Influence of source, rate, and method of applying controlled release fertilizer on nutrient release and growth of ‘Savannah’ holly

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Abstract

An experiment was conducted to determine the effect of rate of fertilizer application and method of application on the rate of nutrient release and growth of ‘Savannah’ holly (Ilex × attenuata Ashe) using three controlled release fertilizers. The controlled release fertilizers used were Osmocote 17N–3P–9.9K, Sierrablen 17N–3P–8.3K, and High-N 24N–1.7P–5.8K, all 12 to 14 month formulations. The three fertilizers had different release rates as determined by leachate nitrate-N and electrical conductivity (EC) measurements. Topdressing of fertilizer had the greatest release rate at seven days after treatment compared to fertilizer incorporation which had the lowest EC readings at 120 days after treatment. Fertilizer source had no effect on the shoot growth of ‘Savannah’ holly. Growth index and shoot dry weight of ‘Savannah’ holly increased linearly as N rate increased from 0.9 to 2.1 kg N m⁻³. A significant linear relationship (R² = 0.97, Nitrate-N = 409 (EC)) between nitrate-N and EC indicates that nitrate-N concentration can be estimated from EC readings when the pour-through method is used with multicoated controlled release fertilizers. The controlled release fertilizers used in this study provided adequate nutrient release rates for up to four months under outdoor nursery conditions during the months of June through October.

Producers of container-grown nursery stock are faced with water contamination problems due to high concentrations of nutrients in runoff water which result in the waste of fertilizer. Three commonly suggested methods of reducing fertilizer waste in runoff water include: 1) collection and/or recycling systems, 2) drip irrigation and 3) the use of controlled release fertilizers. While recycling may be an effective method of handling nutrient runoff, the method requires consistent monitoring of nutrient and pesticide concentrations and is considered too costly for most growers. Drip irrigation is useful for larger containers which are widely spaced in the nursery. However, most container-grown plants are in containers with volumes less than or equal to 3.8 liter, and overhead irrigation is currently the most practical method for watering smaller containers. Many nurseries worldwide utilize liquid fertilization programs via overhead irrigation [2, 4], but this method is less than 30% efficient in most production systems.

Controlled release fertilizers are used to reduce fertilizer application frequency and reduce fertilizer waste when compared to other fertilizer systems [3, 5]. Research has shown that the period of release for controlled release fertilizers may be less than that claimed by manufacturers [7, 9]. Multicoated controlled release fertilizers are manufactured in the Netherlands and the United States and are used by industry in Australia, Europe, Japan, and the United States.
(William Foster, personal communication). The effects of different multicoated controlled release fertilizers on plant growth and nutrient release under nursery production conditions and different environmental conditions are not known. This information is important for the development of nutritional guidelines for controlled release fertilizers when the pour-through method [10] of nutrient extraction is used. Therefore, an experiment was established to evaluate the influence of fertilizer source, rate, and method of application on nutrient release rate and growth of Ilex × attenuata Ashe ‘Savannah’.

Materials and methods

Uniform rooted cuttings of ‘Savannah’ holly were potted in 2.8 liter containers and treatments were applied on 7 June 1990 at the Coastal Plain Experiment Station in Tifton, Georgia. The potting medium consisted of milled pine bark and sand (4:1 by vol) amended with micronutrients (Micromax-Grace/Sierra, Milpitas, CA) at 0.9 kg m⁻³ and dolomitic limestone at 3.6 kg m⁻³. Plants were grown in factorial combinations (eight replications) of three fertilizers, three fertilizer rates, and two methods of fertilizer application. The fertilizers used were: 1) Osmocote 17N–3P–9.9K, 2) Sierrablen 17N–3P–8.3K, and 3) High-N 24N–1.7P–5.8K (Grace/Sierra). All fertilizers were listed as 12 to 14 month release formulations at 21 °C. Fertilizer rates used in this study were 0.9, 1.5, and 2.1 kg N m⁻³ of potting medium. The two methods of fertilizer application were incorporation into the potting medium and topdressing of individual containers.

Plants were irrigated twice daily at 1.3 cm water per irrigation using solid set sprinklers. At 7, 30, 60, 90, and 120 days after treatment, the pour-through method [10] was used to collect leachate from four replications of container media. Electrical conductivity and pH of the leachate samples were determined using conductivity and pH meters, respectively. Nitrate–N (NO₃⁻) was determined with an ion specific electrode. Shoot dry weight, growth index ((Height × Width 1 × Width 2)/300), and a root rating (1 = 0 to 20%, 2 = 21 to 40%, 3 = 41 to 60%, 4 = 61 to 80%, and 5 = 81 to 100% of the rootball covered with white roots) were measured at the termination of the experiment, 5 Nov 1990. Data for leachate analysis and growth parameters were evaluated by analysis of variance using SAS (SAS Institute, Cary, NC).

Results and discussion

There was an interaction between fertilizer source, rate, and method of application and days after treatment for nitrate–N (Figs. 1 and 2). Except for Osmocote at the 0.9 and 1.5 kg N m⁻³ rates, topdressing (Fig. 1) resulted in greater nitrate–N values at day seven compared to incorporation (Fig. 2). By day after treatment 60, all topdressed treatments had lower nitrate–N values compared to the incorporated treatments. When using the pour-through method, Wright [10] reported N concentrations in the range of 50 to 100 mg l⁻¹ to be associated with the vigorous growth of many nursery crops. Except for the 0.9 kg N m⁻³ rate, all three fertilizer sources had nitrate–N concentrations above 50 mg l⁻¹ at 90 days after treatment for both methods of fertilizer application. By day after treatment 120, nitrate–N concentrations for all incorporated treatments were less than 50 mg l⁻¹. There was a significant interaction between rate and days after treatment for nitrate–N concentration. Nitrate–N concentrations were below 50 mg l⁻¹ at days after treatment 90 and 120 for the 0.9 kg N m⁻³ rate and 120 for the 1.5 kg N m⁻³ rate.

Osmocote is a homogeneous fertilizer which contains resin coated N–P–K in every prill (William Foster, private communication). Sierrablen is similar to Osmocote except that 20% of the fertilizer product is uncoated. Mean nitrate–N values with Sierrablen were approximately 72% that of Osmocote (data not shown). High-N is a heterogeneous blend of several resin coated fertilizers and approximately 30% of its formulation is controlled release urea. Mean nitrate–N and EC values for the High-N fertilizer were lower compared to Osmocote and Sierrablen because urea does not increase the EC of container media until hydrolyzed. Since 50% of the N in High-N is coated urea nitrogen, conversion of urea to ammonium and to nitrate through nitrifi-