Applying gypsum at this time may reduce K levels in the root zone. Monitor K status with soil and plant analysis at least every two years to ensure sufficiency.

Nitrogen (N)

Proper N application optimizes efficiency of nutrient uptake, promotes maximum growth and reduces chance of soluble salt injury. Recommended rates are based on uniform application to a 5×5-ft area. If the same amount (e.g., 1.0 oz N) is applied over a smaller area, both the rate of application and the soluble salt index increase in direct proportion to the reduction in area (Figure 1).

Seed/Lineout Beds. Apply N at a rate of 1.0 lb/400 ft² (~2.5 lb/1000 ft²) as a single treatment in the spring prior to bud break. See Table 4 for comparable rates of specific N fertilizers. Apply when foliage is dry and follow with 0.25 inch of irrigation to prevent leaf burn.

Field Establishment. Apply N one month after transplanting or two weeks before bud break on fall- or winter-planted trees. You can reduce fertilizer rates for trees less than three years old. If you apply N over a 3x3-ft area (9 ft²) instead of a 5x5-ft area (25 ft²), apply one-third of the total N recommended. Spread N in a 12-inch band from the drip line outward.

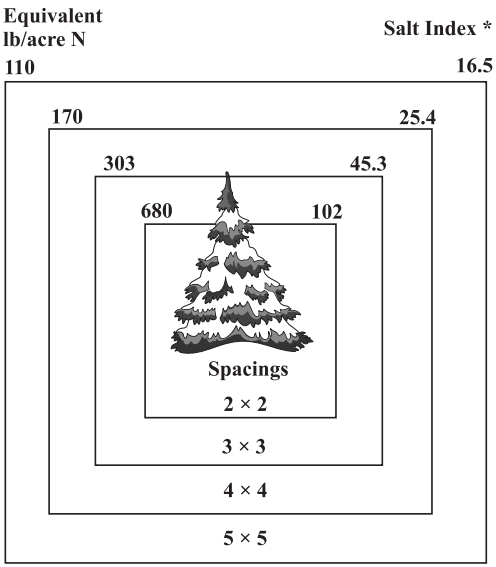

Figure 1. Nitrogen rate and salt index based on area of application of ammonium nitrate.

On small trees, apply N 12 inches from the base of the trunk.

Field Maintenance. The rate of N suggested on the soil report (90–110 lb/acre) is the total annual requirement for broadcast application. This rate delivers approximately 1.0 oz N per tree based on a 5x5-ft tree spacing. Table 5 shows a schedule for applying N based on age of tree in the field.

Table 4. Nitrogen application rates for seed/lineout beds

Source	lb/400 ft²
Ammonium nitrate (33% N)	3
Calcium nitrate (15.5% N)	6.5
Ammonium sulfate (20.5%)	5
Urea (46% N)	2
Diammonium phosphate (18% N, 46% P_2O_5)	5

Table 5. Field nitrogen rates

	N rate (oz/tree)	
Age of tree in field	Spring	Fall
1 to 2 years (establishment)	0.5	–
3 years and older (maintenance)	0.5	0.3 – 0.5

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updated July 2012

NOTE 5: Fertilization of Christmas Trees

High quality Christmas tree production (blue spruce, cedar, Fraser fir, hemlock, Leyland cypress, Norway spruce, Virginia and white pines) requires a properly adjusted pH and an adequate supply of all essential nutrients. Soil fertility promotes maximum tree growth as well as desired dark green color and retention of needles. Trees derive the most benefit from lime and fertilizer when applied at the appropriate time with correct placement.

Soil pH and Lime

Soil pH affects availability of essential plant nutrients as well as potentially acidic elements (aluminum, hydrogen, manganese) that can be toxic to plant roots. Lime raises soil pH by neutralizing acidity while supplying calcium (Ca) and/or magnesium (Mg).

Lime is either calcitic (calcium carbonate) or dolomitic (calcium magnesium carbonate). In North Carolina, most commercially available lime is dolomitic. Choose dolomitic lime when soil Mg levels are low, as indicated by the number *25* in the **Mg** column of the **Recommendations** section of the soil report.

All materials sold as lime in North Carolina are regulated under the N.C. Lime Law. This law requires that a ton (2000 lb) of dolomitic lime contain at least 6% (120 lb) soluble Mg.

The soil report lime recommendation is given in tons/acre (T) to raise the pH to the desired target (Table 1). Lime reacts faster and reduces soil acidity more effectively if mixed into the soil to a depth of six to eight inches. Typically, this can only be done before establishing a new planting.

Table 1. Target soil pH

white pine, Virginia pine	pH 5.5
Fraser fir, hemlock, Norway spruce	pH 5.8, establishment pH 5.5, maintenance
Leyland cypress	pH 6.0
blue spruce, red cedar	pH 6.5

Soil pH management is more difficult in established fields. Surface applications react slowly due to limited soil contact and lime's low water solubility. As a result, samples analyzed 12–18 months after a surface application, especially under prolonged drought periods, may still indicate low pH in the root zone and a need for additional lime. In established fields, a 4-inch sample depth more accurately predicts lime needs.

If too much lime is applied, soil pH can become too high and adversely affect the availability of nutrients, especially micronutrients. When surface-applying lime, never apply more than 1.5 T at any given time. Wait 12 months before applying any additional lime.

