LOBLOLLY PINE SEEDLING PERFORMANCE IS AFFECTED BY ETHYLENE

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Abstract - Ethylene has been indirectly implicated in affecting seedling vigor during storage. The objective of this study was to determine the does-response relationship between ethylene concentration and loblolly pine seedling performance. March-lifted seedlings were exposed to one of six treatments: control, Purafil®ES (ethylene absorbent), 0.5, 1.0, 2.0 and 4.0 ppm ethylene. The fumigated seedlings were stored for six weeks and then outplanted. Bud activity one month after planting, one year height and survival were measured.

Highest bud activity was exhibited by the 4 ppm treatment and decreased with decreasing ethylene concentration. Purafil®ES was equal to the 2 ppm treatment. Survival was again highest for the 4 ppm treatment followed by the Purafil treatment; the 1 ppm treatment had the lowest survival. Height exhibited a nearly linear response; height increased with increasing ethylene concentration. Purafil treatment and control were the smallest in height after one year in the field.

Additional Keywords: Pinus taeda, height, survival, bud activity.

Ethylene, a plant growth regulator, has been indirectly implicated in affecting Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) and loblolly pine (Pinus taeda L.) seedling performance (Zaerr and Lavender, 1980; Barnett, 1980; respectively) and has been detected in seedling cold storage facilities at concentrations well above those known to be physiologically active (Johnson, 1982). Furthermore, ethylene has been demonstrated to be synthesized by loblolly pine needles, roots and intact seedlings (Stumpff, 1984). To further investigate the potential problem of ethylene production and accumulation during storage of loblolly pine, this study was conducted. The objective was to determine a dose-response relationship between ethylene concentration and field performance.

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METHODS

Loblolly pine seedlings (1-0) were operationally lifted in March 1983 from the Virginia Division of Forestry New Kent nursery, Providence Forge, Va. Four hundred seedlings each were placed into Kraft-polyethylene bags with moist paper towels. To reduce ethylene leakage, each bag was triple wrapped with polyvinyl sheeting and then double wrapped with polyethylene bags. The following treatments were administered to each of two K-P bags:

1. Control, no treatment
2. Purafil®ES (an ethylene absorbent) placed inside K-P bag
3. 0.5 ppm ethylene injected into K-P bag
4. 1.0 ppm ethylene injected into K-P bag
5. 2.0 ppm ethylene injected into K-P bag
6. 4.0 ppm ethylene injected into K-P bag

Concentrations of ethylene within the fumigated bags were periodically measured (approximately every two weeks) with gas chromatography and adjusted as needed. After six weeks of cold storage at 4°C, 192 seedlings per treatment were outplanted in a randomized block design at the Reynolds Homestead Research Center located in the Virginia Piedmont.

Bud activity was assessed one month after planting with the method described by Johnson and Barnett (1984). With this technique, buds on each seedling were rated and assigned a value from 0 to 3 depending on the stage of development. A mean value was then calculated for each treatment. Additional variables measured were survival and seedling height after one growing season in the field. The data were statistically analyzed using analysis of variance followed by mean separation with a multiple range test. Survival data were transformed to arc sin prior to the analysis.

RESULTS AND DISCUSSION

The mean bud activity of the outplanted seedlings was significantly affected by the ethylene treatments(fig. 1). The 4.0 ppm treatment stimulated bud break compared to the control. The other treatments did not significantly affect the bud activity. Spring bud activity as measured here is probably a reflection of root growth; seedlings that initiate early root growth also break bud sooner (Johnson and Barnett, 1984; Johnson and Stumpff, 1984). It is apparent then that the 4.0 ppm treatment had a positive effect on root growth. Zaerr and Lavender (1980) reported a similar response in early-lifted Douglas-fir seedlings exposed to 5 ppm ethylene during one month storage.

Survival after one year in the field exhibited significant treatment effects (fig. 2). Overall, survival for all treatments was high, ranging from 94 to 99 percent. The seedlings fumigated with 4 ppm ethylene did exhibit significantly higher survival. The Purafil treatment showed the next best survival. A comparison between the Purafil treatment and the control indicated a trend reported previously. Barnett (1980) found a five percent difference

