

CHAPTER 5 b

Forest Land Application of Animal Manures

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ESTIMATION OF PLANT AVAILABLE NITROGEN

Animal manures contain nitrogen (N) in four forms, organic-N, ammonium/ammonia-N ($\text{NH}_4/\text{NH}_3\text{-N}$), and nitrate-N ($\text{NO}_3\text{-N}$, usually very little). Trees can take up $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ directly, but organic-N must be broken down into $\text{NH}_4\text{-N}$ or $\text{NO}_3\text{-N}$ before trees can take it up. Estimation of plant available-N (PAN) is the sum of organic-N, $\text{NH}_4\text{-N}$, and $\text{NO}_3\text{-N}$ that is available to the trees after correcting for N mineralization and $\text{NH}_3\text{-N}$ loss.

The breakdown of manure organic-N depends on characteristics of the manures, soil, and weather. Currently, the Clemson Agricultural Service Laboratory estimates about 60% of the organic-N is available during the first growing season, but more or less N may be made available depending on conditions. Hot moist conditions increase the rate of organic-N breakdown.

The other major component of N in animal manures is NH_4 , a plant available form of N. Ammonium-N can be converted to $\text{NO}_3\text{-N}$ which is also readily accumulated by trees, or transformed to $\text{NH}_3\text{-N}$. Ammonia is a gas that can be readily lost to the air. When manure is incorporated into the soil, the loss of NH_3 to the air is minimal, but left on the surface, the loss of NH_3 can be great. The Clemson Agricultural Service Laboratory estimates that about 80% of the $\text{NH}_4\text{-N}$ is captured when manures are incorporated into the soil (allowing for a 20% loss of NH_3 during application). For unincorporated manure applications the Laboratory estimates 50% of the $\text{NH}_4\text{-N}$ is lost. Further losses of NH_3 are estimated at 15% of the $\text{NH}_4\text{-N}$ content per day if not incorporated or a ¼ inch rainfall or irrigation does not occur. Two soaking rains are needed after a prescribe burn to minimize $\text{NH}_4\text{-N}$ losses from the surface applied animal manure. The ash after a burn is alkaline and alkaline conditions will increase the conversion of $\text{NH}_4\text{-N}$ to $\text{NH}_3\text{-N}$ and loss to the air.

Nitrate-N can occur in animal manures, but in most cases the quantity found is small. One-hundred percent of the manure $\text{NO}_3\text{-N}$ is plant available and loss during application is negligible.

APPLICATION RATE RECOMMENDATIONS

Nitrogen recommendations for **at or after canopy closure**.

Annual application rates:

75 - 100 lbs PAN per acre for both pines and hardwoods

Periodic application rates:

200 lb PAN per acre every 3 to 4 years

APPLICATION TIMING RECOMMENDATIONS

Fertilization of forest stands should commence when the crop trees have fully occupied the site and overtop the majority of competing vegetation (at or after canopy closure). Animal waste applications at planting and prior to canopy closure are generally not recommended for several reasons: (1) nutrient demand and uptake of seedlings is less than more mature trees (larger root volume and more leaf area), (2) competing vegetation can reduce available moisture and sunlight to seedlings, (3) seedling survival and growth may be reduced due to fertilization of competing vegetation, (4) the high ammonium-N concentration of some animal wastes may burn and kill seedlings, and (5) where a cost is incurred to apply the animal waste, the cost is carried for a longer period of time than when applications are made after canopy closure or a first or second thinning. If a landowner can justify controlling competing vegetation from the seedling stage to canopy closure, then the recommended annual application rate should be 60 - 80 lb PAN/acre from at planting to canopy closure. For forest land application, the recommended water table depth should be greater than 18 inches at time of application. Heavy equipment should not apply animal waste at a site where water can be squeezed out of a handful of soil.

TIME OF YEAR APPLICATION RECOMMENDATIONS

Hardwoods: March (after last frost) - August

Pines: year around

SPECIFIC RECOMMENDATIONS AND CIRCUMSTANCES

Christmas trees

Follow inorganic fertilizer recommendations (timing and rate). Over application of nitrogen or inappropriate timing can cause a large flush of growth and potentially cause an undesirable growth pattern for christmas trees.

Longleaf pine

To increase pine straw production on deep sandy soils:

Periodic Applications of Liquid and Litter Materials

Apply 75 - 100 lb PAN/acre every 3 to 4 years in stands where average dbh (diameter at 4.5 feet above groundline) is 2.5 - 5.0 inches and average height is 15 - 30 feet (approximately age 8-15 years-old). Do not over apply N at this time. We have found that if we apply 150 lb PAN/acre or more of inorganic fertilizer, biosolids, or animal manure that 20% to 35% of the longleaf pines will become top-heavy, bend over, and never straighten back up.

Apply 125 - 175 lb PAN/acre every 3-4 years in stands where average dbh is greater than 5.0 inches and average height is greater than 30 feet (age 15-20 or older).

Annual Applications of Liquid and Litter Materials

Apply 60 - 75 lb PAN/acre annually.

Access in Forest Stands

Access in forest stands can limit where animal manures can be applied. Fourth and fifth row thinnings do allow for ground access but stump height should be as close to groundline as possible in the thinned rows (a contractual matter). If animal manure application is planned for a stand prior to a first thinning, a normal spacing (i.e. 6x10, 6x12, or 8x10 feet) could be employed, but every fifth row would be 14 to 15 feet between the row (and 6 or 8 feet between the trees) to allow for access. These "travel" lanes can also serve as fire control lanes and walking lanes. Uniformity of coverage should be a high priority as well as applying the manure where the majority of tree roots are. In some cases a side port spreader may be a better delivery system for litters than a rear port spreader.

Loblolly Pine Wood Volume Gain and Longleaf Pine Straw Response to Fertilization

Loblolly wood volume gain due to a one-time fertilization after canopy closure can range from 20% to 35% or more (compared to untreated stands) on many of our SC forest soils. The peak wood volume response on most nitrogen deficient sites occurs three to five years after application. Repeat applications should further increase wood volume gain over untreated stands. Longleaf pine forest floor dry weights used to estimate pine straw production have been increased by 35% to 90% two years after fertilization (compared to untreated control plot production) in a 10 and 32 year-old longleaf pine stand on a deep sand (Alpin soil series, Typic Quartzipsamments) in the Sandhills physiographic region of SC. Forest floor dry weights three years after application are still 28% to 90% greater than adjacent untreated control plots.

Manure Applications in Recently Planted Intensively Fertilized Sites

These sites should not receive animal manures until a soil test verifies soil plant available N (nitrate-N plus ammonium-N) levels below 200 lb PAN/ac to a depth of 24 inches. These sites will generally have more than sufficient levels of nutrients for recently planted seedlings.

ONGOING RESEARCH AND DEMONSTRATION SITES

We are now conducting several animal manure projects in SC to determine if higher annual or periodic application rates will adversely affect ground water or surface water. These projects will also address seedling/tree growth response to various animal manures (liquid and litter) versus no manure and effects of vegetation control plus animal manure application to loblolly pine, longleaf pine, and sycamore in the Coastal Plain and Piedmont and loblolly pine on a deep sand in the Sandhills of SC. The aforementioned recommendations may be modified based on new information as it becomes available.

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