Fertilization Practices and Application Procedures at Weyerhaeuser

Mark E. Triebwasser [1] and Steve L. Altsuler [2]

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Abstract - Fertilizer practices used in nine Weyerhaeuser nurseries are compared. Each nursery has developed a unique reliable process for fertilizer application based on soil properties and climate. These processes have evolved over time with changes in other cultural processes. Our application technology also has evolved. Use of computer controlled spray equipment to give precise application is becoming our standard.

INTRODUCTION

Weyerhaeuser Company grows over three hundred and fifty million seedlings of seventy species each year. The species include Douglas-fir *(Pseudostuga menziesh),* ponderosa pine (Pinus *ponderosa),* loblolly pine (Pinus *taeda),* along with additional true firs *(Abies spp.*), cedars *(Thuja* spp.,*Chamaecyparis spp.),* pines *(Pinus spp.),* and cypress *(Taxodium spp.)*. We also grow a variety of deciduous seedlings. Red alder *(Alnus rubra) is* grown in the West, and a variety of oaks *(Quercus* spp.) and other deciduous seedlings in the South. The stock types include one and two-year old seedlings and transplant crops of bareroot and container seedlings. In the West we also produce two million rooted cuttings of Douglas-fir.

Four nurseries are located in the Pacific Northwest, one in central British Columbia, Canada, and four in the Southeast. With so many nurseries, species, and stock types there is a wide diversity of fertilizer prescriptions. This brief overview will comment on our practices and contrast the differences in fertilizer practices in these nurseries. The evolution of our application technology will also be discussed. Weyerhaeuser also has several greenhouse operations but fertilizations practices at these facilities are not included in this summary.

FERTILIZATION PRACTICES

Each of our nursery sites has developed a unique fertilization regime based on the soils and climate of the site. Natural soil fertility, soil texture, structure, organic matter, pH, and other soil properties have shaped the regimes that each facility has developed. The importance of each of these factors has been reviewed by van den Driessche (van den Driessche, 1980, 1984). These regimes have been modified over time based on the growth and development of the seedlings. The color of the seedlings is used as a major indicator of their nutrient status. We use tissue analysis periodically to monitor nutrient levels as we make changes in other cultural practices. Tissue nutrient analysis is also done where nutrient problems are suspected.

All of our facilities use a pre-sow or pre-transplant application of fertilizer. The nutrients used and the rate to apply is determined after a soil nutrient test. Nutrients applied may include triple super phosphate, Sul-Po-Mag, potassium sulfate, ammonium sulfate, ammonium phosphate, lime and/or sulfur. The southern facilities are primarily concerned with levels of potassium and sometimes phosphorous in their pre-sow applications. Lime may also be used. In the West our primary concern is for phosphorous and to a lesser degree potassium. One western nursery occasionally applies lime, while the remainder of our western nurseries are more concerned with high pH and may use sulfur or other means to lower pH. All facilities in the South and some in the West also include a blend of micronutrients in their pre-sow application.

On the ground to be sown no nitrogen sources are used, except at our Canadian facility. No nitrogen is applied because we have found that high nitrogen levels in soils when seedlings are just germinating increases the level of disease (Sinclair et. al., 1975). Nitrogen will be applied to some of these seedlings later in the growing season. In the Canadian nursery ammonium phosphate is used in the fertilizer mix. Only about 15 pounds of nitrogen is applied per acre and then no subsequent growing season applications of nitrogen are made during the first year.

Several months after germination, fertilization begins. The growing season applications are primarily for nitrogen. In the West the source may be ammonium sulfate, urea, calcium nitrate, or N-32 a solution of ammonium nitrate and urea. One to four low rate applications may be made over the next three months. Rates are typically about 15 pounds of nitrogen per acre per application. Only 30 to 60 pounds of nitrogen may be applied during the growing season.

In the southern nurseries, the nitrogen source is ammonium sulfate, which is applied at a weekly rate of 10 pounds/acre. Total nitrogen applications during the season may be 100 to 13 0 pounds per acre. In the South they may also make one or two applications of potassium either as potassium chloride or Sul-Po-Mag (Sulfate of potash-magnesium).

