Germination test using electrical conductivity

A. Montenegro[1], O.M. Royo[1], O. Ayala[2], P.A. Fernandez[1]
[1] INTA EEA, Saenz Peña ARGENTINA
[2] SAGYP, Resistencia ARGENTINA
Correspondence author montenegroalex@chaco.inta.gov.ar; montenegroalex@saenzpe.inta.gov.ar

ABSTRACT

The analysis of electrical conductivity consists of the modification of conductivity caused by the liberation of soluble particles from seeds that takes place in early stages of germination. Although this method is well developed for different species and accepted internationally, in Argentina it is not widely characterized for cotton. For such a reason the present work has as its objective to specify the method of electric conductivity according to the following assumptions: i) Values of electric conductivity for Argentinean cotton are unknown. ii) Cottonseed linters content affects measurements of electric conductivity. The methods (Standard Germination and Electric Conductivity) did not show significant difference, giving an average of 70% for the method of Standard Germination and 69.8% for the method of estimation by Electrical Conductivity. Considering all the plots analyzed, the germination percentage by Standard Test had a negative linear relationship with the modification of conductivity caused by the liberation of soluble particles (r2: 0.75; df: 31), from seed samples, with a range of variation from 53 to 92% of germination percentage for a range of 92,3 to 49.5 mS/cm^{-1} of electrical conductivity. This could be indicating a relationship among the quantity of soluble particles released into water solutions and the germination test estimated by the method of Electric Conductivity for a group of Argentinean cultivars.

Introduction

The most used method worldwide to analyze seed quality is the Standard Germination Test, which reflects the germination percentage of a seed sample after an average of seven days has lapsed, this number of days depending on the species. This amount of time often hinders taking quick decisions about seed utility and management. There are other methods that reflect quality, taking less time and supplementing the standard germination test with other qualitative parameters like Cold test, quick aging test, tetrazolium test, Hiltner test, exudation test and electric conductivity test.

This last analysis (electric conductivity) basically consists on the modification of conductivity caused by the release of soluble particles from the seed that takes place in the early stages of germination (Mathews *et al*., 1980; Craviotto, 1998). When inbibition occurs there is a substantial release of solutes from the seed, like sugars, amino acids and electrolytes, and particularly potassium. Methods that detect this release involve analysis of sugar and amino acid components from the leachate (Armstrong *et al*., 1992).

The loss of electrolytes in the water provides a simpler and quicker method for determining seed quality, and this is possible measuring the water electric conductivity. Specifically, bad quality seeds give high conductivity levels, good quality seed samples give low conductivity levels.

Although this method is well developed for different species and accepted internationally (Bewley *et al*., 1983; Oliveira *et al*., 1984; Bonner and Vozzo, 1986; Herter *et al*., 1989), in Argentina it is not widely characterized for cotton. For such a reason the present work has as its objective to specify the method of electric conductivity according to the following assumptions: i) Values of electric conductivity for Argentinean cottons are unknown, ii) Cottonseed linters contents affect measurements of electric conductivity.

Experimental procedure

The trial was carried out in the fiber and seed laboratory at INTA Experimental Station Saenz Pena, Chaco, with the participation of cottonseed sellers. For determination of the electric conductivity an automatic seed analyzer SAD-2007 was used, which consists of a multiple conductivity meter with the capacity to analyze 100 seeds simultaneously. This analyzer measures the resistance of a solution and hence its conductivity, expressed in μS/cm (microSiemens per centimeter). Conductivity measurements were carried out introducing a couple of steel stainless electrodes, (one for each cell) separated 1 cm apart from each other, into deionised water.

In all experiments, the deionised water had conductivity lower than 8 μS/cm. Seed lixiviation lasted between 18 and 20 hours, time that was adjusted before the trial, so that the seeds could liberate a significant quantity of electrolytes to the water medium.

An important component in cottonseed is linters. All the analyzed samples had a linters content according to how they came from the gin (9% ± 2). Dirt adhered to linters can interfere with conductivity measurements. For this reason a linters treatment was necessary before tests were carried out. It consisted of a washing and two to three rinses of the seeds, putting them in a container with distilled water during two hours.

The determinations were carried out at a temperature of 21 ± 1 °C. This factor was kept in mind, since variations in temperature affected determinations, so we maintained it constant throughout the experiments.