Calcium (Ca)

Calcium promotes adequate shoot and root development. It also reduces needle drop. Christmas trees have a high Ca requirement and may need more Ca than lime supplies. When that is the case, use calcium sulfate ($CaSO_4$), commonly called gypsum. This relatively soluble fertilizer contains 20–22% calcium and 18% sulfur. It will not increase soil pH.

A Ca% level of 50–55 is sufficient for Christmas tree production, depending on the soil's cation exchange capacity (CEC), as found on the soil report. For example, values of Ca%=50 and CEC=5 indicate 891 lb/acre of available Ca. A soil with Ca%=50 and CEC=10 contains 1792 lb/acre of available Ca.

The Ca% and CEC values given on the soil report help determine the rate of gypsum (lb/acre) to apply. The rate in Table 2 assumes a 22% Ca content for gypsum. To convert lb/acre to lb/tree, divide by 1742 (based on 5×5-ft tree spacing). Spreading gypsum in a 12-inch band outward from the drip line of trees increases the efficiency of Ca uptake.

If the soil report recommends lime and Ca% ≤ 45, you need to apply both recommended lime and gypsum at a rate of 10–12 ounces per tree. Generally, gypsum is not needed on soils with CEC > 8.0. On these sites, a Ca% value of 45 is sufficient if lime is not recommended.

Table 2. Gypsum application rates (lb/acre)

	Ca% value given on soil report									
CEC	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
2.0	325	290	260	225	195	160	130	100	65	30
4.0	650	580	520	455	390	325	260	200	130	65
4.5	730	655	580	510	435	365	290	220	145	75
5.0	810	730	650	565	485	405	325	245	160	80
5.5	890	800	715	625	535	445	355	265	180	90
6.0	975	875	780	680	585	485	390	290	191	100
6.5	1055	850	840	735	630	525	420	315	210	105
7.0	1135	1025	910	795	680	570	455	340	225	115
7.5	1215	1095	970	850	730	610	485	365	245	120
8.0	1300	1170	1035	910	780	650	520	390	260	130

Table 3. Magnesium applications rates *

Source	lb/acre	lb/1000 ft²
Magnesium sulfate [10% Mg, 13% S]	200	4.6
Sulfate of potash magnesia [11% Mg, 22% K_2O, 22% S]	182	4.2
Magnesium oxysulfate [36% Mg, 6% S]	56	1.3

* Rates supply 20 lb per acre of magnesium

Magnesium (Mg)

Magnesium is necessary for good tree color. On your soil report, look in the **Mg** column of the **Recommendations** section: *0* indicates that Mg levels are sufficient; *25* indicates that levels are low. Refer to the *$ Note* for additional information on Mg.

Dolomitic lime is an excellent source of Mg, but do not apply it unless the soil report indicates that lime is needed. If Mg is needed (*25*) but lime is not, apply 20–30 lb/acre of a water-soluble source. Sulfate of potash magnesia (0-0-22, 11% Mg, 23% sulfur) is a good source of Mg. If the soil test Mg% value ≥ 20, use calcitic lime. Adding additional Mg when levels are already in excess of 20% could contribute to Ca and/or K deficiency.

Table 3 lists sources of this nutrient and rates that will provide 20 lb/acre of Mg. Blending these materials with other fertilizers ensures a more uniform application.

High Soil pH Concerns and Management

If needles turn yellow or show other deficiency symptoms, soil pH may be too high. High pH can limit availability of many micronutrients, especially manganese. Before taking corrective action, collect both soil and plant tissue samples and have them analyzed.

If the soil report confirms abnormally high pH, apply either elemental sulfur (S) (flowers of sulfur, 90% S) or ammonium sulfate (21-0-0). For sandy textured soils with low CEC values and a pH of 6.0–6.2, apply enough ammonium sulfate to meet the annual nitrogen requirement.

On heavy-textured soils (high organic matter or clay) with high CEC values and pH > 6.2, apply elemental sulfur at a rate of 150–200 lb/acre or 1.4–1.8 oz/tree.

Spread S around trees in a 12-inch swath from the drip line outward. Even distribution helps prevent development of zones of extremely acid soil.

Higher rates of S can be incorporated into lineout beds prior to planting. However, do not exceed 300–350 lb/acre or 7–8 lb/1000 ft². Irrigating after a S application enhances its rate of reaction.

Phosphate (P_2O_5) and Potash (K_2O)

The rates of P_2O_5 and K_2O recommended on the soil report are in units of lb/acre for field production and lb/1000 ft² (abbreviated M) for nursery or lineout beds. Relatively high levels of soil phosphorus (P) promote tree development and good bud set. Rapid growth during the third year of production increases need for potassium (K).

Try to apply P uniformly and incorporate it into the soil whenever possible. In acid soils, P is converted to forms that are unavailable for plant uptake. Liming counteracts this process and increases the amount of P available to plants. Therefore, apply any recommended lime before fertilizing with P. If this is not possible, you can apply lime and P simultaneously.

Unlike P, K moves into the soil even if it is not incorporated. If the soil report recommends applying more than 100 lb/acre of K_2O, apply half in the spring and half in the fall. Applying more than 50 lb/acre at one time increases the risk of soluble salt injury, especially during dry weather. Salt injury is more likely with potassium chloride (0-0-60) than with potassium sulfate (0-0-50).