IMPROVED GERMINATION OF WHITE SPRUCE SEED BY INCREASING MOISTURE CONTENT WITH ABSORPTIVE POWDERS

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ABSTRACT

Greenhouse studies have shown that pelleting white spruce seed with baby powder and Captan 50-W significantly increased germination under exposed conditions. When Captan 50-W was used, the germinants were largely abnormal. Increased germination was apparently due to a more rapid absorption of water and the development of a moisture uptake system resistant to evaporational stresses.

RESUME

Les auteurs a enduit des graines d'Epinette blanche avec de la poudre pour bébés et avec du Captan 50-W puis les a fait germer dans une serre. Le résultat net fut une augmentation du taux de germination des graines semées dans du sable exposé à l'air libre de la serre. Cependant, lorsque le Captan 50-W fut employé, plusieurs parmi les jeunes pousses devinrent anormales. L'augmentation de la germination set probablement causée par l'absorption plus rapide de l'eau et par le développement, chez la jeune pousse, d'une habitude de moins laisser évaporer l'eau absorbée.

INTRODUCTION

Germination of white spruce (*Picea glauca* (Moench) Voss) seed is influenced by a number of factors, both internal and external. The seed is characterized by embryo dormancy which may be broken by storage in moist sand at 40° F for 3 months (Anon. 1948; Baker 1950) or by cold-soaking (Crossley and Skov 1951). The most important external factors affecting germination are moisture and temperature. All seeds must absorb moisture to begin the processes of germination which apparently proceed at an optimum rate between 68° and 86° F (Anon. 1948; Heit 1961).

Since 1963 we have been studying the effects of Captan 50-W, a fungicide, on white spruce seed and have found that germination of both unsoaked and cold-soaked seed was increased following pelleting. Germination of unsoaked seed was increased from 28 to 49 percent and of cold-soaked seed from 46 to 64 percent. However, more than 60 percent of the germinants were abnormal and incapable of developing into normal seedlings². We theorized that pelleting resulted in a rapid absorption of water and created a moisture

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² WALDRON, R. M. and J. H. CAYFORD. 1965. Effects of seed treatment with fungicides and repellents on the germination of white spruce, jack and red pine. Canada, Dept. Forestry, Unpubl. MS. 65-MS-4. 30 pp.

uptake system which was resistant to evaporational stresses. In order to test this theory studies were undertaken to determine the effect of various powders (or adherents) on the germination and moisture absorption of white spruce seed.

METHODS

A germination study was carried out in a greenhouse located at Winnipeg, Manitoba, in the spring of 1965; environmental conditions were maintained to provide for maximum germination. Photoperiods averaged 15 hours; supplementary light was provided by a battery of fluorescent lights. Maximum and minimum air temperature averaged 85° and 73° F respectively; and relative humidity averaged 30 percent.

Seed, testing 92 percent sound by cutting, had been collected at the Riding Mountain National Park in fall 1964 and stored at 35° F until used. Methyl cellulose was used as the sticker and the various powders³ — Captan 50-W, baking powder, baking soda, all-purpose flour, borax, and baby powder—were added until no more would adhere to the seed. For purposes of comparison, unpelleted cold-soaked seed was used. Seeds were sown within a few hours of pelleting.

Individual plots consisted of waxed paper tubs, 4½ inches in diameter and 3 inches in depth, filled with medium-textured sand. Fifty dewinged seeds were sown per plot. In one test, plots were covered with pane glass⁴ and in a second test were left uncovered. All plots were watered periodically to maintain the germinating surface in a moist condition. Under glass a relative humidity of approximately 100 percent was attained. Counts of germinants were made weekly for 6 weeks after sowing. All germinants were recorded as normal or abnormal.

Two additional studies were carried out in the greenhouse to determine moisture absorption trends and to determine the moisture content (based on oven dry weight) required for germination of uncovered or exposed seed. In the first, the average moisture content of fifty ungerminated seeds was determined at 1, 2, 4, 7 and 10 days after sowing for untreated, cold-soaked, sticker, Captan, baby powder and flour treatments. The moisture contents determined for powdered seed included both water held in the seed and in the coatings. In the second, individual moisture contents were determined for 64 untreated seeds at the time of seed-coat rupture and for 65 sound seeds that had not germinated.

The germination test and the moisture content tests were carried out using randomized block designs. Data were subjected to analyses of variance and treatment means were compared using the least significant difference as outlined by Snedecor (1956).

RESULTS

Seed treatment and covering had significant effects on germination (Table 1). Under exposed conditions, pelleting with baby powder or with Captan signi-

³ Brand names can be supplied upon request.

