Ethylene: A Problem in Seedling Storage?

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Root regeneration of loblolly pine seedlings increased during 42 days in cold storage when an ethylene-specific chemisorbent was added to the bags in which the seedlings were stored. Field survival also increased. There was no effect on seedling height through three growing seasons.

Ethylene has long been recognized as a significant factor in the storage behavior of many plants and fruits in the horticultural and fruit industry (*1*). In amounts as low as a few hundred parts per billion, ethylene can reduce plant vigor, contribute to senescence of various plant parts, and reduce stock quality. Dormant nursery fruit stock is damaged if stored in an atmosphere containing ethylene (*3*). Plant tissues, as well as ripening fruit, produce ethylene (*5, 6*). Mechanical injury increases this production *(4),* so it can be assumed that lifting nursery seedlings results in some ethylene being produced by the roots. The sensitivity of plants to ethylene varies, and we have little information available on how sensitive pine seedlings may be to ethylene during storage.

In this study, an ethylene absorbent was placed in storage bags of loblolly pine seedlings, and the influence of this chemical on root regeneration and field survival and growth was examined.

Methods

Loblolly pine seedlings grown at the Columbia Nursery of the Louisiana Office of Forestry were lifted on January 4, 1979, and separated to provide for three replications of treatment variables. Treatments consisted of 21 and 42 days of storage with and without ethylene absorbent. The absorbent was composed of potassium permanganate absorbed on an alumina (Purafil ES), which oxidizes ethylene to water and carbon dioxide (*2*). Although Purafil ES is described as "ethylene specific," it also controls other contaminants such as hydrogen sulfide and nitric or sulfuric acid, which can adversely affect live plants. Purafil ES is packaged for several applications. In this study, two small sachets (24 grams each) were placed in polyethylene bags that contained about 50 seedlings. The sachets were stapled inside the bag so that they would not be in contact with water. Such contact could reduce the effectiveness of ethylene absorption.

After 21 and 42 days of seedling storage at 34° and 36° F, five seedlings per treatment replication were potted in sand and placed in a growth chamber for evaluation of root regeneration potential. The growth chamber was programmed for constant 75° F temperatures and 18-hour photoperiods of 1,500 foot-candles. After 4 weeks in the growth chamber, sand was washed from the seedling roots, and the number of new roots per seedling was counted. This number was then used as an estimate of root regeneration potential.

Another 25 seedlings from each treatment replication were outplanted on a silt loam soil. Survival and heights were measured in the dormant season 1 and 3 years later.

The data were statistically analyzed following a completely randomized design. The 0.05 probability level was used to determine significance in root regeneration potential. The 0.10 probability level was used for statistical tests of field measurements because greater variation was anticipated in the field data.

Results and Discussion

The addition of Purafil ES sachets to bags containing loblolly pine seedlings had no effect on root regeneration potential after 21 days of storage. But after 42 days, seedlings with the ethylene absorbent produced significantly more new roots (table 1). Bags with two sachets enclosed had an average of 149 new roots after 1 month; bags without sachets averaged only 85 new roots.

Seedling survival through three growing seasons was unaffected by length of storage, but seedlings from storage bags that contained Purafil ES averaged 6 percent greater survival than the control (table 1). Seedling heights were not affected by either length or type of seedling storage

Table 1.—*Root regeneration potential, survival, and heights of loblolly pine seedlings lifted from nurserybeds and stored in polyethylene bags with and without Purafil ES[1] media*

Treatment	Application	Stored 3 weeks			Stored 6 weeks		
		RRP[2]	Survival	Height	RRP	Survival	Height
		No. of new roots	*%*	*Ft.*	*No. of new roots*	*%*	*Ft.*
Control	1	163	92	5.4	80	84	4.8
	2	133	76	4.8	90	80	4.3
	3	120	88	4.5	84	84	4.9
Average		139a[3]	85b	4.8a	85b	83b	4.7a
Purafil ES media	1	125	92	4.8	158	88	5.2
	2	106	92	4.3	143	88	4.8
	3	159	88	5.2	147	92	4.5
Average		130a	91a	4.8a	149a	89a	4.9a

[1] Purafil ES Is the trade name of the ethylene absorbent.

[2] RRP -root regeneration potential, which is the number of new roots per seedling after 1 month under controlled conditions.

[3] Means within columns followed by the same letter are not significantly different at the 0.05 probability level for RRP and at the 0.10 probability level for field measurements. Survival and heights reported are those measured after 3 years in the field.

Though no direct measurements of ethylene were made in this study, the improvement in seedling root regeneration and survival with the addition of an ethylene absorbent suggests that ethylene is produced in lifting pine seedlings. If so, this ethylene production may also be at least partly responsible for rapid deterioration of seedlings in storage.

Recommendations

The results from this preliminary study are positive enough to justify further study. Additional studies should better identify the responses of pine seedlings to different concentrations of ethylene and the cost effectiveness of adding ethylene absorbents to sealed storage bags or to coldstorage facilities if seedlings are stored in bales. Filter systems are available that could absorb ethylene produced in storage rooms. These evaluations should be made in terms of improved survival and growth in the field.

Literature Cited

1. Abeles, Frederick B. Ethylene in plant biology. New York, NY: Academic Press; 1973.
2. Abeles, Fred B.; Heggestad, Howard E. Ethylene: an urban air pollutant. J. Air Pollut. Control Assn. 23(6): 517-521; 1973.
3. DeClement, Ronald; Frecon, Jermone L.; Childers, Norman F. Ethylene gas damages fruit stock. Am. Nurseryman. 149(1):12, 72, 74, 78; 1979.
4. Kramer, Paul J.; Kozlowski, Theodore T. Physiology of Woody Plants. New York, NY: Academic Press; 1979. 811 p.
5. Lieberman, M.; Juniski, A. Synthesis and biosynthesis of ethylene. HortScience. 6: 4-8;1971.
6. Mapson, W.; Hulme, A. C. The biosynthesis, physiological effects and mode of action of ethylene. Photochem. 2: 343-384; 1970.