Minimizing nitrogen runoff and improving nitrogen use efficiency in containerized woody ornamentals through management of nitrate and ammonium-nitrogen

FREP Contract # 00-0509

Project Leader
Donald J. Merhaut
Dept. of Botany and Plant Sciences
University of California
Riverside, CA 92521

Objectives
1. Determine the fate of ammonium (NH_4^+) and nitrate (NO_3^-) from controlled release fertilizers (CRF) and liquid feed (LF) fertilizers in containerized woody ornamentals growing in acid (5.0) or neutral (7.0) pH media during a 12-month period.

2. Develop fertilization and irrigation guidelines for woody ornamental crop production that will minimize NO_3^- runoff and improve nitrogen use efficiency.

3. Disseminate guidelines to growers, fertilizer producers, consultants, farm advisors, educators and extension specialists involved in woody ornamental crop production.

Description
Horticulture is a 2.2 billion dollar industry in California. Over 70% of ornamental production is located in the coastal regions of Southern California, an area of the state where urban communities, agricultural developments and protected wetlands are in proximity to each other. Due to these geographical constraints, along with the high use of fertilizer and water by the industry, nitrate (NO_3^-) leaching from agricultural lands continues to threaten local drinking water supplies and the neighboring ecosystems.

Federal and state laws now prohibit excessive polluting of surface waters. Federally enforced laws are issued through the Clean Water Act of 1972 and state regulations are enforced through the state's Porter-Cologne Water Quality Act of 1969. Lawsuits have been pending in the regions of San Diego and the Central Coast. Unless fertilization and cultural practices are restructured, many nurseries will be unable to comply with the new water quality control programs that have been implemented in recent years.

In the following project, field trials are being conducted to determine the fate of different types of coated, controlled-release fertilizers (CRF) and liquid fertilizers (LF) as affected by acid pH (5.0) and neutral pH (7.0) media. The fate of nitrogen (N) in the crop is being determined by performing weekly measurements of nitrate in the leachates and monthly measurements of total N in the media and the plants. With this information, we will know the time period in the production cycle when N leaching is most likely and the time period when N uptake into plants is at its optimum. The information from this

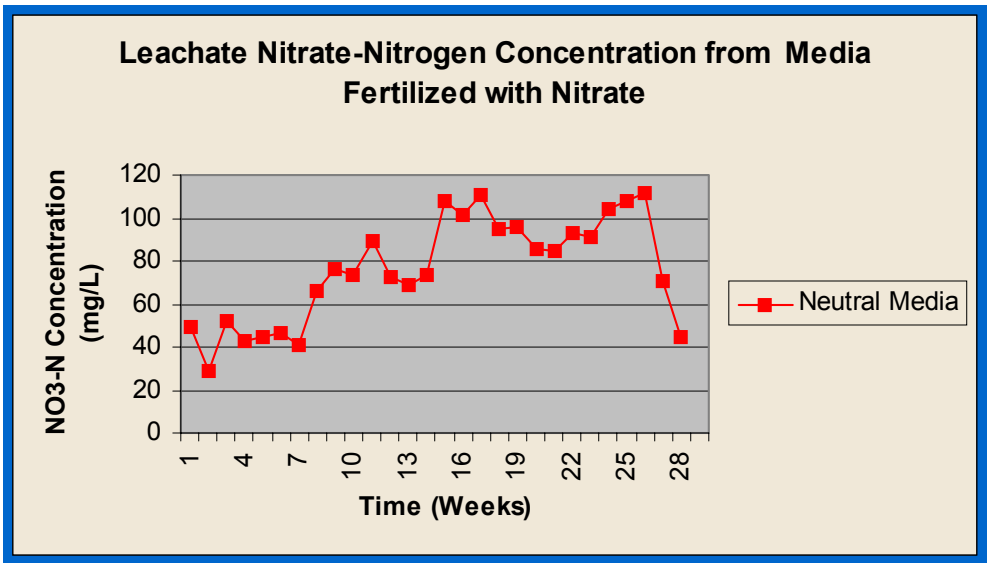
experiment will help us develop irrigation and fertilization programs that will minimize the likelihood of nitrate leaching and maximize nutrient uptake efficiency. This will not only help growers comply with new water quality regulations but also improve potential profits through more efficient use of water and fertilizer resources. These guidelines will be actively communicated to growers, CE advisors, consultants, the fertilizer industry, teachers and students through extension programs, workshops, seminars, and publications (newsletters, trade magazines and journals).

