Effect of storage on germination of R-55 repellent-treated seed of white spruce

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Abstract

Determination of seed fate by radio-tracer methods have indicated seed losses to small mammals in Alberta could be as high as 50% during some years even when the widely accepted formulation of aluminum powder-endrin-arsan-latex had been applied to protect the seed supply in direct seeding operations. The need for a better seed coating formulation led to the development and evaluation of a potent rodent repellent, R-55, to protect spruce seeds from rodent damage. As part of the evaluation of this repellent, white spruce seeds were coated with a 4:1 (weight ratio) mixture R-55/graphite and latex. Treated and non-treated (controls) seed lots were stored in a refrigerator for a 2-year period during which eight germination tests were conducted at 2-3 month intervals to test seed viability. Except for one slight mid-winter decline in germination corresponding to a possible seasonal response of the seeds, no significant decline in germination resulted with storage up to 2 years duration. Studies with other coniferous seeds suggest considerable variability in seed species in response to the R-55/graphite coating and to storage of the treated seed.

Introduction

The need for a better coating formulation to protect coniferous seeds against rodent damage led to use of a potent rodent repellent, R-55. As part of the evaluation of this repellent, white spruce seeds were coated with a 4:1 (weight ratio) mixture of R-55: graphite and latex. Treated and non-treated (controls) seed lots were stored in a refrigerator for a 2-year period during which eight germination tests were conducted at 2-3 month intervals to test seed viability. Except for one slight mid-winter decline in germination corresponding to a possible seasonal response of the seeds, no significant decline in germination resulted with storage up to 2 years duration.

The widespread practice throughout North America of treating coniferous seed prior to direct seeding operations is to minimize major losses to small mammals, birds, insects and mold. Prompt use of treated seed is not always possible for a variety of reasons — inclement weather, shortage of equipment, manpower or other delays — and the seed may be returned to storage for several days, weeks, or even until the next seeding period a year later. Few studies have identified the influence of storage on the germinative capacity of the treated seed and the results may depend upon a variety of factors such as tree species, coating formulation, moisture conditions, storage temperature and duration.

One coating formulation which had received wide acceptance and application was accorded by an aluminum powder-endrin-arsan-latex combination (Spencer 1952). Although intended for use initially on Douglas fir seeds, the method was adopted by foresters across the country and soon applied to a wide variety of coniferous seeds with varied results. Radio-tagged seed fate studies in Alberta have in-

dicated losses to small mammals of treated white spruce seeds (*Picea glauca*) as high as 50% within 3 to 4 months after spring seeding (Rad-vnyi 1966, 1970a). Dissatisfaction with the degree of protection accorded by this treatment led to experimentation and the eventual development of an alternate seed coating formulation for white spruce which not only resulted in a high degree of protection against the most common seed eating small mammals but also yielded better germination of treated seed than the former treatment (Radvanyi 1970b, 1971). The new coating formulation employs a potent rodent repellent, R-55 (tertiary butylsulfenylidimethyldithio carbamate), which under laboratory conditions is 95-98% effective in preventing seed depredation by deer mice (*Peromyscus maniculatus*) or red-backed voles (*Clethrionomys gapperi*). As part of the tests to evaluate the effectiveness of the new coating formulation, experiments were conducted to determine the influence of the coating treatment on treated and non-treated white spruce seeds during a 2-year period of storage. Tests on the effect of storage on similarly treated and stored black spruce seed are reported in another paper (Radvanyi 1974).

Materials and methods

White spruce seeds used in this study were obtained from the Alberta Forest Service and originated from the Rocky Mountain House, Alberta, area. Initial germination tests indicated 87% seed viability. In the coating procedure, the seeds were moistened with diluted and acidified Dow latex 612 and then sprinkled with a 4:1 (weight ratio) mixture of the R-55 rodent repellent and graphite added to the seeds as they were tumbled in a hand-operated cement mixer. The treated seeds were spread to dry over night. Seeds sufficient for an initial germination test were withdrawn and the remainder sealed in a glass jar and placed in a refrigerator at 2°C. A similar quantity of non-treated control seeds were placed in a second jar and similarly stored. Treatment and storage commenced in early April 1972. Eight germination tests at 2 to 3 month intervals were conducted on the seed lots over a 2-year period of storage.

Germination tests were carried out on moist perlite in open petri dishes placed in a Stultz germinator operating on an 8-hour light and 16-hour dark regime at $27 \pm 0.5^\circ\text{C}$ and $19 \pm 0.5^\circ\text{C}$ respectively. Five hundred treated and a similar number of non-treated control seeds (five replications of 100 seeds) from each lot were used in each test. Throughout the study, a seed was considered to have germinated when the radicle equalled the length of the seed, and germinants were removed from the petri dishes as they occurred, usually every other day.

