

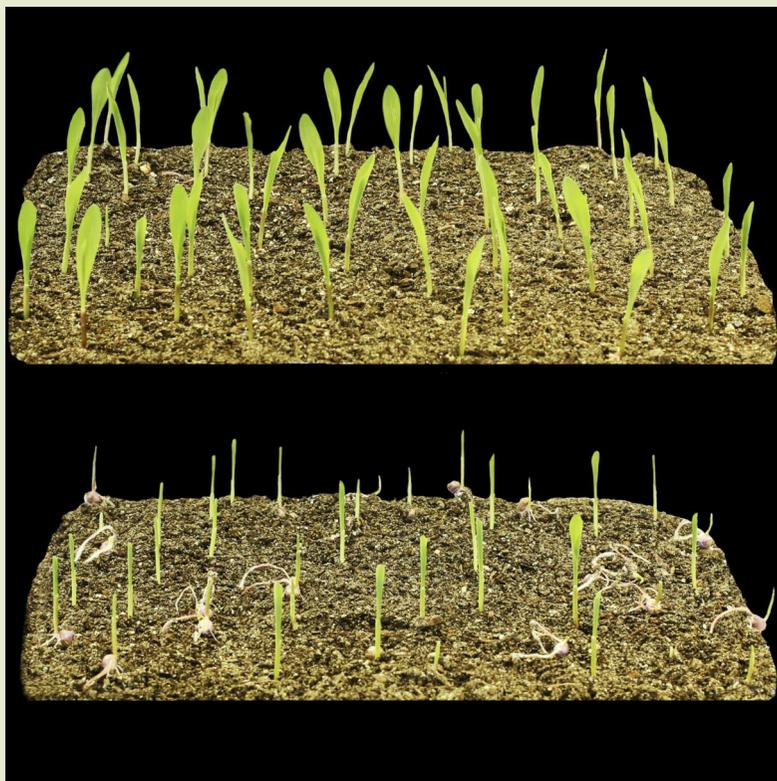
# Seed Technology

*An International Journal Serving Seed Scientists and Technologists*

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2014

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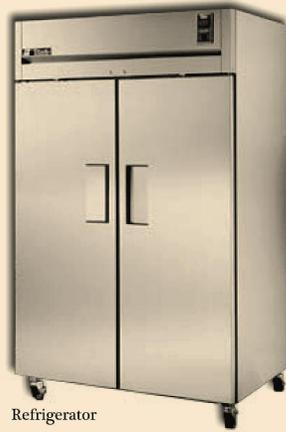


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Volume 36, Number 2 • 2014



**Published jointly by:**

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SOCIETY OF COMMERCIAL SEED TECHNOLOGISTS

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# Seed Technology

**THIS JOURNAL** is co-sponsored by the two predominant organizations in North America with a direct interest in seed technology: the Association of Official Seed Analysts and the Society of Commercial Seed Technologists.

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**AIMS AND SCOPE** – *Seed Technology* is an international journal containing scientific and technological papers in all areas of Seed Science and Technology. The emphasis is on applied and basic research in seed physiology, pathology and biology that may relate to seed development, maturation, germination, dormancy and deterioration. Studies on seed production, sampling, testing, conditioning, distribution and storage are also included. Short communications from seed analysts and technologists are encouraged and will be published as Seed Tech Notes. These notes include new techniques, standardization of laboratory tests and documentation of anatomical and pathological observations of seed and seedling development. The journal also includes timely review articles of seed technology that may relate directly to the seed industry.

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**COVER ILLUSTRATION:** The favorable conditions under which the standard germination test is conducted, necessary for reproducible test results within and among laboratories, frequently produce results that overestimate seed quality as well as field emergence under less than ideal conditions. Vigor tests, such as the cold test (seeds planted in wet, unsterilized soil, kept at 10 °C for 7 days, then transferred to 20–30 °C for 7 days), can reveal differences in seed quality undetected by the standard germination test. When two corn (*Zea mays* subsp. *mays*) seed lots with identical standard germination test results (96%) were evaluated using the cold test, percentage germination of the high vigor seed lot (top) showed no significant decline (95%), while that of the low vigor lot (bottom) dropped to 63%. Photo credit: Riad Baalbaki, California Department of Food and Agriculture.

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- Bernard, R.L. and M.G. Weiss. 1973. Qualitative genetics. p. 117–154. *In Soybeans: improvement, production, and uses*. B.E. Caldwell, R.W. Howell, J.W. Judd and H.W. Johnson (eds.). 1st ed. Agron. Monogr. 16. ASA, CSSA, and SSSA, Madison, WI.
- Engels, J.M.M., H. Dempewolf and V. Henson-Apollonio. 2011. Ethical considerations in agrobiodiversity research, collecting, and use. *J. Agric. Environ. Ethics*. 24(2): 107–126. Retrieved from <http://www.springerlink.com/content/jv26675022010063/> (verified 12 Dec. 2011).
- Fehr, W.R. and C.E. Caviness. 1977. Stages of soybean development. Spec. Rep. 80. Iowa Agric. Home Econ. Exp. Stn., Iowa State Univ., Ames.
- Koning, G., D.M. TeKrony, T.W. Pfeiffer and S.A. Ghabrial. 2001. Infection of soybean with soybean mosaic virus increases susceptibility to *Phomopsis* spp. seed infection. *Crop Sci*. 41: 1850–1856.

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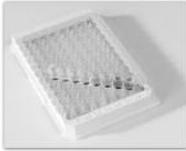
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