Fertigation and Nitrogen Movement in Field Nurseries

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INTRODUCTION

Water use efficiency and nutrient movement are among the most important factors facing nurserymen. Soil loss due to erosion can be reduced by 92% (Cripps and Bates, 1987) and plant growth increased (Skroch, et al , 1986) by planting ground covers instead of keeping aisles bare.

Nitrogen (N) is the fertilizer element used in greatest quantity by nurseries EPA has set a limit of 10 ppm nitrate-N as the maximum level tolerated in drinking water All North Carolina water has been designated as "highest use - drinking water"; that is, all fresh water for nursery use can legally be claimed for drinking water and must meet the 10 ppm nitrate-N limit. North Carolina nurseries need to: (1) use the most efficient means for irrigating crops, (2) use the least N fertilizer resulting in profitable growth, (3) know whether 10 ppm nitrate-N or more leave the nursery and, (4) adopt practices that limit the runoff potential for nitrate-N.

WATER USE EFFICIENCY

We normally get 42 to 54 in of rainfall per year in Western North Carolina. If rain fell evenly each year, we would not need to irrigate Unfortunately, if we depend upon average rainfall, we cannot grow plants good enough to compete on today's market. Most irrigation is solid-set impact sprinklers with portable pipe for moving systems from field to field. The trend is towards travelling gun irrigation for larger shade tree and conifer growers, mostly because of cost.

These irrigation systems wet everything in the field They effectively activate herbicides and soil-active insecticide They also break tender tissue, knock over newly set transplants and cause erosion if not calibrated properly. We use these systems because we have learned how to make them work on our hilly nurseries, but they do waste valuable water.

Drip or trickle irrigation delivers water at low pressures, usually working at under 15 psi. As a result, smaller, less expensive pumps are needed. Water flows through very small openings in irrigation tubing so any savings in pumps are lost in purchasing water-filtering systems and miles of tubing. Drip irrigation applies water to the soil near plants so that the crop plant gets efficient use of the water and no fertilizer is washed away.

Research The reasons for using drip irrigation instead of overhead irrigation are to use less water or grow a better plant. Currently water is plentiful in Western North Carolina so the switch to drip or trickle irrigation has been slow. We have conducted research on shade trees that indicated flowering dogwood, river birch and linden trees grow faster when irrigated with drip rather than overhead irrigation (Bir and Warren, 1988; Bir and Bonaminio, 1987). In practice, nurseries that are currently using drip irrigation are growing trees in one year less field time than similar nurseries using overhead irrigation

Crop survival once a plant goes to the landscape can also be affected by the type of irrigation used. Our research into drip versus overhead irrigation has shown that with some species a significantly larger number of roots exists inside the harvested rootball of B&B trees when they are grown under drip instead of overhead irrigation (Bir and Warren, 1988).

Conclusion. Drip irrigation can be used to grow larger B&B shade trees with more roots using less water.

FERTIGATION

A grower using drip or trickle irrigation has a system that applies water efficiently enough to include fertilizer in the irrigation water (fertigation). Most overhead irrigation systems are too inefficient to economically apply liquid fertilizers because they apply fertilizer to areas where trees will not benefit from it.

Most western North Carolina soils are heavily weathered clays that are highly acidic and low in calcium, magnesium and phosphorous. The most efficient means for applying these elements and correcting soil acidity is to surface apply dolomitic limestone and a source of phosphorous, then mix them thoroughly with the topsoil. Only N needs to be surface applied during most crop cycles.

Research. We've found little information available concerning fertigation. As a result, we established experiments comparing surface fertilizer applications and fertigation on flowering dogwood, red maple and mountain laurel. We fertilized with standard N.C. Extension recommendation (0.25 oz N per plant the first year plants are in the field, 0.5 oz the second year and 1.0 oz the third year). Granular urea was applied to bare soil in March before vegetative growth began. Fertigation treatments were established so that plants received half, standard and twice the recommended rate of total N per year. Fertilizer N (urea dissolved in water) was applied by injecting into the irrigation system as buds were swelling in the spring and weekly for the next seven weeks (a total of eight applications).

Results varied somewhat by species. However, after three seasons of growth, larger plants of each species were produced with fertigation using only half the N used as when topdressing granular fertilizer (Bir, et al., 1991). We attribute this to actually reaching the plants with more fertilizer.

After two years in a similar experiment with eastern hemlock, willow oak, and yellowwood, there is no statistical difference in growth between one-quarter-rate N applied by fertigation and normal rates of granular fertilizer applied to the surface. All plants in this test are drip irrigated.

Conclusions. N applied to field nurseries can be reduced by at least one half if plants are drip irrigated and N fed through the irrigation system.

NUTRIENT MOVEMENT

Research. Thanks to a startup grant from the Horticultural Research Institute, we are investigating N movement in three field nurseries. They are located on either sandy loam, clay loam or clay soils in hardiness zones 7 and 8 of western North Carolina. Two nurseries draw water from adjacent streams, applying it either through a traveling gun or solid-set impact irrigation. Their runoff flows to ditches or drain tile then back to the streams. The third nursery drip irrigates, drawing water from ponds. All runoff returns to these ponds.

During 1990 and 1991 we sampled water from these nurseries before they were fertilized, then a day, a week, two weeks and four weeks after fertilizing. Samples were taken from the water supply and where water would return from the nurseries as well as from ditches and drain tiles. In no case did nitrate-N approach concentrations of 10 ppm.

