Reduction of Nitrates in Nursery Surface and Ground Water

Ronald R. Amos
Evergreen Nursery Co., Inc., 5027 County TT, Sturgeon Bay, Wisconsin 54235

INTRODUCTION

Nitrogen in an essential element in the production of plants. Management of nitrogen to prevent surface and ground water contamination will be affecting all nursery operations in the future. Some nurseries have already had to address this problem. Nurseries provide a product that is a benefit to the environment, but past and current fertility practices have created environmental problems. Federal and state governments are examining nitrate sources in agriculture and commercial agriculture will most likely be looked at more closely than family farms. Potential problems and some solutions in greenhouse, field and container areas will be discussed. Examples of what Evergreen Nursery is doing to combat these problems will illustrate what has been done in one operation.

GREENHOUSES

Greenhouses have often been considered the area with the least nitrate problem. Large numbers of plants are grown in a relatively small area. High plant density and lack of rain leaching nutrients caused little nitrate to leave the greenhouse. However, recent studies have shown nitrate concentrations in the top 3 ft of soils under some benches to exceed 2,000 lb of nitrogen per acre in decades-old greenhouses (Mcavoy et al., 1992).

Nitrate loss from greenhouses can be reduced by altering the methods of application and types of nitrogen applied. Examples include:

(1) Monitoring fertility levels in the growing medium and applying nitrogen only when the electrical conductivity (EC) or soil test falls below the level required for the crop are necessary to avoid excessive loss. Research to determine the necessary level of nitrogen may be needed.

(2) Subirrigation where benches or floors are flooded during irrigation captures and reuses water and nutrients thus eliminating loss.

(3) Designing greenhouse floors to capture and reuse runoff will reduce nitrate loss.

(4) Drip irrigation is an efficient way to irrigate plants. Water and nutrients are applied only to the pots and not the surrounding surfaces.

(5) Slow-release fertilizers release nitrogen directly to the medium, eliminating loss caused by irrigation runoff from the foliage and surrounding surfaces.

(6) The simple practice of repairing leaky hoses and pipes will reduce nitrate loss from greenhouses.

At Evergreen Nursery, we have worked at reducing nitrate loss by monitoring the EC in our greenhouse crop media. This has reduced the frequency of fertilizer injection during irrigation. It is very important to closely monitor crop growth. We have seen a reduction of growth when EC levels dropped below what the crop requires.

FIELD

Field fertility recommendations in the past were designed to provide a high level of nutrients to the crops at all times. It was cheaper to apply additional nitrogen beyond the crops needs to prevent the financial loss of underfed and undersized plants. With the knowledge that the potential for surface and ground water nitrate contamination exists, new recommendations are necessary to determine the most efficient level of nitrogen needed to grow the crop.

Table 1. Rate of nitrogen application in organic and inorganic forms to test plots.

Year	Total nitrogen lb/A	Inorganic nitrogen lb/A	Sludge nitrogen lb/A	Milorganite nitrogen lb/A
		PL2-4		
1989	300	175	125	0
1990	150	0	0	150
1991	200	0	0	200
1992	200	0	0	200
		PL7-12		
1989	300	125	175	0
1990	150	0	0	150
1991	200	0	0	200
1992	200	0	0	200
		PL70		
1989	300	0	300	0
1990	0	0	0	0
1991	200	200	0	0
1992	200	0	0	200