⁴ Baking soda, flour, and borax treatments not studied under pane glass.

ificantly increased germination. The proportion of abnormal germinants was increased by the Captan (51 percent), but not by the baby powder treatment (29 percent), over that obtained from untreated seed (27 percent). None

EFFECT OF VARIOUS POWDERS ON THE GERMINATION OF WHITE SPRUCE SEED

Seed Treatment	Number of Germinants (per 100 seed sown)		Basis: number of seed sown
	Exposed	Glass Covered	
1. Untreated	6 cd ²	51 c	500
2. Sticker	4 cd	58 b	500
3. Cold-soaked ¹	2 cd	56 b	500
4. Baking powder	8 c	59 b	500
5. Baking soda	2 cd	—	250
6. Flour	1 d	—	250
7. Borax	0 d	—	250
8. Captan 50-W	25 b	67 a	500
9. Baby powder	40 a	63 a	500

Analysis of variance

Source of variation	Degrees of Freedom	F	Degrees of Freedom	F
Total	44		29	
Blocks	4	1.55 ^{NS3}	5	1.55 ^{NS}
Treatment	8	33.59**	4	2.97*
Error	32		20	

¹ Cold-soaked in water for 18 days.

² For each exposure any two results not followed by the same letter differ significantly at the 5 per cent level.

³ NS - non-significant

* - significant at the 5 per cent level

** - significant at the 1 per cent level

of the other treatments, including cold-soaking, significantly increased germination. Under glass, all treatments tested significantly increased germination, but the greatest increase resulted from the Captan and baby powder treatments. The increases in number of germinants for Captan and baby powder treatments were much less under glass than in exposed conditions.

Rates of absorption and amount of moisture absorbed varied considerably for the different treatments (Figure 1). Both were greatest for seed treated with baby powder or Captan, for which, 10 days after sowing, moisture contents were 80 and 98 percent, respectively, for exposed seed. Untreated, flour- and sticker-pelleted seed did not attain moisture contents exceeding 40 percent while cold-soaked seed, which was at a moisture content of 52 percent at the time of sowing, decreased to 27 percent after 4 days. This rapid loss of moisture from the cold-soaked seed clearly illustrates the severe evaporational stress to which the seeds were exposed.

Determination of the moisture content of individual ruptured and un-

FIGURE 1. Moisture content (per cent of oven dry weight) of exposed, pelleted and unpelleted white spruce seed at various time intervals since sowing. Each plotted point represents a fifty seed sample.

germinated seeds suggested that white spruce seed must attain a moisture content of at least 30 percent before germination can begin. Only when moisture content exceeded 50 percent did more seed germinate than did not. All seeds germinated when moisture content exceeded 80 percent (Figure 2).

DISCUSSION

The effects of the seed treatments on germination were evidently very closely related to moisture absorption. Under exposed conditions, only seeds treated with baby powder or Captan germinated in large numbers. Covering the tubs with glass increased atmospheric relative humidity to 100 percent and permitted most seed, regardless of treatment, to attain the critical moisture content required for germination.

These results suggest that the germination of field-sown seed may be increased by treatment with baby powder. It may also be postulated that such an increase may be most pronounced in dry years and in exposed conditions. The possible beneficial effects of other hygroscopic materials should be in-

FIGURE 2. The per cent of untreated sound seed which germinated by moisture content (per cent of oven dry weight).

vestigated.⁵ On the other hand, the possibility of damaging seed by excess moisture (Baldwin 1942) cannot be ignored. Captan cannot be recommended owing to the high proportion of abnormal germinants produced.⁶

REFERENCES

- ANON. 1948. Woody-plant seed manual. United States, Dept. Agriculture, Misc. Publ. 654. 416 pp.
- BAKER, F. S. 1950. Principles of silviculture. McGraw-Hill Book Co. Inc., New York. xii + 414 pp.
- BALDWIN, H. I. 1942. Forest tree seed of the north temperate region with special reference to North America. Chronica Botanica Co., Waltham, Mass. xvi + 240 pp.

⁵ Tests using Keltex FF, a hygroscopic Algin derivative, as a mulch to improve the micro-environment of red pine seed spots on exposed sites have been unsuccessful (Fraser and Bickerstaff 1962, 1963).

⁶ See footnote 2.

CROSSLEY, D. I. and L. SKOV. 1951. Cold-soaking as a pre-germination treatment for white spruce seed. Canada, Dept. Resources and Development, Forestry Branch, Silv. Leaflet 59. 4 pp.

FRASER, J. W. and A. BICKERSTAFF. 1962. Algin mulch for seed spots. For. Chron. 38(4):448-449.

_____. 1963. Algin mulch. For. Chron. 39(2):224.

HEIT, C. E. 1961. Laboratory germination and recommended testing methods for 16 spruce *Picea* species. Proc. Association of Official Seed Analysts. 51:165-171.

SNEDECOR, G. W. 1956. Statistical methods, 5th ed. Iowa State Coll. Press. xiii + 534 pp.