Measurements taken by the method of Standard Germination Test were carried out using an automatic humidifier and a thermal cycler that alternates an eight hours period at 30 °C with a 16 hours period at 21 °C, using as substrate sterilized sand trays. The duration of the test lasted for five days for determining germination percentage.

Samples came from fields from the main cotton growing regions of Argentina: Chaco, Formosa, Salta, Cordoba, and Santiago del Estero. Cultivars analyzed were: GUAZUNCHO 2 INTA, PORA INTA, GRINGO INTA, CHACO 520 INTA.

Treatments consisted of two different methodologies: electric conductivity and test of standard germination. The statistical design was a completely randomized, with 31 replications. For each replication, 400 seeds were taken.

The differences between the means of the treatments of each experiment were determined by means of the least significant difference when the variance analysis revealed significant differences. Regression analysis was used after averaging the replications for each treatment. The level of significance used was P=0.05 in all analyses.

Results and Discussion

Seed lots of pea and soybean are often treated prior to being received for testing, and following the work of Tao (1980c), AOSA recommended removal of seed treatment by methanol and on the other hand Loeffier *et al.* (1988) indicated that the conductivity of seeds may also be altered by the methanol washing. With the proposed methodology for linters treatment, reliable levels of non-interference of linters were reached for the measurement of electric conductivity. After resting two hours, electric conductivity was measured giving values of 4 ± 2 μS/cm, being lower than the required values for final seed imbibition (during 18/20 hours). As described above in the methodology, these treated seeds are ready for the measurements of electric conductivity.

Temperature was kept at 21 °C ± 1, which was enough for the elimination of variations present in the measurements and on the time lapsed for leach (18/20 hours). Bedford *et al*. (1974) described a relationship of a 2% germination loss for each increase in degree Celsius of temperature, creating a source of variation.

The methods (Standard Germination and Electric Conductivity) did not show a significant difference, giving an average of 70% for the method of Standard Germination Test and 69.8% for the method estimated by the Electric Conductivity Test (Table 1). Similar results have been obtained in other experiments for different species. (Bewley *et al.*, 1983; Oliveira *et al.*, 1984; Bonner and Vozzo, 1986; Herter *et al.*, 1989). Although this first result showed an absence of significance, there are certain considerations to be made. Samples came from seed production fields, hence their quality, as for Germination Test, were high. A wider range of germination percentages would be suitable in order to refine more this methodology.

Considering all the plots analyzed, the germination percentage by Standard Germination had a negative linear relationship with the modification of conductivity caused by the liberation of soluble particles (r2: 0.75; df: 31; Figure 1) from the seeds, with a range of variations from 53 to 92% of germination percentage for a range of 92.3 to 49.5 μS/cm of electrical conductivity.

Conclusion

1. The methods (standard germination and electric conductivity) did not show a significant difference, giving an average of 70% for the method of standard germination and 69.8% for the method estimated by electric conductivity.
2. Considering all the plots analyzed, the germination percentage by the standard germination test had a negative linear relationship with the electrical conductivity for a group of Argentinean cultivars.

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***Table 1**. Averages for electric conductivity (µS/cm), percentage standard germination test and percentage seed prediction analyzer.*

Samples	Electric conductivity (µS/cm)	Std. germination test (%)	Seed analyzer prediction (%)
1	92.3	53	53
2	82.9	63	53
3	84.7	67	58
4	77.3	72	64
5	82.1	64	60
6	69.1	72	62
7	78.4	73	64
8	68.8	79	70
9	77.9	71	64
10	84.9	67	68
11	83.4	65	68
12	81.1	69	68
13	80.9	67	68
14	87.9	60	64
15	89.8	61	68
16	64.9	75	70
17	73.5	67	70
18	73.7	71	72
19	80.2	63	70
20	80.5	67	72
21	82.5	65	72
22	74.6	69	76
23	68.3	80	80
24	73.1	73	80
25	80.5	70	75
26	75.8	70	73
27	75.7	70	77
28	83.2	63	70
29	73.9	72	76
30	49.5	92	88
31	68.5	94	92
Averages	77.4	70a	69.8a

a: Same letter are mean values not significantly different, based on $LSD_{(0,05)}$ to be compared by the standard germination test (%) with seed analyzer prediction (%).

Figure 1. Relationship between percentage standard germination test and values of electrical conductivity.