Development of a fertility program requires an understanding of the needs of the specific crop. Consulting extension specialists at universities and other growers is helpful. The form of nitrogen, method of application, timing of application(s) and irrigation program should all be considered. Regular soil sampling may be necessary to determine the correct nitrogen loading. Sampling in and below the root zone will provide information on nitrate loss from the field. Identifying the actual nitrogen removal by a crop will help determine nitrogen needs. A conifer seedbed study showed that 152 to 265 lb N/A was removed from the soil (Iyer et al., 1989). Crop density, type of crop, and weather will affect nitrogen removal. Nitrogen loss can be reduced using drip irrigation, arranging planting beds and fields to prevent excessive runoff, and filling sink holes which provide an open conduit to the ground water. Knowing the current nitrate levels in the ground water and the direction of flow is information that can affect the amount of nitrogen that is applied annually to a crop. Evergreen Nursery has done extensive work to reduce soil and ground water nitrates. In 1989 a fertility management study plan was developed by Evergreen Nursery to provide the State of Wisconsin data for nitrate management on our site. The birch crop was used to determine the most efficient form and level of nitrogen to apply to the crop. Test plots were set and monitoring wells installed up gradient, two in fields of different nitrogen loadings (Table 1) and one down gradient. Nitrogen was applied in organic and inorganic forms to the test plots. Soil was sampled at 0 to 10 in. and 10 to 18 in. Ground water was sampled every two weeks. Plants were harvested at different times during and at the end of the growing season, and analyzed to determine nitrogen uptake and removal. The crop was measured annually to determine the effect of nitrogen on growth. Irrigation was modified to put less water on more often to prevent leaching of nitrates.