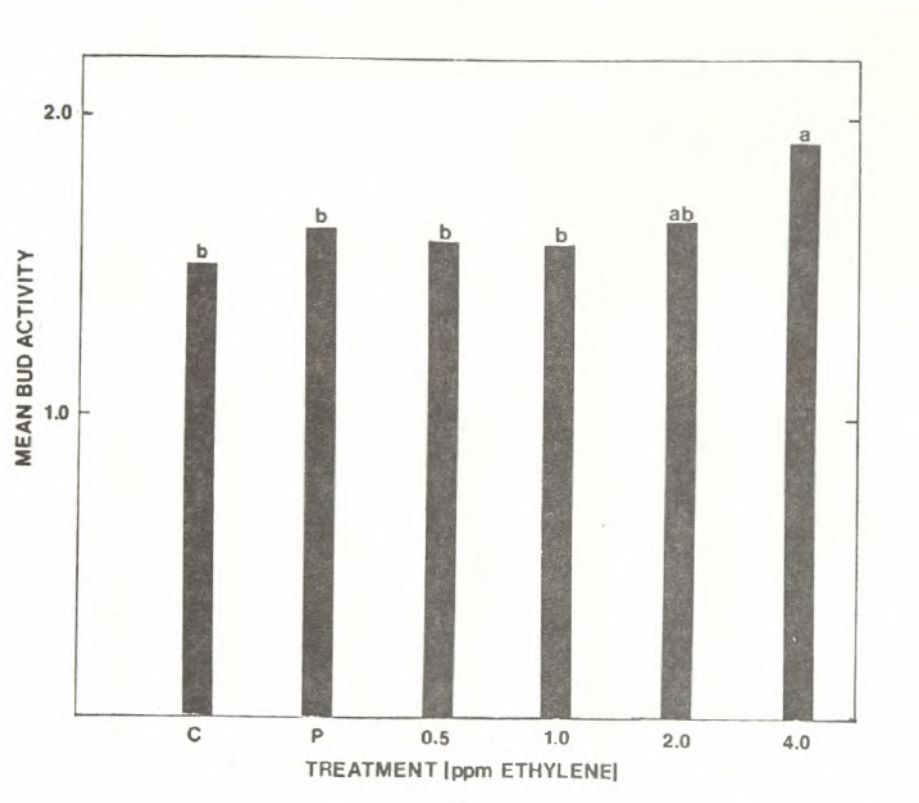

Figure 1. Mean bud activity one month after outplanting of loblolly pine seedlings stored for six weeks. Storage treatments were: C-control; P-Purafil; 0.5, 1.0, 2.0 and 4.0- ethylene concentration in parts per million injected and maintained in seedling K-P bags. Bars with the same lower case letter are not statistically different at a 5 percent probability level.

in survival between Purafil and control for loblolly pine seedlings stored for six weeks and then outplanted. The lowest survival in our study was recorded in the 1.0 ppm treatment which appears to be in the range of the highest concentration measured in cold storage facilities (Johnson, 1982). In Douglas-fir, ethylene treated seedlings exhibited 93 percent survival compared to the control value of 37 percent (Zaerr and Lavender, 1980).

Seedling height after one year in the field was significantly affected by treatment (fig.3). Again, the 4.0 ppm treatment exhibited the greatest response of 36 cm. The 0.5, 1.0 and 2.0 ppm treatments were all similar at 30 cm while the control and Purafil treatment exhibited the smallest height (28 cm). The equal height of the control and Purafil treatment was corroborated by Barnett (1980).

The results of this study illustrated the fact that the physiological processes involved in seedling survival and height growth were not the same. By absorbing ethylene evolved by the seedlings with Purafil, survival was enhanced compared to the control seedlings, whereas seedling height in both

