Performance evaluation of Whatman germination paper

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Abstract

We evaluated the performance of Whatman Grade 1 (Product code 1001090) and Grade 3236 (Product code 10345576) papers. The following parameters were evaluated: (1) physical characteristics; (2) biological toxicity; and (3) germination. We used both top of paper (TP) and pleated paper (PP) methods to perform seed germination tests. The results show that Whatman Grade 1 and Grade 3236 met the International Seed Testing Association's requirements for seed testing paper.

Introduction

The choice of paper for seed germination has important implications because factors such as conductivity, pH, and the presence of toxic substances may have adverse effects on the results of seed germination. This study evaluates the performance of Whatman Grade 1 and Grade 3236 papers.

Materials and methods

We selected two paper grades (Whatman Grade 1 and Grade 3236) for performance evaluation. The following characteristics were evaluated: 1) physical characteristics; 2) biological toxicity; 3) germination. Conductivity and pH were evaluated for both papers. In order to establish the presence or absence of toxic substances in the paper, we performed biological toxicity tests with sensitive seeds (*Eragrostis curvula*). Seed germination testing was carried out using two seed types: Whatman Grade 1 was evaluated using the TP method and *Brassica napus* seeds; Whatman Grade 3236 was evaluated using the PP method and *Cucumis sativus* seeds. The tests were carried out using International Seed Testing Association (ISTA) methods.

Table 1. Product codes and lot numbers of the papers used in this study

Papers	Product code	Lot number
Whatman Grade 1	1001090	FC009602
Whatman Grade 3236	10345576	G1469626

Determination of physical characteristics

Triplicate samples were analyzed for each paper type and test.

For the conductivity test, about 0.5 to 1.0 g of germination paper (actual weight designated as W) was placed in a clean 100 ml beaker with 100 ml of ultrapure water. The sealed beaker was incubated for 24 h at 20°C to release dissolved components from the paper. After incubation, a conductivity meter was used to measure the conductivity (C1) of the solution. The conductivity (C0) of the ultrapure water used in this study was also measured. The final conductivity of the germination paper was calculated as:

$$\text{Conductivity} = (\mu S \bullet cm^{-1} \bullet g^{-1}) = (C1 - C0)/W)$$

For the pH test, germination paper (0.5 g) was placed in a clean 100 ml beaker with 100 ml of ultrapure water (pH 6.0), sealed with plastic wrap, and incubated for 5 h. We measured the pH at the end of the incubation period.

Biological toxicity test

Toxicity testing of Whatman Grade 1 was carried out using the TP method. For Grade 1, three pieces of paper moistened with distilled water (pH 7.3) were placed into separate Petri dishes. Whatman Grade 3236 was tested using the PP method, in which one piece of pleated paper saturated with distilled water (pH 7.3) was placed into a germination box. For both TP and PP testing methods, 300 seeds (replicates of 100 seeds) of *Eragrostis curvula* were grown. The growth of seedlings was observed after 2, 4, and 7 d in a 20°C incubator with 12 h of light illumination per day.

Germination test

We used 400 seeds (replicates of 100 seeds) to conduct a germination test for each paper. The TP method was used for testing Whatman Grade 1, and the PP method was used for Whatman Grade 3236. For the TP method, a three-layer thickness of saturated germination paper (pH 7.3) was placed in a Petri dish, which was sealed with plastic wrap. The germination results were recorded after 8 d of growth at 20°C with 12 h of light illumination per day. In the PP method, a piece of saturated seed testing paper (pH 7.3), was placed in a germination box, and the results were recorded after 8 d growth at 20°C with 12 h of light illumination per day.

Results and discussion

Evaluation of physical characteristics

Both of the tested papers met ISTA specifications for low salinity (no more than 40 mS/m). In addition, the pH values of both the papers were within the recommended range of 6.0 to 7.5.