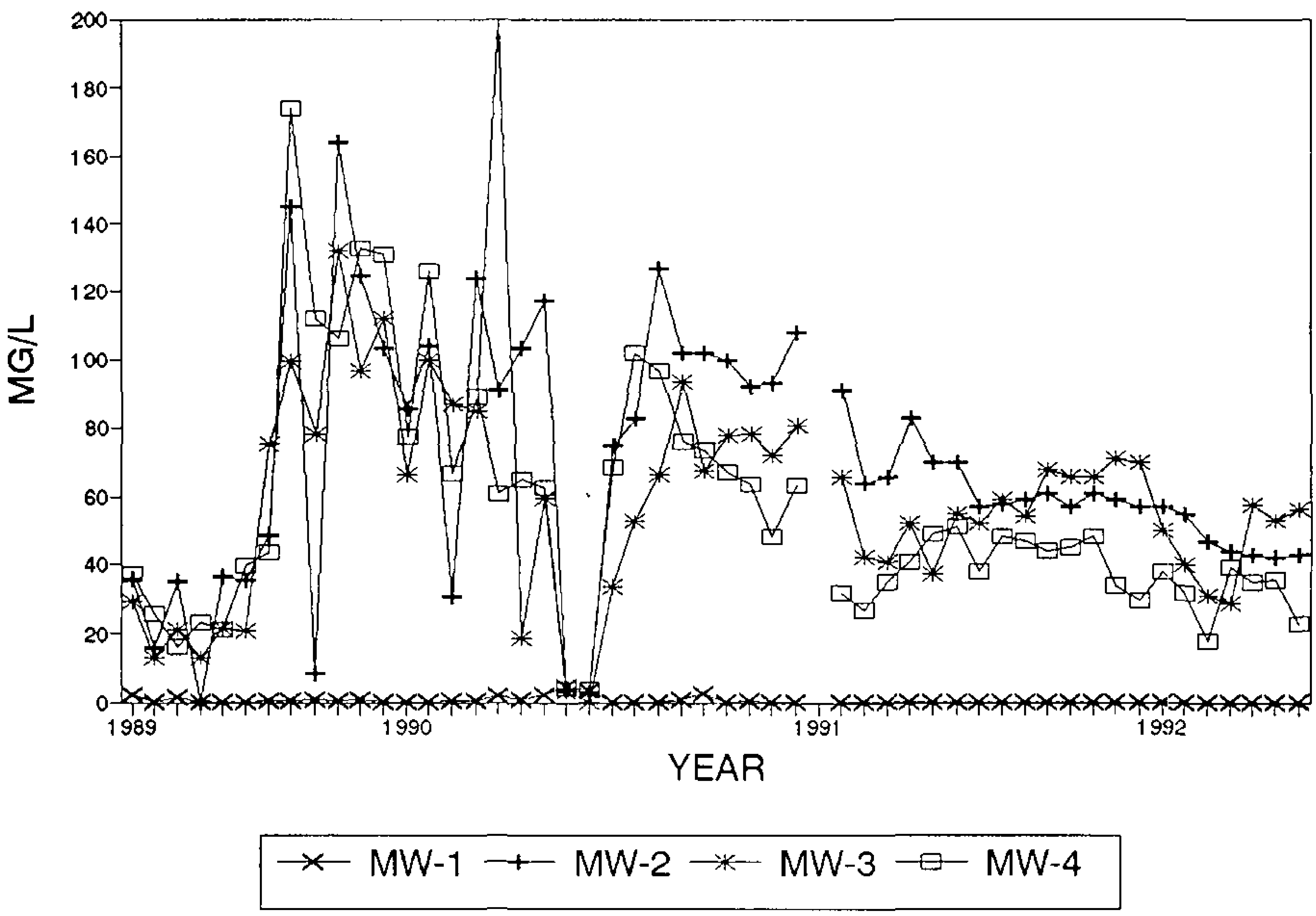

Figure 1. Nitrate-nitrogen levels in monitoring wells 1989 to 1992.

Soil and ground water sampling is ongoing. Monitoring wells have shown a steady decline in nitrates (Fig. 1). Soil nitrates have decreased with a decrease in nitrogen loading. The form of nitrogen applied has affected both the soil nitrate levels and dry weight accumulation (Fig. 2). The initial loading rate of 300 lb N/A was reduced to 150 lb N/A the second year, this caused a decline in growth (Fig. 3) and nitrogen loading was raised to 200 lb N/A. In 1992 all plots were fertilized with organic nitrogen applied as Milorganite.

Conifer field plantings have had nitrogen reductions and applications are timed to provide nutrients at the estimated time of optimal uptake. The county soils and water conservation department is working with us on a plan to further reduce our runoff and prevent surface and ground water contamination.

CONTAINERS

Container growing areas are a major concern for nitrate runoff. Container media differ from soils in there ability to hold water and nutrients, usually requiring greater inputs of both. Spaced containers occupy only a part of the total surface area. Injection feed systems may waste up to 75% of the nitrogen applied between the pots. Slow-release fertilizers applied directly to the pots eliminate nitrogen between pots, but the irrigation frequency and need to flush water through the pots causes irrigation runoff. Medium rate applications of slow-release fertilizers applied to unspaced pots can represent nitrogen loading rates of over 800 lb N/A. Reducing nitrate loss in containers is in some ways more complex. Efficient irrigation systems are as important as nitrogen application. Application of water through drip irrigation reduces total water use and runoff. Subirrigation contains

