e., to determine whether the allele profile of a sample is identical to that of an authentic reference variety.

Principle

DNA is extracted from seeds and a minimum number of microsatellite markers are amplified by the polymerase chain reaction (PCR). The amplified DNA fragments are separated according to size using electrophoresis and detected using an appropriate technique.

- Triticum, 2017 ISTA Rules
- Zea mays, 2018 ISTA Rules
# DNA BASED METHOD FOR *Triticum*

## Table 8.5. Prescribed microsatellite markers and PCR primers for verification of wheat varieties

<table>
<thead>
<tr>
<th>Marker</th>
<th>Forward primer</th>
<th>Reverse primer</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>DuPw167</td>
<td>cggagcaaggacgatagg</td>
<td>caccacaccaatcaggaacc</td>
<td>A</td>
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<tr>
<td>DuPw217</td>
<td>cgaattacacttcctcttccg</td>
<td>cgagcgtgtaacaagtgcc</td>
<td>A</td>
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<td>DuPw004</td>
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<td>tgggagcgtacgtgtatcc</td>
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<td>DuPw115</td>
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<td>cctcgaatctcccagttatcg</td>
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<td>DuPw205</td>
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<td>ctccgccctcacatccttgc</td>
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<td>aatcattggaaatccatatgcc</td>
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<tr>
<td>Xgwm413</td>
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<td>Xgwm003</td>
<td>gcagcggcactgtacatctt</td>
<td>aatatcgcatacactttc</td>
<td>B</td>
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## Table 8.6. Recommended supplementary microsatellite markers and PCR primers for verification of wheat varieties

<table>
<thead>
<tr>
<th>Marker</th>
<th>Forward primer</th>
<th>Reverse primer</th>
<th>Source</th>
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<td>Xbarc184</td>
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<td>ccgtggtgatcgtgtgctggcttgctg</td>
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<td>Xbarc074</td>
<td>gcggcttcctgagcggag</td>
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<td>Xgwm052</td>
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<td>Xgwm095</td>
<td>gatcacaatcaccacacctcc</td>
<td>aatgcgaagtgaaaccctgg</td>
<td>B</td>
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</table>
The object of testing for seeds of genetically modified organisms (GMOs) is to give guidelines to detect, quantify or confirm the presence of GMO seeds in seed lots.

These guidelines can be applied to testing adventitious presence (AP) of genetically modified organisms (GMOs) and GMO trait purity testing.

*GMO- Genetically Modified Organisms*
TESTING FOR SEEDS OF GMO

Testing Approaches

• 19.5.1 DNA-based methods
  – 19.5.1.1 General principles of DNA-based testing
  – 19.5.1.2 End-point qualitative PCR
  – 19.5.1.3 Real-time PCR
  – 19.5.1.4 Other technologies

• 19.5.2 Protein-based methods
  – 19.5.2.1 General principles of protein-based testing
  – 19.5.2.2 Lateral flow strip test
  – 19.5.2.3 Enzyme-linked immunosorbent assay

• 19.5.3 Bioassays
  – 19.5.3.1 General principles of bioassays
  – 19.5.3.2 Scoring of GMO presence
Avdenticous Presence

**Ability to detect:**
- bulk testing qualitative
- 3 impurity levels (blind)
- 10 samples/level
- 400 seeds/sample

**Ability to quantify:**
- bulk testing quantitative
- Individual seed testing
- 3 impurity levels,
- 3 samples/level

Trait Purity

**Ability to detect:**
- bulk testing qualitative
- 3 impurity levels (blind)
- 10 samples/level
- 400 seeds/sample

**Ability to quantify:**
- single seed testing
- 3 impurity levels (blind)
- 3 samples/level
- 90 seeds/sample
TESTING FOR SEEDS OF GMO

Reporting results on an ISTA Certificate

• Qualitative results
  “The test target was detected/was not detected”

