Bull. Environm. Contam. Toxicol. 21,365-370 (1979)

The Effect of Spray Treatments on Some Germination Characteristics of White Pine and Yellow Birch

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Fenitrothion (O, O-dimethyl O-(4-nitro-m-tolyl)- phosphorothioate) is widely used in Canada to control attacks of the spruce budworm (FETTES 1968). Two sprayings are generally carried out each spring, (early and late May) to control the feeding larva. It is therefore possible that during their ontogeny, conifer seeds developing in the cone, and the mature and germinating seeds may be exposed to six separate spraying of fenitrothion. In this connection, HALLETT et al (1975) reported that considerable quantities of fenitrothion accumulated into the embryo of the white pine seeds following treatments with a field concentration (4 oz/acre; ca. 10 ppm) of the pesticide, and the question arose whether this accumulated concentration (up to 9 oz/acre/year, ARMSTRONG and RANDALL 1969, KREHM 1972) would affect the germination and seedling vigor. With this objective in mind, experiments were designed to evaluate some aspects of germination and seedling vigor of field-sprayed eastern white pine and yellow birch seeds that had been exposed to field spray formulations of fenitrothion enclosed in the cone (pine) or exposed (birch) during development.

METHODS

Seed Samples: The seeds of the eastern white pine (*Pinus strobus* L.) and yellow birch (*Betula alleghniensis* Britt.) were gathered from the Petawawa Forest Experiment Station in Chalk River, Ontario during September 1972. Two types of seeds were obtained at this time; those from areas within the Station which had been sprayed extensively in previous years (S) at a rate of 2-4 oz fenitrothion per acre and control seeds from regions in which fenitrothion spraying had never been carried out (C). Pine seeds were exclusively obtained from cones which had fallen to the ground, the birch seeds were collected from the trees.

To extract the pine seeds, the closed cones were placed in an incubator at 28°C for approximately 36 hr and this resulted in complete separation of seeds from the cones. Prior to each experiment the seeds were dewinged by hand.

Seeds of yellow birch were removed from the nut by hand. Seeds of both species were stored in tightly sealed glass containers at 2°C until required for experimental procedures (WANG, 1973).

0007-4861/79/0021-0365 $01.20

Conditions of imbibition and stratification: Like many other forest seeds, white pine seeds require prechilling for successful germination, and accordingly, seeds from the control and sprayed areas were stratified for periods of 0, 7, 14, 21, and 28 days at the U.S.D.A. prescribed temperature of 10°C. This chilling requirement was carried out in small peat pots, watered to field capacity. Thirty-six lots of ten seeds from each treatment, (S) and (C) were germinated in the dark in petri dishes. The petri dishes were placed in environmental growth chambers, maintained at a fluctuating temperature of 20°C for 12 hr (U.S.D.A. 1949).

Assessment of germination: All seeds used in this study were routinely sterilized for 10 min in a 2% hypochlorite solution and then thoroughly washed. A minimum of 30 replicates of 10 seeds each was used for each species from each of the control (C) and spray (S) areas.

For the progress of germination, the seeds were examined daily with a dissecting microscope (50 x magnification). They were considered to have germinated when the radicle pierced through the seed coat. Then according to procedure of MAGUIRE (1962) germination percentages and germination rates were determined for each treatment. After 4-7 days the fresh and dry weights of the seedlings (radical and hypocotyl) germinated as above and stratified for 0, 7 or 14, and 21 or 28 days for pine and 0, 12, 26, 40 and 54 days for birch were determined. Water uptake capacity was followed at each time period to give a comparative assessment of the absorptive capacity of the seeds. Further, to compare sprayed seeds with seeds exposed to 10 and 1000 ppm fenitrothion emulsions under laboratory conditions, 30 replicates of 10 seeds each per series were placed in glass dishes and exposed to 10 ppm or 1000 ppm fenitrothion during the course of 21 days stratification. The fenitrothion was obtained from the Pesticides Division of Sumitomo Chemical Company Ltd., Osada, Japan and was determined to be 99.5% pure before use.

Following 4 days of germination the seedlings were reweighed to measure percent water uptake. The seeds were removed after each weighing and used for other studies. All results were subjected to the t-test analysis.

RESULTS

Pine seeds: Seeds from all stratification periods that were not skoto (deeply) dormant germinated on or before 21 days, those which had not germinated by that time failed to do so. Seeds obtained from areas which had been previously sprayed compared to those from unsprayed area exhibited a not too disimilar pattern of germination regardless of the length of chilling pretreatment. One exception was evident however, that of nonstratified-sprayed area seeds which had a germination percentage of 40.00 (S.E. ± 14.11); the means differed for 14 days (70 ± 5.48%), (Figure 1).