Table 2. Conductivity and pH results of two germination papers[1]

Seed testing paper	Conductivity ($\mu S \cdot cm^{-1} \cdot g^{-1}$)	pH
Whatman Grade 1	2.7 ± 0.21	6.30 ± 0.00
Whatman Grade 3236	12.4 ± 0.59	6.63 ± 0.06

[1] Results include standard deviations (n=3).

Biological toxicity

For the TP method, we observed seed germination after 2, 4, and 7 d of seed growth (Fig 1) without any signs of root inhibition (e.g., shortened and discolored roots or bunched root hairs).

The results were similar for the PP method: seed growth was normal (Fig 2), and we did not observe any symptoms of root inhibition.

(A)

(B)

(C)

Fig 1. Biological toxicity testing: seed growth on Whatman Grade 1. *Eragrostis curvula* seeds and the TP method were used. (A) Seed growth after 2 d; (B) Seed growth after 4 d; (C) Seed growth after 7 d.

(A)

(B)

Fig 2. Biological toxicity testing: seed growth on Whatman Grade 3236. *Eragrostis curvula* seeds and the PP method were used. (A) Seed growth after 2 d; (B) Seed growth after 7 d.

Germination test

For the TP method, we observed seed germination after 2, 4, and 8 d of growth. The growth of the seedlings on Whatman Grade 1 was normal after 4 and 8 d of growth (see Fig. 3).

The results for the PP method tests (Whatman Grade 3236) are shown in Figure 4.

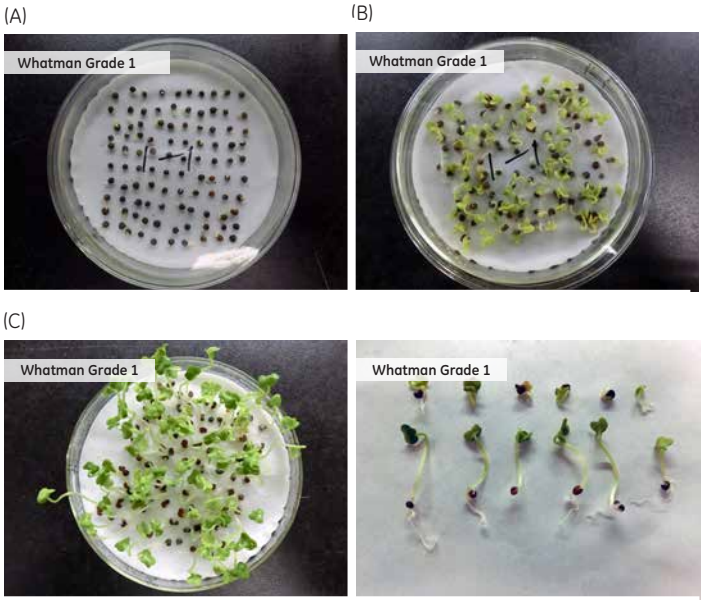

Fig 3. Germination of *Brassica napus* seeds: (A) Germination after 2 d; (B) Germination after 4 d; (C) Germination after 8 d and comparison between normal and abnormal seedlings.

Fig 4. Germination of *Cucumis sativus* seeds: (A) Germination after 2 d; (B) Germination after 4 d; (C) Germination after 8 d and comparison between normal and abnormal seedlings.

Table 3. Germination results after 8 d[1]

Germination paper	Normal seedlings (%)	Abnormal seedlings (%)	Ungerminated seeds (%)
Whatman Grade 1	83.0 ± 3.56	7.8 ± 2.87	9.3 ± 1.71
Whatman Grade 3236	80.5 ± 4.04	6.3 ± 2.22	13.3 ± 2.99

[1] Results include standard deviations starting with 100 seeds (n=4).

The results of the germination study are summarized in Table 3. Both Whatman papers performed well with only a low level of abnormal seedling development.

During the whole germination process, the roots were grown on the surface of the germination paper.

Conclusion

In this study, we evaluated the effectiveness of Whatman germination paper under ISTA requirements. The results show that Whatman germination papers meet ISTA requirements.

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