• Quantitative results by multiple qualitative tests
  “The test target was detected. The % of seeds with test target was determined to be ...% with 95% CI of [...%, ...%]”

• Quantitative measurements in bulk samples
  “The test target was detected. The % of the test target in the seed lot was determined to be ...% ...% with 95% CI of [...%, ...%]”
PHYSICAL PURITY
Chapter 3 ISTA Rules
Composition of the seed lot and the the identity of the various species of seeds and inert particles – percentage (%) 

OTHER SEEDS BY NUMBER
Chapter 4 ISTA Rules
Estimate the number of seeds of other species stated by the applicant either generally (e.g. all other species) or by reference to one category of seeds (e.g. species scheduled as noxious in a certain country), or specifically (e.g. Elytrigia repens).

In international trade this analysis is used mainly to determine the presence of seeds of noxious or undesirable species.
PHYSICAL PURITY
OTHER SEED DETERMINATION

Avoids inert maters, weeds and other species

Methods:
  Lenses, microscopes, sieves
  Blowers (light material: chaff, empty florets)
Assesses germination potential of a seed lot
Primary assessment of physiological quality

Optimum conditions to achieve maximum potential
Temperature, light, dormancy breaking

Seedlings assessed
Normal seedlings will give a plant in optimum conditions in the field

Basis of seed regulations for acceptable commercial material
SEED SURVIVAL CURVE

High germination, commercial seed

% Germination

Time
GERMINATION
GERMINATION ASSESSMENT: MAIZE

Normal seedlings

Abnormal seedlings

Coleoptile split >1/3

Deformed seedlings

Coleoptile split and spiralled
GERMINATION
RESEARCH AND TESTS DEVELOPMENT

Extension of current test methods

- Germination test conditions for new species

New introduction in the 2018 ISTA Rules

*Brassica carinata*
TETRAZOLIUM (VIABILITY)
Chapter 6 ISTA Rules

- Identifies if seeds are living or not

- Positive tetrazolium test (TZ) + low germination, reveals dormancy

- Identifies specific damage that may explain why seeds fail to germinate
RAPID ASSESSMENT OF VIABILITY
Tetrazolium Chloride staining

Living tissues stain red
GOOD ESTABLISMENT

1. Germination
   high percentage of normal seedlings

2. Vigour
   seed ability to perform in a range of conditions
   field, glasshouse, storage
SEED VIGOUR
Chapter 15 ISTA Rules

➢ Provides information about the planting value in a wide range of environments and/or the storage potential of seed lots.

➢ Provides additional information to the standard germination test (Chapter 5) to assist in the differentiation of seed lots of acceptable germination.

➢ A seed lot of acceptable germination is one which, in the absence of seed dormancy, has an acceptable standard germination level for that species.
Seed survival curve

Seed lots A, B and C have high germination but differ in physiological age.
CONDUCTIVITY

Cicer arietinum (Kabuli type),
Phaseolus vulgaris
Glycine max
Pisum sativum (garden peas only excepting petit-pois varieties)
Raphanus sativus

Accelerated ageing test
Glycine max
RADICLE EMERGENCE (RE)
*Brassica napus, Raphanus sativus, Zea mays*

Seed vigour is accurately reflected in a single count of radicle emergence early in germination and relates closely to other expressions of the rate of germination.

High counts of radicle emergence early in germination are indicative of high seed vigour; low counts indicate low seed vigour.
CONTROLLED DETERIORATION

Brassica spp

Seed quality:
- problems of emergence and storage
- quality related to physiological age

Seed survival curve

% germination vs Time
The seed moisture content (mc) is the amount of water in the seed; it is usually expressed as a percentage on wet weight basis in any seed-testing laboratory.

It is the most vital parameter, which influence the seed quality and storage life of the seed.

Is closely associated with several aspects of physiological seed quality.

