# A screening to study the effect of various smoke solutions and cold-moist stratification on *Carex*©

D. Schoemaker, S. Ebelhar and D.L. Sanford[a]

Department of Plant Science, The Pennsylvania State University, Berks Campus, Reading Pennsylvania 19610, USA.

## INTRODUCTION

The research was conducted to serve as screening of several *Carex* species to determine the effect smoke and cold-moist stratification had on germination.

Since early hunter-gather society, humans have observed that after a forest fire, small, prairie plants, are one of the first species to germinate. The rejuvenation in growth is known as secondary succession. For centuries, this process has been suggested as a natural occurrence, however, current research shows that species react to fire due to internal genetic signaling through the protein MAX2 and smoke isolate compound karrikin.

## MATERIALS AND METHODS

The current research looked to screen for the effect that liquid smoke and cold-moist stratification has on nine different *Carex* species. Each *Carex* species was tested with a 30, 60, and 90 day cold-moist stratification periods and four different smoke groups, plus a control of deionized water. The species *C. vulpiniodea* and *C. bicknelli* had germination percentages greater than 50%. All other species percent germination was less than 50%. Within *C. vulpiniodea* and *C. bicknelli*, cold-moist stratification assisted in increasing the percent of germination better than any of the smoke solutions.

Each *Carex* species was rinsed in 10, 5, 1% bleach, and deionized water before being transferred to cold-moist stratification. Using HEPA filter environment, each *Carex* species was transferred into Petri dishes containing a filter paper and three milliliters of deionized water. The seeds were then placed into a cold room at and removed after 30, 60, or 90 days. The cold room temperature ranged between 1.6 and 4.4°C, and contained no light. A total of 800 seeds per cold treatment were transferred for each species.

A 2, 5, and 10% Haddon House Hickory Smoke liquid smoke solutions were made. Also, a solution of Super Smoke Plus from Cape Seed Primer was made from smoke infused filter paper. Finally, a control of deionized water was tested. After seeds were removed from the cold stratification, 160 seeds were transferred to each smoke solution for a 24-h soak at 21°C.

After soaking the seeds were transferred to Petri dishes containing filter paper and 3 mL DI water. There were eight trials per experimental group. Each Petri dish contained a total of 20 seeds. Petri plates were placed in a growth chamber set at 23°C during a 12-h light photoperiod and 15°C dark period during each 24-h cycle.

## RESULTS

The number of seeds germinated per group per Petri dish was counted on a weekly basis for a total of 3 weeks. The seedling was considered “germinated” at the first sight of a root radicle. The percent germination was collected once a week for a total of 3 weeks. Results are presented in Table 1.

[a]E-mail: dls30@psu.edu

Table 1. Percent germination for selected *Carex* species with 0, 30, 60, 90-day cold-stratification followed by a 24-h soak in a smoke solution. The table shows the percent germination, smoke group, and cold-stratification period for each of the *Carex* species studied during the screening process. All numbers in parentheses after the species name represents the cold-stratification in number of days for the individual species.

| Species-cold period (days) | Control (%) | 2% Smoke (%) | 5% Smoke (%) | 10% Smoke (%) | Smoke paper (%) |
|---|---|---|---|---|---|
| *C. bicknellii* (0) | 1.25 | 2.50 | 1.88 | 1.88 | 1.25 |
| *C. bicknellii* (30) | 18.13 | 14.38 | 8.75 | 3.13 | 27.50 |
| *C. bicknellii* (60) | 48.75 | 45.63 | 34.38 | 18.75 | 50.00 |
| *C. bicknellii* (90) | 40.00 | 51.88 | 45.00 | 10.00 | 58.75 |
| *C. blanda* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. blanda* (30) | 6.25 | 11.25 | 4.38 | 4.38 | 8.13 |
| *C. blanda* (60) | 3.75 | 1.25 | 1.88 | 3.13 | 2.50 |
| *C. blanda* (90) | 11.25 | 7.50 | 1.88 | 1.88 | 8.75 |
| *C. cryptolepis* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. cryptolepis* (30) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. cryptolepis* (60) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. cryptolepis* (90) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. comosa* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. comosa* (30) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. comosa* (60) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. comosa* (90) | 0.00 | 0.63 | 1.25 | 0.63 | 0.00 |
| *C. crinite* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. crinita* (30) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. crinita* (60) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. crinita* (90) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. frankii* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *C. frankii* (30) | 1.25 | 1.88 | 0.00 | 1.25 | 4.38 |
| *C. frankii* (60) | 3.13 | 3.75 | 5.63 | 1.88 | 5.63 |
| *C. frankii* (90) | 1.25 | 3.75 | 4.38 | 1.88 | 8.13 |
| C. *haydenii* (0) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. *haydenii* (30) | 1.25 | 0.63 | 0.00 | 1.25 | 1.25 |
| C. *haydenii* (60) | 5.00 | 2.50 | 1.88 | 0.00 | 4.38 |
| C. *haydenii* (90) | 1.25 | 1.25 | 1.88 | 1.88 | 1.88 |
| *C. pensylvanica* (30) | 12.50 | 6.25 | 2.50 | 0.00 | 12.50 |
| *C. pensylvanica* (60) | 15.00 | 6.25 | 4.38 | 1.25 | 15.63 |
| *C. pensylvanica* (90) | 5.63 | 5.63 | 3.13 | 1.25 | 15.00 |
| *C. vulpinoidea* (0) | 5.00 | 0.63 | 0.63 | 1.25 | 6.88 |
| *C. vulpinoidea* (30) | 93.75 | 95.00 | 86.25 | 53.13 | 95.00 |
| *C. vulpinoidea* (60) | 91.88 | 97.50 | 88.75 | 76.25 | 95.63 |
| *C. vulpinoidea* (90) | 93.13 | 97.50 | 93.75 | 86.25 | 96.25 |

## Additional reading


Guo, Y., Zheng, Z., La Clair, J.J., Chory, J., and Noel, J.P. (2013). Smoke-derived karrikin perception by the α/β-hydrolase KAI2 from *Arabidopsis.* Proc. Natl. Acad. Sci. U.S.A. *110* (*20*), 8284–8289 https://doi.org/10.1073/pnas.1306265110. PubMed

Krock, S., Smith, S., Elliott, C., Kennedy, A., and Hamman, S.T. (2016). Using smoke-water and cold-moist stratification to improve germination of native prairie species. Native Plants J. *17* (*1*), 19–27 https://doi.org/10.3368/npj.17.1.19.