On western seedlings that are to be grown for two years little or no growing season nitrogen is used during the first year. Application of nitrogen causes too much growth the first year and makes it difficult to control growth during the second year. No growing season applications of nitrogen are needed on red alder. This three to four-foot tall, one-year-old seedling is produced without nitrogen. This species has a symbiotic bacterium, Frankia, that fixes nitrogen from the atmosphere. We inoculate the beds with ground Frankia nodules to ensure infection.

Fall fertilization is desired to allow for good nutrient status when the seedlings enter dormancy (Thompson, B, 1983). The fall application also promotes good bud development. Fall fertilized seedlings have a dark green color and can be more frost hardy than seedlings that have not been fertilized. Once again the primary nutrient for the fall application is nitrogen. One or two applications may be made. In Canada the fall application is made in late August, using ammonium phosphate or ammonium sulfate. Calcium nitrate may be used for the fall application in our Washington nursery. The other Pacific northwest nurseries use their normal nitrogen sources. In the South, ammonium sulfate is the nitrogen source for fall fertilization. In all facilities the rate is between 15 and 30 pounds per acre.

In the West many seedlings are grown as two-year-olds The seedlings receive much the same nutrient regime as the one-year-old seedlings although the rates are increased and the application time is earlier in the year. Prior to bud break an application of ammonium phosphate is made followed with two or three applications of nitrogen prior to early July.

In the West the desired stock type for reforestation is a transplant seedling. These seedlings are generally larger in height and caliper than the 2+0 stock. They have more branches and buds, and a heavier, mop like root system. These seedlings receive much the same fertilizer regime as the 1 +0 seedlings except that sixty pounds of nitrogen is included in the pre-plant application. Nitrogen applications during the growing season are approximately twice the rate of the one-year-old seedlings. Total amount of nitrogen applied will be from 120 to 180 pounds per acre.

APPLICATION PROCEDURES

Most of the nutrient sources used in the preplant applications are of low solubility. This necessitates the use of a fertilizer spreader that can apply granular material such as a rotary spreader. Many of our facilities contract with a commercial applicator to apply the pre-plant applications. These contractors use the same type of equipment but can apply fertilizer to large acreage much more efficiently than we can using smaller tractor mounted equipment. The variation in rate of application is large using this type of equipment. The distribution of the commercial applicators is only slightly more uniform than with nursery equipment.

A rotary spreader can also be used for growing season applications. A major disadvantage is the lack of uniformity of application. Many times the appearance of yellow stripes in the field will be apparent from the variation in application when using this type of equipment. Also, almost 40% of the area fertilized is in tractor wheel paths. For a more uniform application a drop or box spreader may be used. The advantage of this type of spreader is that it produces a much more uniform application. Wheel paths are not fertilized. The disadvantages are that they are slow and require frequent filling. Most of our southern nurseries still use drop spreaders. The use of gangs of spreaders that allow them to fertilize three beds with each pass speeds up the application. In the Pacific Northwest we still use this type of equipment for special applications and for fertilizer experiments. Canada has added drop tubes to their spreader to allow placement of the fertilizer between the rows of seedlings. This prevents fertilizer from lodging in the foliage and causing fertilizer bum.

In the West about thirteen years ago we began using our spray equipment to apply fertilizer. Applications could be made that were very uniform with great accuracy. Our sprayers are capable of applying fertilizer to a full section of trees, either 6 or 7 beds at one time. When we first began this type of application we simply took the granular fertilizer material and poured it into the spray tank. The agitation in the tank dissolved the fertilizer before spraying. There were several disadvantages to this process, including: safety of moving 80 pound fertilizer bags on small, awkward platforms; length of time to get all the material to dissolve in the sprayer; impurities in the mix may not dissolve and can plug the nozzles and screens of the sprayer.