It is related to seed maturity, optimum harvest time, mechanical damage, economics of artificial seed drying, seed longevity and insect and pathogens infestation.
MOISTURE DETERMINATION

- Determination of moisture content by the constant temperature, oven method:
  - low-temperature method (low)
  - high temperature (high) method

- Determination of moisture content by moisture meters
MOISTURE DETERMINATION

Grind/ not grind → Heat to remove water

Moisture meters
MOISTURE DETERMINATION

The diagram illustrates the relationship between seed moisture content and storage temperature. It shows different zones corresponding to various storage conditions and the impacts of moisture content on seed viability. The x-axis represents storage temperature in °C, ranging from -20 to 60, and the y-axis represents seed moisture content in percent, ranging from 0 to 30. The zones include:

- Freezing injury
- Germination
- Mites
- Insects
- Fungi and bacteria
- Storage fungi
- Good storage conditions
- Desiccation injury

The diagram also highlights conditions sufficient for one year of storage of cereals.
Why are these tests important?

Seed borne inoculum may:
- Cause disease in the crop
- Introduce disease to new regions
- Reduce germination and % normal seedlings

Testing may indicate need for seed treatments

ISTA Seed Health Methods valid for 2017 are posted on ISTA website
SEED HEALTH

The test used depends on the organism being tested for and the purpose of the test.

fungi, bacteria, viruses, nematode, insect
location of inoculum
sensitivity required
New version of method 7-004: Detection of *Leptosphaeria maculans* and *Plenodomus biglobosus* on *Brassica* spp. seed
New method 7-031: Filtration method for detection of *Ditylenchus dipsaci* on *Medicago sativa* (alfalfa), *Ditylenchus dipsaci* and *Ditylenchus gigas* on *Vicia faba* (faba bean) seed.

*D. dipsaci* - a quarantine pest on alfalfa seed in some areas in the world

Figure 1. a-f) Nematodes' extraction by filtration method

Figure 2. a) *Ditylenchus dipsaci* extracted from alfalfa, b) *Ditylenchus gigas* extracted from faba bean
PCR CONFIRMATION, 7-031

Figure 3: Aspect of electrophoresis gel after amplification of specific primers DdpS1 and DdpS2.
Figure 4: Aspect of electrophoresis gel after amplification of control amplification primers rDNA1 and rDNA2.
New method 7-032: Detection of *Verticillium dahliae* on *Spinacia oleracea* (spinach) seed

Microsclerotia of *Verticillium dahliae* formed in concentric rings on NP-10 agar medium (No magnification, photograph courtesy of B. Brenner) and b) Microsclerotia of *Verticillium dahliae* on a blotter (60x magnification, photograph courtesy of G. Hiddink).
New method 7-032: Detection of *Verticillium dahliae* on *Spinacia oleracea* (spinach) seed

Viable microsclerotia of *Verticillium dahliae* growing on a blotter versus, b) non-viable microsclerotia on a spinach seed based on the lack of microsclerotia forming on the blotter plus the lack of conidiophores observed on the pericarp after incubating the plated seed for 14 to 21 d (photographs courtesy of E. Gilijamse).
The quality of the results for the above mentioned tests depends on the quality and representativity of the sample tested.

Chapter 2 of ISTA Rules states the requirements to be followed when sampling for the issuance of an Orange International Certificate.

- Manual sampling
- Automatic sampling
The ISTA-system for deciding whether a seed lot may be sampled or not.

1. Application for sampling
2. Testing the requirements: marking of the lot, sealing of the lot, lot size
3. Requirements fulfilled?
   - No: Sampling refused
   - Yes: Obvious heterogeneity found?
     - No: Taking primary samples
     - Yes: ISTA heterogeneity test
6. ISTA heterogeneity test:
   - No: Lot classified as heterogeneous
   - Yes: Obtaining the submitted sample
   - Application withdrawn by the applicant
   - Sampling refused due to heterogeneity
## SALES OF ONLINE ISTA RULES
### 2014 – 2016