Research plots are set up at the Agricultural Experiment Station at the University of California at Riverside. A total of 910 plants, at the liner-stage, were obtained from commercial nurseries. Two different plant species are being used, one typically produced in acid pH media (Azalea 'Phoenicia') and one typically produced in neutral pH media (*Ligustrum japonicum*). Treatments are a 2 x 7 factorial of 2 different media pH (5.0 and 7.0) and seven different fertilizer treatments (Table 1). Substrates for the low pH-medium consists of a mixture of 2:1:1 volumes of composted pine bark, peat, and sand, respectively. The neutral pH-medium consists of 3:1 volumes of composted forest products and sand respectively. Lime was added to adjust pH. Micronutrients were added to all treatments at recommended rates. For treatments 1-3, the liquid fertilization (LF) is injected through the irrigation system. For treatments 4-7, one of four different 12-month CRF was incorporated into the planting media at the initiation of the study. Drippers are located in each container and irrigation is controlled electronically to water at specific time intervals, depending on crop water requirements.

Table 1. List of fertilizer treatments. Nitrate = NO_3 and ammonium = NH_4.

Treatment	**Fertilizer Rate**	**Fertilizer Type**
1	100 ppm N as 75% NH_4 and 25% NO_3	LF
2	100 ppm N as 50% NH_4 and 50% NO_3	LF
3	100 ppm N as 75% NO_3 and 25% NH_4	LF
4	3.0 lb N/yd^3	Osmocote CRF
5	3.0 lb N/yd^3	Polyon CRF
6	3.0 lb N/yd^3	Nutricote CRF

The first phase of this project has been completed and we are currently analyzing the data. We are also currently repeating the study. However, based on preliminary experiments, we have seen that the conversion of ammonium to nitrate may occur in planting media. In this preliminary trial, even though media was steam sterilized, the conversion of ammonium to nitrate in ammonium-fertilized containers became evident after 12 weeks of fertilization (Figure 1A and B). This data suggests that fertilization with fertilizers consisting of ammoniacal nitrogen may initially reduce the potential for nitrate leaching, but will eventually be converted to nitrate (nitrification) after a given time period. With the current trial being conducted, we will be able to determine the extent of the conversion of ammonium to nitrate and the extent of nitrate leaching from the different types of controlled release fertilizer and the different types of liquid fertilization regimes.



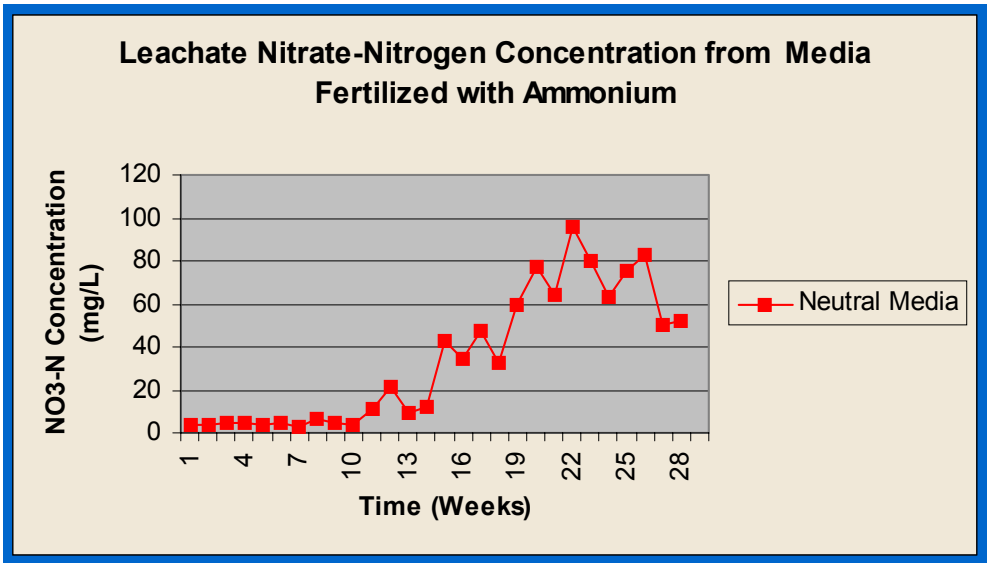


Figure 1. Nitrate concentrations in leachates collected from media fertigated with 100 mg N/L as (A) calcium nitrate or (B) ammonium sulfate. Fertilization trials began on January 17, 2001 (Week 1) and continued until August 6, 2001 (Week 29). Containers received fertigation via drippers every other day at a rate of 1000 ml/container/week.