The rates of germination of both seed types (C and S) differed significantly. In all seeds at the various stratification periods, with the exception of 21 days stratification, the control area seeds germinated before sprayed seeds but thereafter the germination curves were more or less comparable. There was a general trend which seemed to indicate a consistent lag in the germinative capacity of the spray-area seeds. This difference was very clearly marked in the rates of germination (Figure 2). Here two major trends were evident. Firstly, there existed a significant difference ($P < 0.1$) in the germination rates of unstratified control seeds (C) (rate 10.95 ± 1.29 per 1,000 seeds). Secondly, there was an indication that stratification increased the rate of germination to a significantly high level. For example, for the spray area seeds which were stratified for 7 days, the rate rose from 5.40 to 14.8. A similarly accelerated rate is evident in the unsprayed seeds without pretreatment, as compared to those which received 28 days of stratification.

Changes in the fresh weights (Figure 3) of the hypocotyl axis of the seedlings also suggests two trends. With increasing length of the pretreatment period, the mean fresh weight increased in both seed types. It is also evident that the mean weights were lower in the sprayed area seedlings when compared with those from unsprayed regions. The difference between nonstratified spray-area seedlings with a mean fresh weight of 14.1 ± 7.4 mg when compared with the seedlings derived from 21 day stratified seeds, with a mean fresh weight 32.3 ± 4.7 mg., was highly significant. A similar pattern was indicated in the dry weights of the root hypocotyl axis of these two sets of seedlings (Figure 4).

Comparable results were obtained at the termination of the stratification period and following 4 days of germination (Figure 5). The spray-area seeds, however, did not differ significantly from the control seeds exposed to the 10 ppm fenitrothion emulsions during imbibition. However, in the laboratory, seeds exposed to a 1000 ppm (fenitrothion solutions) did show a significantly large increased ($P < 0.1$) water uptake over the control and 10 ppm treated seeds.

Yellow Birch: Germination of yellow birch seeds obtained from unsprayed (C) and sprayed areas (S) following specific stratification periods showed few significant differences in germinability, (Figure 6a). Final germination percentages were essentially similar for the "C" and "S" series following all comparable stratification periods. Unsprayed control seeds and those exposed to 10 ppm fenitrothion gave similar daily total germination percentages. However, seeds exposed to a 1000 ppm fenitrothion concentration exhibited a significant lag in germination and this persisted from the onset of germination to the final day (Figure 6b).

There was no significant difference (at the 5% level) in the fresh weights at 4 days. However, a trend was evident indicating that prior field spraying had somewhat decreased the seeds capacity to take up water (Figure 6c).

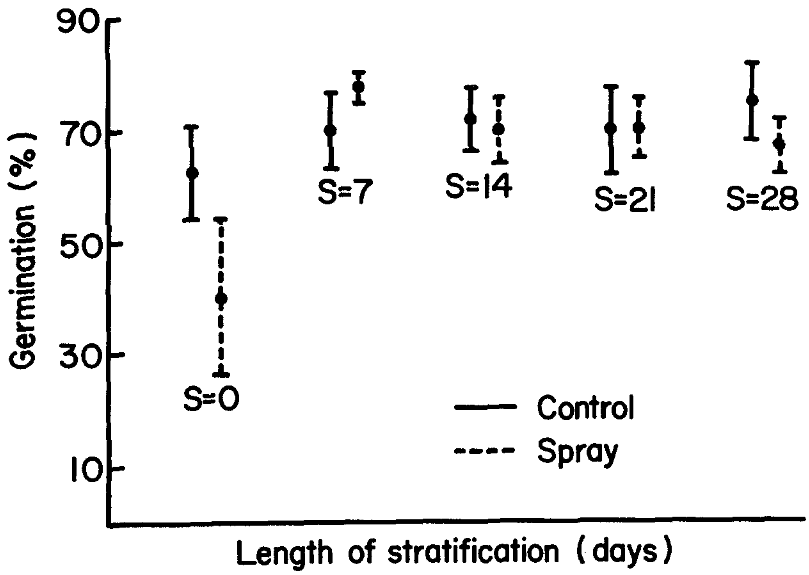

Figure 1 White pine: stratification v.s. % germination.

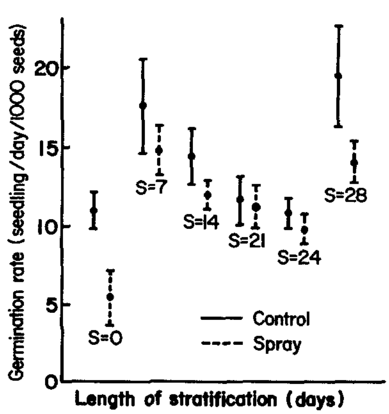

Figure 2 White pine: stratification v.s. rate of germination.