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<th>2014</th>
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<td>Multiple-user access (e.g. non-member labs)</td>
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<td>Single-user access (Associate Members; TCOM Members)</td>
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<td><strong>TOTAL</strong></td>
<td>139</td>
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ISTA Rules are provided for free to ISTA members.
Chapters 1, 2, 7 are published on the ISTA website and can be downloaded for free.
ACCREDITATION PROGRAMME

https://www.youtube.com/watch?v=EZSNg6p-Skg

VIDEO 3
ISTA ACCREDITATION OVERVIEW

134 ISTA accredited laboratories
61 countries/distinct economies with at least one ISTA accredited laboratory
BENEFITS OF ISTA MEMBERSHIP

- Standardised Methodologies: # ISTA RULES
- Standardised Performance: # ACCREDITATION PROGRAM
- Standardised Reporting Results: # ISTA CERTIFICATES
- Benchmark Standard Performance: # PROFICIENCY TEST
- Access to Premium Knowledge: # ISTA PUBLICATIONS
- Continued Education: # ISTA WORKSHOPS
- Professional Networking: # ISTA COMMITTEES & EVENTS
ISTA PROFICIENCY TESTS

- Testing of samples in accordance with determined methods
- Statistical analysis
- Evaluation of the laboratory’s proficiency
- Detection of systematic errors
- Detection of trends in performance
- Results of mandatory laboratories influence their accreditation status
ISTA PROFICIENCY TESTS

Seed Health Tests
- infected seed samples
- Two Proficiency Test rounds per year
- Quantify amount of known plant pathgenes

Basic Tests:
- Different PT rounds different crops
- Germination
- Purity
- Other Seed Determination
- Moisture Determination
- Tetrazolium
- Vigour
- (Certificate issuance)

GMO Tests
- Conventional seed Samples “spiked” with GM seed
- Laboratories use various methods
- Have to determine “event”
- And/or determine quantity
ISTA PROFICIENCY TESTS
Standard tests

Tests:

- Germination
- Purity
- Other Seed Determination
- Moisture Determination
- Tetrazolium
- Vigour
- Certificate issuance

Crop groups:

Group 1: Grasses
Group 2: Cereals
Group 3: Small legumes
Group 4: Pulses
Group 5: Other agricultural crops
Group 6: Vegetables
Group 7: Forest species
Group 8: Flower species
Ratings are assigned: **A**, **B**, **C** and **BMP** (Below Minimum Performance) for each test in each round.

After six rounds of participation calculation of overall rating.

Only mandatory test results are included in overall rating.

Performance of a laboratory influences their accreditation:

- Overall rating of **C** $\rightarrow$ warning letter
- Overall rating of **BMP** $\rightarrow$ suspension
- Not participated in 2 rounds out of 6 $\rightarrow$ suspension

For the new candidates for accreditation to obtain **A** and/or **B** for the test they are interested to have in the accreditation scope is a mandatory condition.

ISTA PROFICIENCY TESTS

The overall ratings are given for the 2016 three test rounds for germination.

Accredited Laboratories perform significantly better than non-accredited Laboratories
ISTA PROFICIENCY TESTS

The overall ratings are given for the 2016 three test rounds for physical purity.

Accredited Laboratories perform significantly better than non-accredited Laboratories
ISTA ACCREDITATION

The official language for communication is **English**.

Accreditation can be granted for:
- Sampling Entities performing ISTA sampling only
- Laboratories performing ISTA Testing only
- Laboratories performing ISTA Sampling and Testing

Is open for Seed Testing Laboratories and Sampling Entities from the public and the private sector.