All of these nurseries allow some vegetation to grow between tree rows. Low levels of nitrogen might have been captured by non-crop vegetation within the nursery. However, vegetation is not allowed to grow near nursery stock where the greatest concentration of fertilizer is applied If the level of fertilizer applied is greater than can be used by nursery stock or it leaches deeper into the soil than feeder roots extend, nutrient pollution of the subsoil and, potentially, ground water, could occur.

To evaluate nutrient movement in the soil profile, soil cores to a depth of 5 ft or to water-bearing layers of soil shallower than 5 ft were collected. Soil from each depth was analyzed for ammonium and nitrate-N content. Samples were taken in each of these nurseries before planting and after the first year of production.

Analysis of these samples indicates that nitrate-N levels before planting did not exceed 4 ppm in the top 5 ft of soil. However, levels increased following the first year of fertilizer application at distances of 6 and 18 in. from the base of the tree but did not increase at 36 in. from the tree (Fig. 1). The 6-inch core was taken from a bare soil area, the 18-in. core from the edge of the sod aisle and the 36 in. core from within the sod aisle (Bir and Hoyt, 1991).

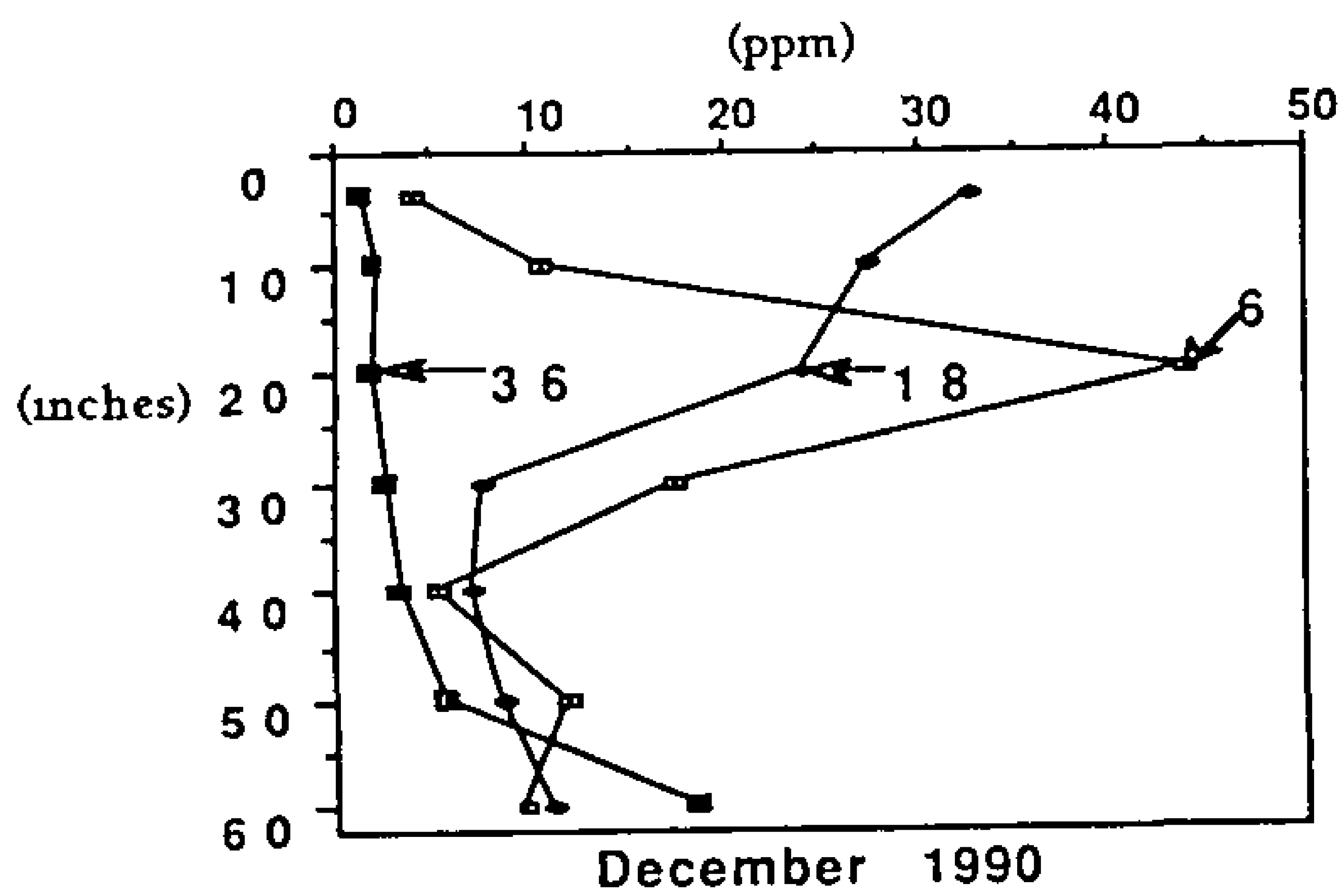

Fig. 1. Soil nitrate-N in cores sampled at 6, 18, and 36 inches from the plant (ppm)

Conclusion. Very preliminary data indicates that field nurseries fertilized at rates not exceeding 150 lb nitrogen per acre may not be causing pollution due to nitrate-N runoff.

Nitrate-N levels are increasing in soils beneath the effective feeding zone of deciduous tree crops in late fall following spring application of nitrogen during the first year of production We will continue to determine whether or not these levels continue to increase.

OVERALL CONCLUSIONS

• Drip irrigation can reduce the amount of water needed to grow some field nursery crops while not reducing plant growth.

• If nitrate pollution is a problem in field nurseries, the amount of N applied can be reduced by fertilizing with drip irrigation without reducing growth

• Nitrates that escape the target crop appear to be captured by sod barriers adjacent to production areas.

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