The next improvement at one facility was to move the dissolving operation to a separate tank with mechanical and jet agitation. The tank was situated on a raised platform with ample work area. The heavy fertilizer bags still had to be picked up, but there was less risk from climbing and moving bags in a restricted area. The mixing was done unattended while the operator was out spraying the previously mixed batch. There was also the ability to screen out impurities as the solution was pumped into the sprayer.

The next improvement came when we converted from the bagged granular material that needed to be dissolved to a liquid formation. The fertilizer is delivered in bulk tanks of 250 gallons. When adding fertilizer to the sprayer a forklift raises the bulk tank and simple gravity feed delivers the material to the tank. The desired quantity of fertilizer is decanted into the sprayer. The tanks are calibrated for easy measurement. Water is added to get the desired concentration. Although we are using the sprayer for application, the solution is not for foliar feeding. The fertilizer is washed off the foliage and into the soil with irrigation immediately after spraying. We have done some experiments with foliar applications but to date have not found any real advantage of using these more expensive Materials.

COMPUTER CONTROLLED SPRAY INJECTION SYSTEM

Although it is not required for application of fertilizer through the spray system, all of our Pacific northwest nurseries have converted to computer controlled injection systems on our sprayers. The southern nurseries are considering making this change. The system consists of a 500 gallon tank containing water or fertilizer solution, two tanks to hold pesticide concentrates, a tank to collect rinseate, and a tank of clean water for emergency washing. The ground speed is monitored using radar. The on-board computer then calculates the rate of injection of pesticide and the flow rate for the water. Electronic controls on the pump and solenoid valves deliver the desired application rate per acre of both carrier and product. Tractor speed is not critical. The system can adjust for variation in ground speed.

Another advantage of using computer controlled injection systems is that since the material is not diluted, only five or ten gallons of pesticide concentrate are placed into the chemical tanks. Thus, only a limited amount of chemical is being transported instead of 500 gallons of diluted mix. This usually is enough for a full day of spraying. Additional water can be obtained from many locations on the site. In the event of an upset or spill the environmental damaged would be much easier to cleanup.

There is no concern for preparing the exact amount of chemical solution to use. The chemical is not diluted so it can be left in the chemical tank for use another day. If left in the chemical tank it must be labeled. The chemical can be decanted back into the original labeled container if desired. The same is true if weather conditions become unacceptable and you must stop spraying before the project is complete. Any rinse water generated when emptying containers is placed in a special tank, and then pumped out as part of the chemical application at very low rates. The system also has the ability to fully rinse the chemical tank and all booms while still in the field. This rinse water is then applied as part of the spray operation to the crop, thus there is no rinse water to deal with later. All of the valves necessary for spraying, rinsing, or pumping are controlled electronically from the control panel located on the tractor. The operator does not need to get off the tractor for any reason.

For fertilizer applications we do not use the injection system but simply mix the solution in the spray tank. The desired rate of fertilizer solution in gallons per acre is loaded into the controller and it accurately delivers the desired rate of material per acre. If we are also applying a fungicide at the time of fertilizer application this can be put into the chemical tanks and it will be metered into the solution as it is sprayed on the crop.

FUTURE RESEARCH

Weyerhaeuser Company continues to do research in fertilization practices. As an alternative to frequent applications of fertilizer the use of slow release fertilizer is being tested. Although we have not found benefits we continue to investigate the use of foliar applications of nutrients. Other studies are exploring the role of fertilizer in development of frost hardiness and production of improved root fibrosity.

SUMMARY

Each facility must develop its own reliable process for fertilization of seedlings. Each nursery will develop a unique nutrient prescription based on climate, soils, and species grown. Careful monitoring of results will allow improvements in the process. Use of sprayers allow for the greatest accuracy in application of fertilizer.

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[1]*Weyerhaeuser Aurora Forest Nursery, 6051 S. Lone Elder Rd., Aurora, OR 97002; Tel.: 503/266-2018; Fax: 503/266-2016.*

[2] *Weyerhaeuser Turner Regeneration Center, 16014 Pletzer Rd., SE, Turner, OR 97392; Tel: 5031327-259 1; Fax: 503/327-2591.*

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