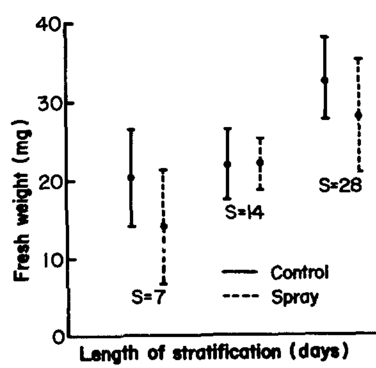

Figure 3 White pine: stratification v.s. fresh wt.

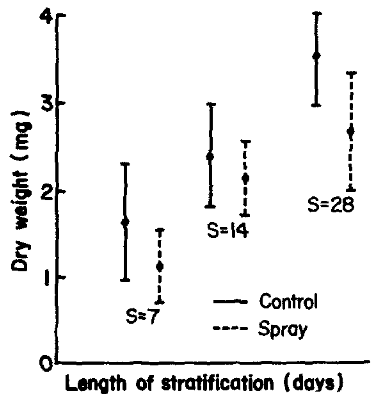

Figure 4 White pine: Change in dry wt with stratification period

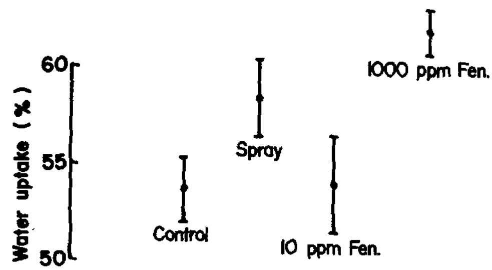

Figure 5 White pine seedlings (4 days): Change in water uptake

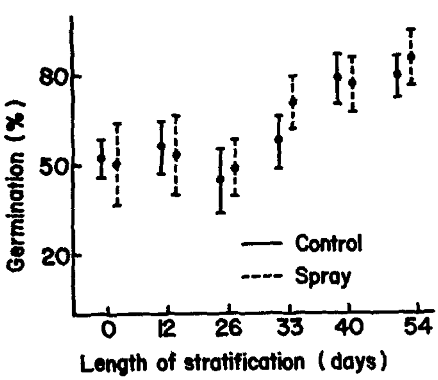

Figure 6a Yellow birch: final germination percentage v.s. stratification period.

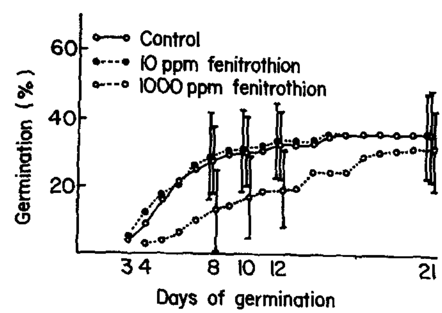

Figure 6b Yellow birch: daily cumulative germination

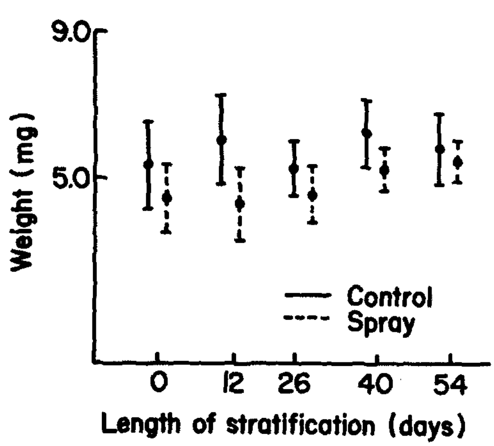

Figure 6c Yellow birch seedling (7 day): Fresh wt v.s. stratification period

DISCUSSION

A number of trends are evident in these studies. For both pine and birch, stratification not only tends to increase the percentage of germination but also significantly increases the seedling weight. This information, when applied to the fresh and dry weights of the root hypocotyl axis suggest a possible dwarfism being developed in non-stratified seeds. However, long term growth studies would be required to validate this.

In both species there appears to be real difference in the germination characteristics of seeds from sprayed areas and unsprayed areas. The overall germination percentage, germination rates and fresh and dry weights of the root hypocotyl seem to be lower in seeds derived from previously sprayed areas. These differences became less significant as the length of the stratification period was increased to twenty one days in pine and 54 days in birch. Generally, it was observed that the germination and growth characteristics of spray-area seeds was comparable to those of control seeds imbibed with 10 ppm emulsion of fenitrothion. Thus it would appear that aerial spraying at 4 oz/acre of fenitrothion does not lead to a persistent decreased level of germination. Clearly, the initial depression in germination brought about by fenitrothion is gradually released and the seedling growth recovers. Thus the pine, and yellow birch seeds behave comparably to cocoa bean and rice grains (MIAMOTO and SATO 1965, MIAMOTO et al 1965).

ACKNOWLEDGEMENTS

The authors wish to thank B. Wang (Petewawa Forest Experiment Station) and D. Travnick (Chemical Control Research Institute, Fisheries and Environment Canada, Ottawa) for assistance in collection of seed samples.

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