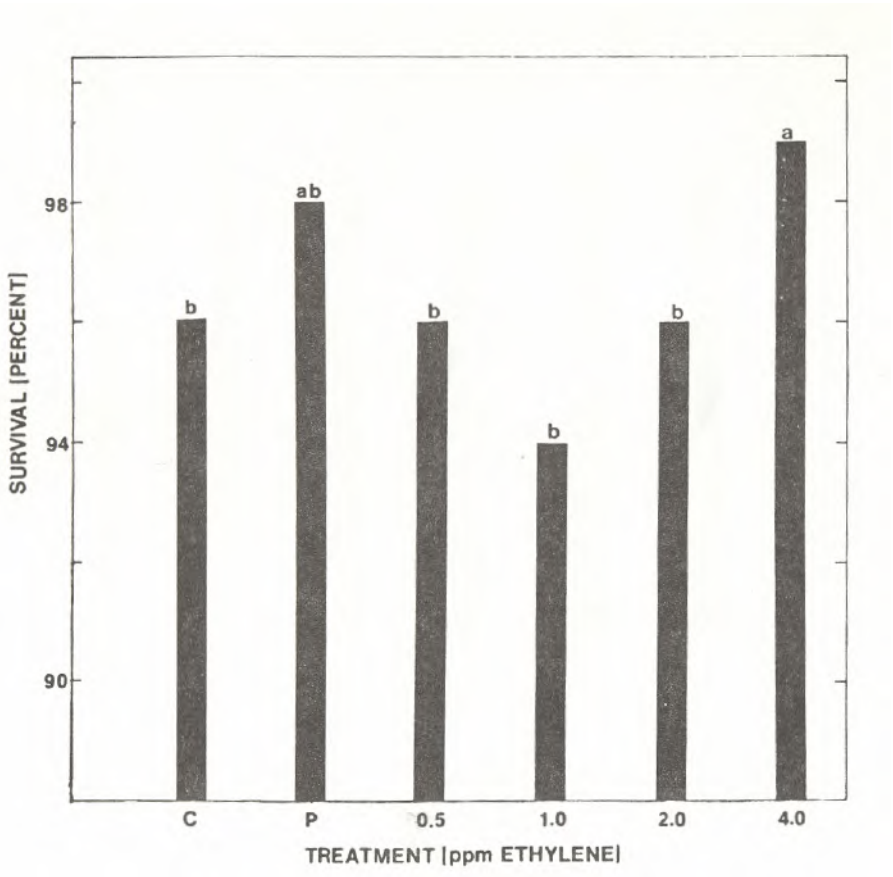

Figure 2. Survival after one year in the field of loblolly pine seedlings stored for six weeks. Treatments and statistics are described in fig. 1.

treatments were virtually identical. The enhancement of both survival and height by the 4.0 ppm treatment was probably a result of separate influence on early root growth and bud elongation, respectively.

The results presented should be viewed as an initial attempt to demonstrate the effect of ethylene on seedling survival and growth. The reader is reminded that the data is based upon one lifting date (early March) and that the response of seedling physiology to ethylene undoubtedly changes with seedling phenology.

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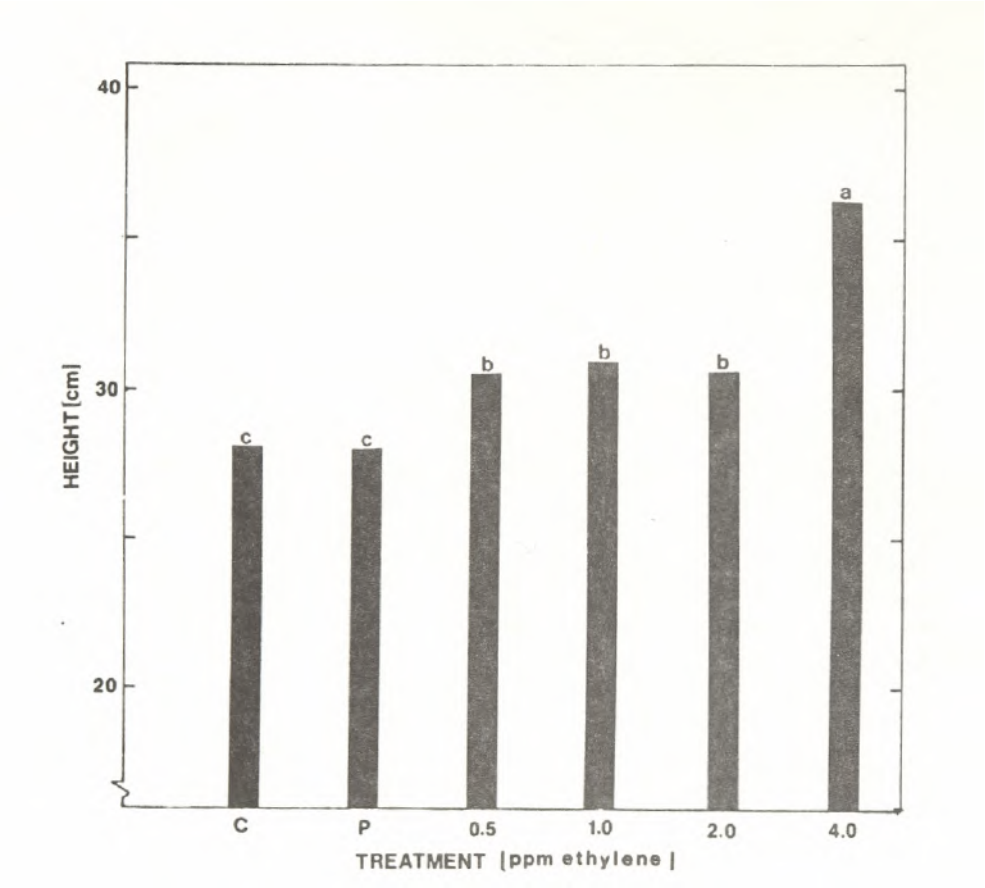

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