Audit performed in compliance with ISTA Accreditation Standard for Seed Testing and Seed Sampling

QUALITY MANAGEMENT SYSTEM

ISTA Accreditation
Standard & ISTA Rules:

ISTA Membership
ISTA Proficiency Test Programme
Quality Management System
ISTA Audit
Granting Accreditation
Follow up Programme

ISTA Certificate
Sampling of Seed Lot

- Organisation and Management structure
- Independency, confidentiality
- Competency and Training
- Job description
- Supervision of staff
- Work environment
- Maintenance of equipment
- Calibration of equipment
- Sampling documents
- Goals
- Storage of samples
- Lot identification
- Monitoring of samplers
- Purchasing
- Testing in accordance to Rules
- Rules, HB, SOPs up to date available
- Handling of samples
- Management Review
- Computer and automated systems
- Reporting of subcontracting
- subcontracting
- Internal Audits
- Review of Requests and tenders
- Up to date records of staff and training
- Audit trail – 6 years
- Storage conditions
- How to make corrections
- Corrective Action & complaints
- Quality Assurance System
- Document Control
- Quality Control Procedures
- Control of NCW
- PT

75
ISTA ACCREDITATION AUDIT

PRE-AUDIT:

- Submission of Quality documentation in English (e.g.: Quality Manual, SOPs, policies, procedures, forms)
- Review of Proficiency Test results

AUDIT:

- Two auditors (System and Technical Auditor)
- Scheduled for 1 – 1.5 days
- Auditing of sampling, testing, Quality Management System, laboratory staff competence, laboratory premises, equipment, consumables, etc.
- Audit Report
ISTA ACCREDITATION AUDIT

**POST- AUDIT:**

- Audit report and checklist
- Deadline to address the substantial NC
- Auditors will review the corrective actions and evidence provided to remove the substantial NC
- Possibly additional deadline to provide more data/evidence

The audit process must be finalised in not more than 6 months after the audit (on-site assessment) day.
GRANTING ACCREDITATION
Issuance of ISTA Certificates possible

- All substantial non-conformities must be addressed and evidence provided
- Accreditation and Technical Department recommends granting accreditation to the ISTA Executive Committee

Once approved:

- Certificate of Accreditation issued
- Listed as accredited laboratory on ISTA website with Scope of Accreditation
- Proficiency test participation for the crop groups from the accreditation scope will be obligatory
ISTA CERTIFICATES

Only ISTA accredited laboratories are entitled to issue ISTA Certificates

Only ISTA-accredited laboratories are authorised to issue ISTA Certificates for seed analysis.
By reporting seed test results on ISTA Certificates, the issuing laboratory assures that the sampling and testing has been carried out in accordance with the ISTA Rules.
ISTA Certificates are accepted by many authorities and are mentioned into the Seed Act of several countries.
The ISTA Certificates are assuring that the test results are reproducible, true and represent the quality of the seed.

An Orange International Seed Lot Certificate is issued when both sampling from the lot and testing of the sample are carried out under the responsibility of an ISTA-accredited laboratory.
MAINTAINING ACCREDITATION

- Accreditation Audit
- Proficiency Test Programme
- Membership

ISTA Accreditation Audit

ISTA Membership
ISTA Proficiency Test Programme
Quality Management System
ISTA Audit
Granting Accreditation
Follow up Programme

Re-Accreditation Audit
Proficiency Test Programme
SALES OF ISTA CERTIFICATES

**166 500** ISTA Certificates were sold by the end of the year

A **decrease of 2.6%** compared to the previous year

1.4 % for Orange ISTA Certificates

20.6 % for Blue ISTA Certificates

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<td>172 100</td>
<td>150 700</td>
<td>190 600</td>
<td>160 300</td>
<td>158 000</td>
</tr>
<tr>
<td>Blue ISTA Certificate</td>
<td>6 450</td>
<td>5 700</td>
<td>10 400</td>
<td>7 400</td>
<td>6 300</td>
<td>10 700</td>
<td>8 500</td>
</tr>
<tr>
<td>TOTAL</td>
<td>138 650</td>
<td>134 750</td>
<td>182 500</td>
<td>158 100</td>
<td>196 900</td>
<td>171 000</td>
<td>166 500</td>
</tr>
</tbody>
</table>
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