Results

The cumulative mean percentage germination of R-55/graphite treated and non-treated white spruce seeds stored up to 2 years are shown in Fig. 1. Germination of the repellent treated seed was 80.4% (controls 86.0%) in the initial test following

treatment in April 1972. During the subsequent two tests (July and November 1972) germination of both seed lots declined slightly. In January 1973 the germination of treated seed was 61.6%, controls 76.6%. These figures represent a decline of 18.8% for treated and 9.4% for non-treated control seeds compared to germination obtained immediately after application of the coating treatment. At the end of one full year of storage, germination of treated seeds had improved to 76.8% (only 3.6% lower than immediately after treatment). In the corresponding test, control seeds germinated 83.0%, or only 3.0% less than in the initial test.

During the second year of storage, the germinative capacity of both treated and non-treated white spruce seeds continued to improve. By the end of the second year of storage, germination of R-55 treated seeds was 77.4%; non-treated controls 83.6% or only 3.0 and 2.4% lower respectively than at the commencement of the storage experiment.

To ascertain whether improved germination of R-55 treated white spruce seed during the latter part of the storage period was due to the repellent having gradually expired and become ineffective (and, therefore, no longer exerting a possible slight phytotoxic quality upon the seeds), treated and non-treated seeds were used in a 5-day feeding trial on *Peromyscus maniculatus*. In the tests, 2,000 non-treated and 1,000 treated seeds were scattered on the floor of a small room. An adult animal was released into the room and allowed to choose from either seed type on an individual seed basis. The mouse was allowed to feed during a 24-hour period, at which time the seeds were retrieved and a new batch of seeds placed out. Using the formula of Besser and Welch (1959) the calculated effectiveness of the coating treatment in preventing destruction of the spruce seeds after 2 years of storage was 88.1%, indicating insignificant change in the repellent ingredient.

Discussion

The studies on R-55/graphite treated and stored seeds of white spruce indicate no marked decline in germination results with this species when stored up to 2 years. As shown in Fig. 1, a gradual decline in germination of both treated and non-treated seeds occurred during the first year resulting in a lowered germination value during tests conducted in January 1973. To what degree this gradual decline is attributable to the seed response to the coating ingredients, to storage itself, or is an innate negative response of the seed to the season of the year as suggested by Baldwin (1942) remains unknown. Germination, for both treated and non-treated seeds, increased again following the first midwinter low. Unfortunately no germination test was scheduled during January 1974 to ascertain a possible second midwinter low germination potential. Such a test is scheduled for January 1975.

Ideally, coniferous seeds to be used in direct seeding operations should be sown as soon as possible after coating. Phytotoxic effects, if caused by coating ingredients, may be many fold greater under storage conditions than upon seeds broadcast into the environment where soil moisture provides a dilution factor. My tests with black spruce seeds (*Picea mariana* (Mill.) B.S.P.) have indicated no significant initial reduction in germination occurs with the initial application of the R-55/graphite coating but seeds so treated should not be stored beyond a 1-year period (Radvanyi 1974).

As the originator of the R-55/graphite coating method, I have sought to determine what effect prolonged storage may have on viability of stored treated seed of spruce. Results of my earlier studies involving R-55 revealed that coniferous seed species could differ markedly in their response to the repellent coating. While very acceptable germination results were achieved shortly after treatment of white spruce and black spruce, the same treatment applied to lodgepole pine (*Pinus contorta* Doug. L. var. *latifolia* Engelm.) or to Douglas fir (*Pseudotsuga*

FIG. 1. Mean germination of R-55 treated and non-treated white spruce seed stored for up to 2 years. The number of days in storage prior to the germination test are shown in circles.

menziesii (Mirb) Franco) seeds markedly reduced germination (Radvanyi 1971). Similar reduction in germination was subsequently noted in tests on Douglas fir and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) by Edwards and Olsen (1972). Studies to date indicate that while R-55 may be detrimental to germination of some species, one treatment cannot be expected to function equally well for all seed species, and more research is required to develop suitable means of application.

Storage and germination tests on the R-55/graphite treated seeds and the non-treated controls are to continue until a major decline in germination can be demonstrated. The tests to date indicate R-55/graphite treated seeds of white spruce can be cold-stored for at least 2 years without significant reduction in seed viability.

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