Ethylene in Cold Storage - Is It a Problem?
by Thomas D. Landis

During winter, many nursery plants are in refrigerated storage and, almost every year, I get a question about possible ethylene injury. Ethylene is a plant hormone that is unique because it is a gas, and is best known for its ability to hasten the ripening of fruit. In ancient times, Egyptians used ethylene to stimulate the ripening of figs and Chinese burnt incense in closed rooms to enhance the ripening of pears. Ethylene has also been shown to have detrimental effects on stored plants; for example, when carnations were exposed to 0.5 to 1.0 ppm ethylene in storage, their buds failed to open (Sherman 1985).

In addition to ripening fruit, ethylene also affects many other vital plant functions such as:

- release of dormancy
- shoot and root development
- leaf and fruit abscission
- increased seed germination
- bud development
- protects plant against bacteria and fungi.

Although it is produced naturally produced by plants as part of normal metabolic activity, ethylene is also generated by stress or wounding. This stress ethylene can be induced by mechanical injury, extreme heat or cold, and moisture stress. In fact, stress ethylene evolution has been used as an indicator of plant stress and was even considered to be potential index to cold hardiness. Subsequent testing, however, refuted this hypothesis (Burr and others 1990).

Ethylene in cold storage. Forest nurseries have often used commercial refrigerated fruit storage units for long-time overwinter storage and, because ethylene is known to be produced by ripe fruit, there has been concern about possible harmful effects. This concern spawned several research trials in the 1980's and early 1990's. The first tests showed that very high ethylene levels caused significantly reduced shoot growth in Fraser fir (*Abies fraseri*), and inhibited root growth in Douglas-fir (*Pseudotsuga menziesii)* (Table 1). Subsequent research confirmed that rough handling of nursery stock could increase the amount of ethylene produced in storage containers. Hand-lifted loblolly pine (*Pinus taeda*) seedlings produced significantly less ethylene compared to machine-lifted stock (Figure 1), in which root were torn and stem compressed by lifting belts (Johnson and Stumpff 1985).

This concern lead to a search for a treatment to reduce ethylene inside refrigerated storage bags and boxes. Purafil ES® is a commercial ethylene absorbent that consists of alumina pellets saturated with potassium and is widely used to reduce the risk of ethylene damage to stored fruits and vegetables. When Purafil packets were included in kraft-poly storage bags, the initial tests were promising – the absorbent did reduce ethylene concentrations and increased new root growth and

Table 1—Published research on the effects of ethylene on forest nursery stock stored under refrigeration

Species Studied	Effects of Ethylene	Source
Abies fraseri	Shoot growth reduced at very high concentrations (17.5 ppm)	Hinesley and Saltveit (1980)
Pseudotsuga menziesii	Lateral root growth inhibited at 0.15 ppm	Graham and Linderman (1981)
Pinus taeda	Addition of ethylene absorbent increased root growth and survival after outplanting	Barnett (1983)
Pinus taeda	High concentrations increased outplanting performance	Johnson and Stumpff (1984)
Pinus taeda, P. elliottii, P. virginana	1) No effect on outplanting performance 2) Minor effects on root growth potential	Garrett-Kraus and others (1985)
Pseudotsuga menziesii, Tsuga heterophylla, Abies procera	1) Variable effects on new root growth 2) High concentrations (3 to 5 ppm) improved outplanting performance 3) Addition of ethylene absorbent did not increase performance	Blake and Linderman (1992)

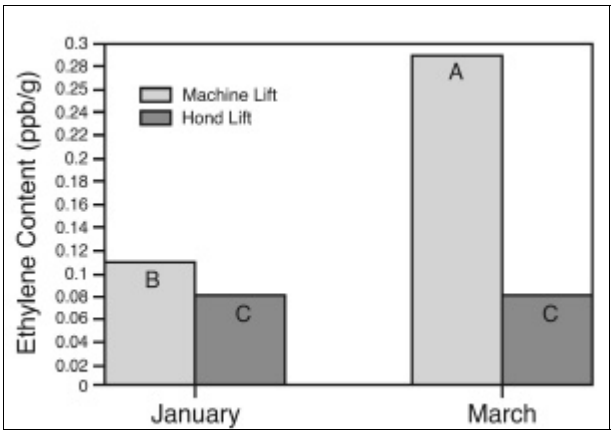

Figure 1 - When ethylene concentration was monitored in storage containers, a significant difference was shown between hand and machine harvesting. The amount of wound ethylene also increased in March compared to the ideal lifting window in January (modified from Johnson and Stumpff 1985).

survival after outplanting (Barnett 1983). Subsequent research trials confirmed that Purfil ES® was effective in reducing ethylene levels but did not find the same beneficial effects on seedling performance (Barnett and others 1985). In fact, the higher ethylene concentrations actually improved outplanting performance of loblolly pine nursery stock (Figure 2). Working with Douglas-fir, western hemlock (*Tsuga heterophylla*), and noble fir (*Abies procera*), Blake and Linderman (1992) monitored ethylene concentration in refrigerated storage containers and found that Purfil ES® packets did not consistently improve seedling quality. They also observed that high (3 to 5 ppm) concentrations of ethylene improved seedling vigor and survival after outplanting.

There has been no additional published research on the effects of ethylene on stored nursery stock. However, in case you are still considering ethylene absorbents for your storage containers, some recent research by Reid and Dodge (1995) tested Purafil ES® against some newer mineral ethylene absorbents. They found that Purafil ES® absorbed the ethylene almost immediately whereas the other products were totally ineffective.

Summary

Ethylene is a gaseous plant hormone that has been shown to increase in closed storage containers, especially when stock has been handled roughly . Purafil ES® ethylene absorbent packets are effective in lowering ethylene concentrations in storage bags or boxes, but research results on whether they improve outplanting performance are inconsistent.

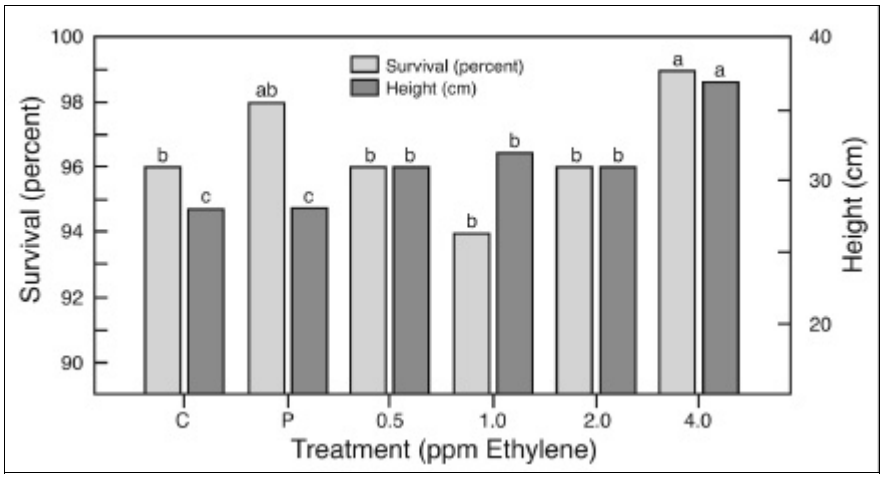

Figure 2— Although Purafil ES® ethylene absorbent packets significantly increased outplanting survival compared to the control, the highest ethylene concentrations actually increased both survival and growth (modified from Barnett and others 1985).

Sources

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