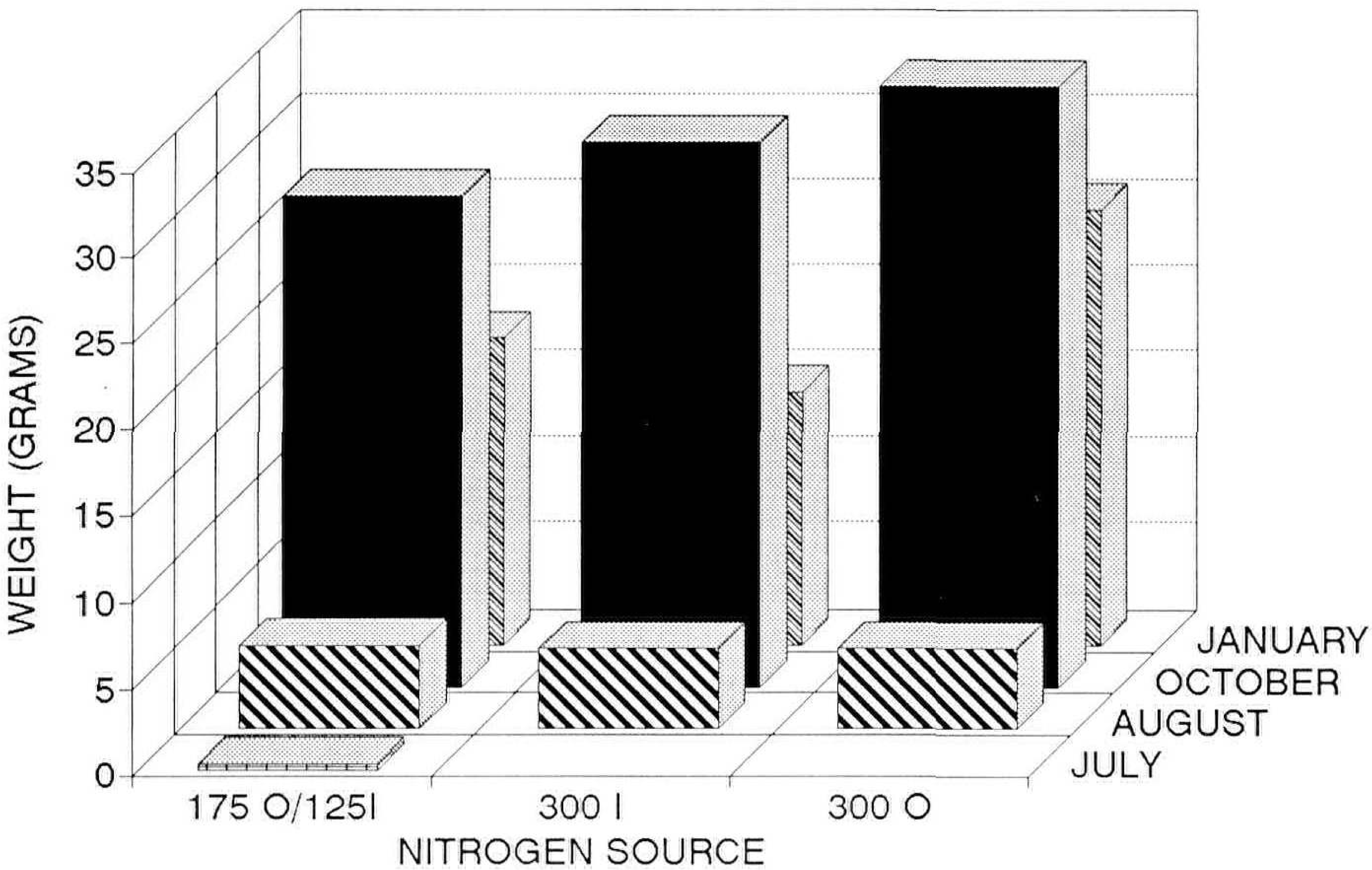

Figure 2. Nitrogen form effects on dry-weight accumulation.

and reuses irrigation water. Watering based on plant need instead of a schedule can also reduce irrigation loss. Altering media for greater water-holding capacity will reduce the irrigation frequency. Wetting agents can increase the rate of water absorption to reduce the length of irrigation.

The method of reuse or disposal of irrigation water will determine the nitrates leaving the container area. Reuse of irrigation water can be done by designing areas so water is collected, treated, and reapplied. This is basically a closed system that can be expensive and may not be possible for many growers. Disposal of

