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Report on the evaluation of the performance of the Q2 Seed Analyser in Seed Quality Analysis

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Introduction

ISTA has for over a century developed and validated methods for evaluating seed quality, which are included in the International Rules for Seed Testing. These methods have largely been developed within the technical committees and their supporting laboratories. Any equipment required to complete these tests is typically generic and test methods define only the specifications of the equipment and not a specific make.

The use of metabolic, biophysical and molecular measurements of seed performance have, however, led to the development of equipment that may or may not have potential for use in seed quality testing. One of the Terms of Reference of the Seed Science Advisory Group is, when requested by an ISTA member or developer of equipment, to evaluate the evidence for the effectiveness of these developments. This evidence can be gathered from both published papers and formal requests to developers for supplementary evidence and proof of effectiveness. The overall aim of an SSAG review of equipment is to provide information to ISTA members regarding the claims for the use of that equipment.

In 2015 the SSAG was asked by Astec Global, the producers of the Q2 seed analyser to undertake a review of this piece of equipment (personal communication from B van Duijn, Chair of the ATC to Chair of SSAG). This article summarises the aims and results of this review.

Basis of the review

The review was based on articles and data provided by those who

- produce and market the Q2 (Astec Global),
- have been involved in its development and marketing (Johan van Asbrouck, Bert van Duijn)
- complete research on behalf of the Q2 users group (Kent Bradford).

In addition, information available online from companies selling the Q2 (Astec Global; Centor Group including Centor Thai, Centor Oceania / India, Rhino Research, Aginnovation; Fytogoras) was used.

Three members of the SSAG, **Professor Françoise Corbineau** (Université Pierre et Marie Curie, France) and **Dr Brigitte Hamman** (Syngenta Global Seedcare Institute, Switzerland) and **Dr Alison Powell** (University of Aberdeen, UK), individually reviewed the documents, all of which were also available to all members of the SSAG. When the three individual reviews were completed, a set of conclusions was put together by the three reviewers and the three reviews and conclusion were made available to all the SSAG for comment and approval. The reviews and conclusions were subsequently submitted to the ECOM for approval.

Claims for use of the Q2 Seed Analyser

The claim made for Q2 by Astec Global (Frederick Schreurs, Global Director New Business, Astec Global, personal communication, 15/10/15) is:

'The technical principle or claim behind the Q2 is the oxygen consumption of a single seed in a closed compartment. This could be used as a performance evaluation (validation?) method or technique'. A specific use of Q2 in seed testing was not stated.

A similar view was expressed by Bert van Duijn (Fytagoras, personal communication, 15/09/15):

'I would look for claims such as: Measurement of oxygen consumption of (germinating) single seeds in (closed) containers'.

In contrast promotional material for the Q2 makes very specific claims for the use of the Q2 in seed quality testing, namely:

-the Q2 is *'a fast germination tool'* with *'germination results in 24-48 hours'* (Astec Global ref.1)

-gives *'a holistic picture of vigor'*, and it is stated that the information provided gives support for checking levels of pathogens, breeding programmes and predicting feasibility of priming methods. (Astec Global website; Centor Group, Centor Thai, Rhino Research; refs 1,2, 3 and 6)

'Q2 data is more robust and defining than traditional germination tests' and *'You will easily determine dead, dormant and actively germinating seeds. Although it does not provide specific details of seedling abnormalities the Q2 can give quicker and more accurate indications of the vigor and homogeneity of the seed lot'*. (Centor Group ref 2)

-the Q2 system is a *'practical germination alternative'* (Centor Oceania,ref 4)

-Q2 can be used for *'Fast prediction of germination'* (Centor Thai,ref 3).

-the Q2 *'correlates respiration rate to the germination and vigor characteristics of the seed, provides a great overview of your seed lots vigor'* and *'results predict how seed lots will perform under water stress'* (Centor Thai, ref 3).

- Q2 assesses *'quality and vigor'*(Centor Oceania/Centor India ref.4).

- the target for the Q2 is *'Seed germination and vigor tests in general'* and the Q2 can be applied for *'seed quality and vigor analysis'*, provides *'quantifiable vigor data'* and is the *'most sensitive seed vigor indicator'*. (Aginnovation, ref 5)

- the Q2 has many applications including as a *'device to determine the viability of seeds'*, providing a *'complete overview of vigor'* and allowing a check of *'bacterial and fungal infections of seeds'*. (Fytagoras, ref 7).

Aim of the SSAG review

The aim of this review was therefore to evaluate the claims made above that the Q2:

1. Measures the oxygen consumption of single seeds in a closed compartment
2. Identifies dead, dormant and germinating seeds
3. Is more robust and defining than traditional germination tests
4. Provides a complete view of vigour.

Conclusions

The conclusions following the review of the information available on the Q2 have been accepted by the whole SSAG and the ECOM. The three reviews on which the conclusions are based are available on the SSAG page of the ISTA website.

1. The Q2 can measure the depletion of oxygen in a closed system during seed germination. This can reveal:
 - a. the homogeneity of oxygen consumption,
 - b. differences between dead, dormant and germinating seeds in the pattern of O2 depletion,
 - c. the effects of ageing and priming.

Nevertheless, potential users should be made aware of the following cautionary comments:

- a. The Q2 does not discriminate between oxygen uptake due to respiration and that from lipid and/or phenolic compound oxidation
 - b. Seeds of different sizes and from different cultivars can differ in their sensitivity to oxygen depletion in a closed system as used in the Q2
 - c. Differences in single seed weight are not accounted for
 - d. There is no evidence of repeatability of the system
2. There is little evidence that '*Q2 data is more robust and defining than traditional germination tests*'.
 - a. Most work has been done on artificially aged seeds or those with widely different germination percentages. There are few significant relationships between Q2 data and germination of commercial seed lots and no convincing predictions of germination.
 - b. No evidence has been presented to illustrate repeatability and reproducibility of the data.
3. There is no evidence that the Q2 data predicts vigour. There is limited experimental work that examines the relationship between Q2 data and field emergence or storage potential and no significant relationships have been shown between Q2 values and either expressions of vigour or the results of other vigour tests.

4. There are limitations to the potential use in testing commercial seed lots in addition to the cautionary comments noted in 1 above:
 - a. Protocols for a range of different species and different sized seeds are not available
 - b. Q2 values are not the same for every species and need to be developed for a new species before potential use of the system can be evaluated.
 - c. Seed treatment with insecticides can reduce germination on agar, as in the Q2 system
 - d. Temperature sensitivity requires a temperature controlled environment

Overall conclusions

On the basis of the evidence provided by those involved with the Q2, and the evidence available in the public domain, the claims made for use of the Q2 in seed testing to predict germination and vigour of commercial seed lots are not supported. The Q2 may have a use in general seed science research, where different biological variables can be considered and accounted for.

Addendum

Since this review was completed a further paper on the application of the Q2 has been published:

Single-seed oxygen consumption measurements and population-based threshold models link respiration and germination rates under diverse conditions.

Pedro Bello and Kent J. Bradford; Seed Science Research (2016) 26, 199–221 doi: 10.1017/S0960258516000179

This research used a completely different approach to the use of data from the Q2 compared to that described in the literature reviewed in this report. This new approach does not relate the Q2 data reported in this paper to vigour as expressed in field emergence and/or storage potential.

Web references

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