

Tree Physiology and Fraser Fir Needle Loss



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1997 Needle Loss

In October, 1997, Christmas tree growers in western North Carolina reported that a number of Fraser fir were displaying an unusual amount of needle-shed. In nearly all cases, shedding included both younger needles and the older needles, normally lost at that time. Needle loss was often observed throughout the trees rather than being localized, which sometimes happens with nutrient deficiencies. Because of the time of occurrence, this problem was of major concern for trees being prepared for market.

The obvious questions are what caused this abnormal needle-shed and what can be done to prevent it? The short answer to both questions is that we really don't know. However, there are some clues from which we can develop possible hypotheses.

Since plant stress often results in needle loss, potential causes of stress such as soil and/or plant nutrient status were considered. However, soil and tissue analysis relative to this problem gave somewhat conflicting results and did not point conclusively to a specific nutritional problem. To further complicate the issue, the abnormal needle loss coincided with the time of natural loss of older needles. Field observations indicated that the affected trees were often in areas that were drier or less suitable for Fraser fir than other parts of the field.

The Process of Needle Loss

To better understand what may cause excessive needle loss, it is useful to examine what occurs when needles are shed normally. In the natural sequence for each needle, an abscission zone is formed prior to actual needle-drop. Within this zone, a series of chemical reactions then result in a weakening of plant tissue. The needles subsequently become detached from the stem either through a dissolution of the supporting cells or a mechanically-induced break.

The series of plant cell events leading to abscission (needle loss) appear to be primarily controlled by hormonal balances. By definition, hormones are organic growth substances essential for plant development that act at very low concentrations. The amount and balance of each of these hormones are influenced by light, temperature, moisture content and other environmental factors.

The more important of the growth substances in leaf abscission appear to be **auxins**, **ethylene** and **abscisic acid (ABA)**. **Auxins** are produced in growing root and shoot terminals and move away from the point where they are produced. Auxins have a number of effects

on plant growth including promotion of cell elongation and cell division, and initiation of lateral and adventitious roots. In larger amounts, auxins may actually inhibit growth, and are sometimes used as herbicides. Auxins retard abscission and appear to act in opposition to ethylene (described below) in the process of needle drop.

Ethylene is a gaseous compound of carbon and hydrogen found in most plant organs, although in varying concentrations. It was originally studied by plant physiologists because of its being produced in large quantities by ripening fruits, and its hastening of the ripening process in bananas, citrus, and other crops. It is currently believed that the actual trigger for leaf abscission is ethylene, with auxins having a delaying or prevention effect.

Abscisic acid (ABA) is produced in almost all plant organs and is primarily a growth inhibitor. Absciscic acid retards stem elongation and can delay germination of seed. It also is positively correlated with leaf abscission in many species. The amount of ABA has been shown to increase dramatically in leaves of plants suffering from water deficits as a result of dry soil, waterlogged soil, or excess soil salinity.

How do these three major growth substances (auxins, ethylene, and ABA) interact to cause leaf abscission? Many scientists believe the auxin-ethylene balance is the critical factor in the abscission process. As ethylene increases or auxin decreases, needle-fall is increased. Absciscic acid is involved in that it promotes the production of ethylene, and thus has an impact on the auxin-ethylene balance.

In the fall, changing environmental conditions such as lower temperatures and short days provide the stimulus for leaf senescence (degradation prior to death). During senescence, cells have a decreased capacity for synthesis of proteins and other compounds. Thus, auxin production is reduced, and its flow through the leaf is diminished. The ratio of ethylene to auxin increases, and the abscission process is initiated. The process continues until the needle falls. It is reasonable to describe the fall 1997 needle loss in Fraser fir fields in the following manner: 1) some increase in the amount of ethylene and a decrease in the amount of auxin naturally occurred as a result of lower temperatures and shorter daylengths. Because of their age, older needles already have a reduced auxin/ethylene ratio, and were the first to be lost. 2) Dry sites, soils with excessive salinity, or other site-related stresses resulted in additional abscisic acid being produced in the plant. The abscisic acid then promoted higher levels of ethylene in plant tissue, which subsequently caused additional needle loss.

What Caused the Needle Loss?

The above explanation appears reasonable to describe what may have occurred in some Fraser fir fields, but it does not answer

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the question of what specific factor was responsible. It is certainly true that plant stresses are often cumulative, and several environmental conditions (disease, inadequate nutrition, etc.) may have contributed to the problem.

A review of the 1997 rainfall at the Upper Mountain Research Station near Laurel Springs as opposed to the historical rainfall pattern of the region may provide some answers.

While the Research Station provides only one sample point, it does allow for some indication of a lack of precipitation in the latter part of 1997. Rainfall at the Research Station for the months of August through October was 7.59 inches. This amount is far less

than the region's historical average of 12.58 inches. The lack of moisture in this three month period quite possibly caused sufficient plant moisture stress to contribute to the observed excess needle-fall.

What can be done in the future to avoid this problem? If moisture was the critical factor, perhaps irrigation or the use of more extreme moisture-conserving measures? In all likelihood, the best answer to this problem is the same as for many other Christmas tree problems - proper management of soil nutrition, proper weed control, avoiding marginal sites, etc. to reduce the possibility of plants undergoing extended periods of severe stress.

Important Notice

Regarding Withholding North Carolina Income Tax from Wages Paid to Agricultural Labor

On May 29, 1997, Governor Hunt signed into law House Bill 57. The law provides that, effective January 1, 1998, North Carolina income tax must be withheld from wages paid to an individual employed on a farm for services rendered on the farm in the production, harvesting, and transportation of agricultural products to the market for the farmer-employer if federal income tax is required to be withheld from the wages. Wages paid for agricultural labor are generally subject to federal income tax withholding if the worker is paid \$150 or more during the year or the employer pays \$2,500 or more during the year to all agricultural workers.

A farmer-employer who is not registered for withholding with the State should request Form AS/RP1, *Registration Application for Sales and Use Tax and/or Income Tax Withholding*, by writing to:

North Carolina Department of Revenue
Tax Compliance- Withholding Tax
Post Office Box 25000
Raleigh, North Carolina 27640-0001

Form AS/RP1 may also be obtained from any of the Department's local offices or by calling 919-715-0397. Form AS/RP1

should be completed and returned to the Department of Revenue. Upon receipt, a withholding identification number will be assigned to the employer and appropriate income tax withholding forms will be mailed to the employer. Form NC-30, *State of North Carolina Income Tax Withholding Tables and Instructions for Employers*, is being revised to include information about the law change for farm labor and other applicable changes and will be available by November 1, 1997. If the completed Form AS/RP1 is mailed to the Department after December 15, 1997, the employer should contact the Department of Revenue and request the revised Form NC-30.

A farmer-employer currently registered for withholding with the Department should obtain a completed form NC-4, *Employee's Withholding Allowance*, from each employee previously exempt from withholding. Beginning January 1, 1998, North Carolina income tax should be withheld from the employee's wages. The additional withholding should be included with any other tax withheld by the employer when paid to the Department of Revenue.

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