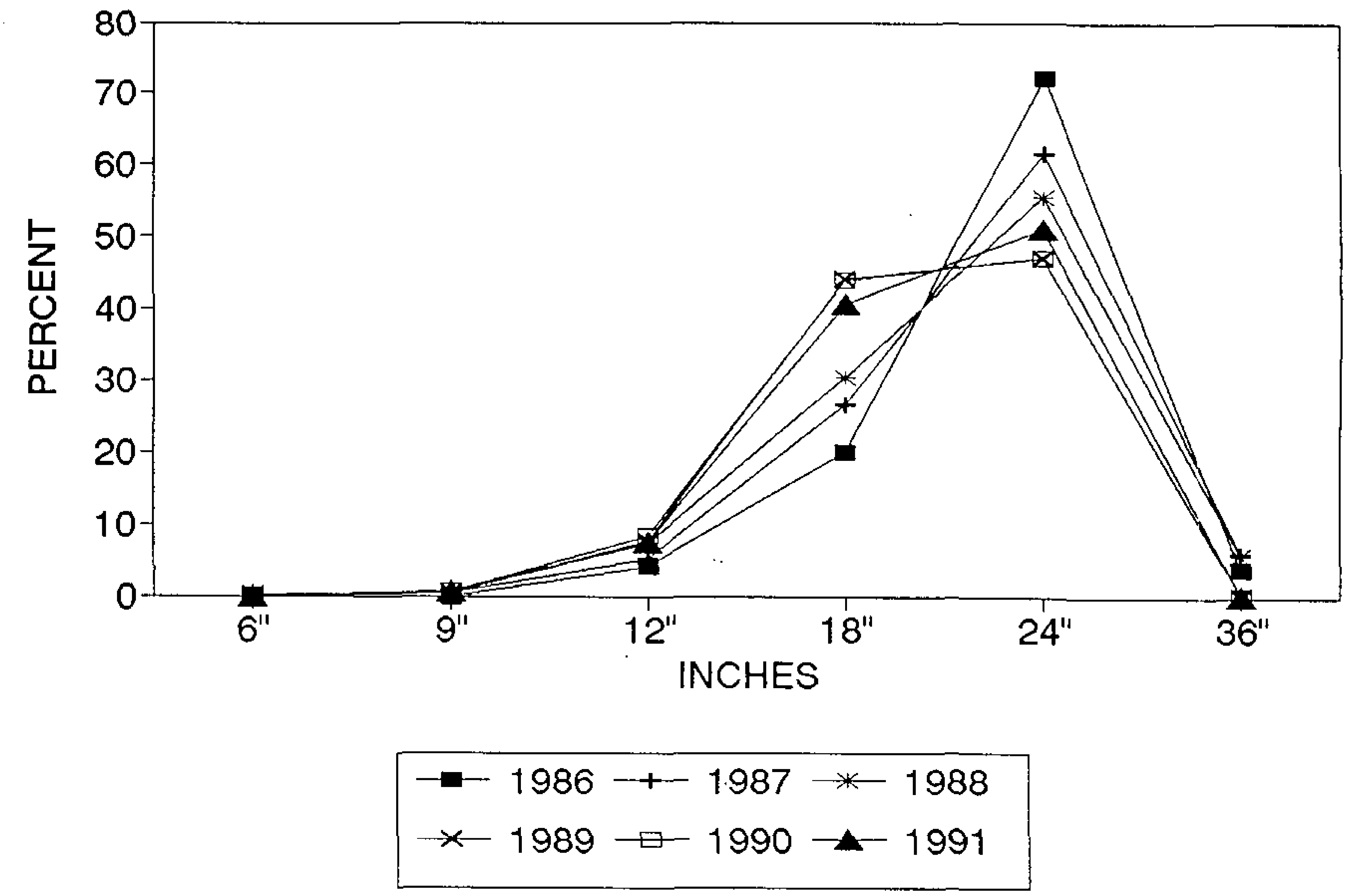

Figure 3. Effect of nitrogen loading rate on growth of birch.

irrigation water can be done by draining container areas to evaporation ponds. Collected water could be land applied to other crops. Wetlands have been looked at as way of reducing nitrates from runoff. Wetlands have been constructed to reduce nitrates and filter water. Municipal treatment systems could treat irrigation water, though this would not be practical in many areas.

At Evergreen Nursery the container operation has switched from injection feed to slow-release fertilizer with injection-feed backup. Water-holding capacity of the growing medium was increased. To determine how much nitrate nitrogen was leaving the container area, pot stands were set up in different locations of the container area to collect irrigation run off from the pot and area surrounding the pot. Samples were collected from slow-release pots and from injection-feed pots. Nitrate runoff in slow-release fertilizer plots averaged 8.6 mg/liter nitrate nitrogen and in injection-feed plots 69.3 mg/liter nitrate nitrogen. This proved the benefit of slow-release fertilizers but also provided data on the loss of nitrates from the container area. Slow-release fertilizers are effective products in providing plant nutrients. In 1992 we have a cooler than normal year. The slow-release products did not release fast enough to provide adequate fertility to the crop. Injection feed was necessary to supplement the nutrition. This reinforces the need to collect and control the runoff from container areas. Evergreen Nursery in currently working with engineering consultants, soil conservation departments, and state agencies to develop the best possible management plan for our nursery.

CONCLUSION

Reduction of nitrates in surface and ground water in nurseries is a complex problem. The best approach is to collect as much information as possible about the nursery and surrounding area. Determine groundwater nitrate levels by testing irrigation wells. Check the local geological survey for direction of ground water flow to see what other sources are influencing the ground water. If government becomes involved, work with them to accumulate information on needs of your crops. It may be up to the nursery to educate the government agency on nitrogen usage. Nurseries provide an environmentally positive product, and with education and research the production of the products can be environmentally positive as well.

LITERATURE CITED

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