Fertilizer Requirements for Container-grown *Buxus* spp.[1]

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Abstract

The objective of this study was to determine the nutritional requirements for container-grown boxwood and to determine if summer dormancy of boxwood can be removed via nutrition. *Buxus sempervirens* L. 'Suffruticosa', *B. sempervirens* L. 'Vardar Valley', and *B. sinica* var. *insularis* Nakai 'Justin Brouwers' were used for these studies. Various levels of Osmocote 15N–3.9P–9.8K (15N–9P_2O_5–12K_2O) and a 10N–1.7P–4.9K (10–4–6) liquid fertilizer were applied to boxwood in a pine-bark substrate. Maximum shoot dry weight (OSDW) was achieved at 12 to 16 g (.42 to .56 oz) Osmocote per 3 liter (#1) container and 100 to125 ppm N from the liquid fertilizer. Leachate EC corresponding to OSDW ranged from 0.5 to 0.7 dS/m and 0.7 to 1.5 dS/m for Osmocote and the liquid fertilizer, respectively. Leaf tissue N levels corresponding to OSDW weight ranged from 3.1 to 4.3% for Osmocote and 5.0 to 5.5% for the liquid fertilizer. While the fertilizer requirements for boxwood OSDW were determined, additional growth flushes did not occur.

Index words: container-grown, nutrition, nursery crops, woody ornamentals.

Species used in this study: *Buxus sempervirens* L. 'Suffruticosa', *B. sempervirens* L. 'Vardar Valley', and *B. sinica* var. *insularis* Nakai 'Justin Brouwers'.

Significance to the Nursery Industry

Boxwood is becoming more popular as a landscape plant due to the introduction of new cultivars with different growth habits and foliage textures. In addition, boxwood is relatively resistant to deer browsing, making it very desirable as a foundation plant for landscapes where deer populations are high. Results from this study will provide growers with nutritional guidelines for producing boxwood in containers with either controlled-release or liquid fertilizers.

Introduction

Boxwood typically produces a single episode (flush) of growth in the spring. The plant remains dormant for the rest of the year, producing only slight, erratic growth at best. Dormancy is defined as 'a temporary suspension of visible growth in any plant structure containing a meristem' (6). When that dormancy is due to a stimulus from outside the plant (such as temperature, moisture, nutrient availability), it is considered ecodormancy (6). Some plant species like *Ilex crenata* Thunb. 'Helleri' produce only one flush of growth in natural landscape settings; however, when given optimal fertility and water, multiple flushes can be induced (17). Whether multiple flushes can be induced with boxwood given optimal nutrition and irrigation is questionable.

In fact, definitive nutrition studies with boxwood are limited. Bilderback and Cartwright (1) found that of several slow-release fertilizers applied to two different media in a single application, Osmocote incorporated into composted hardwood bark:sand (2:1 by vol) media at 4.1 kg/cu m was most effective in encouraging growth of Japanese boxwood (*Buxus microphylla* Sieb. & Zucc. var. *japonica*). Dickey (3) performed an experiment that examined the effect of nitrogen application levels and two fertilization intervals on the growth and chemical composition of Japanese boxwood. The rooted cuttings grown in a peat moss/sand media that were fertilized twice a month had a higher number of bud breaks and were of higher visual quality than those fertilized at the same rate once a month. In addition, it was found that the number of bud breaks increased as nitrogen levels increased from 556 to 1116 kg/ha per year. Huett (5) conducted a study in which five plant species, including *B. sempervirens*, were grown in a pine bark:hardwood sawdust:sand (5:3:2 by vol) substrate, and received fertilizer treatments of Osmocote 19–12–10, Nutricote NPK 16–16–24, Dynamic Lifter 3–10–6, and a liquid fertilizer that consisted of a carnation formulation developed by the author. The liquid fertilizer treatment produced the highest growth rates and was applied at an electrical conductivity (EC) of 2.0 dS/m every six hours through a trickle irrigation line. Even with these studies, adequate information on the fertilizer requirement of boxwood does not exist. Therefore, the purpose of this research was to establish the minimum levels of slow-release and liquid fertilizer to produce maximum growth of boxwood.

Materials and Methods

Osmocote rate. Rooted cuttings, 10 cm high (3.9 in) of *B. sempervirens* L. 'Suffruticosa', *B. sempervirens* L.'Vardar Valley' and *B. sinica* var. *insularis* Nakai 'Justin Brouwers' were potted March 2, 2000, 1 per pot, into 3-liter (#1) black plastic containers using a pine bark media amended per cu m (cu yd) with 3.6 kg (6 lb) dolomitic limestone and 0.9 kg (1.5 lb) Micromax (Scotts Sierra Hort. Products, Co., Marysville, OH). Osmocote (15N–3.9P–9.8K) 15N–9P_2O_5–12K_2O (Scotts-Sierra Hort. Products, Co., Marysville, OH) was surface applied March 8, 2000, at 0, 2, 4, 8, 12, 16, 20, or 24 g (0, 0.07, 0.14, 0.28, 0.42, 0.56, 0.71, 0.85 oz)/pot. Plants were grown for 35 weeks under natural photoperiod and day/night temperature of approximately 26/21C (79/70F). There were 8 replications per treatment for *B. sinica* var. *insularis* 'Justin Brouwers' and *B. sempervirens* 'Vardar Valley' and 11 replications per treatment for *B. sempervirens* 'Suffruticosa'

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(English boxwood). Treatments were completely randomized by cultivar. The plants were hand irrigated as needed. At 24 weeks following treatment initiation, nutrients were extracted by the pour-through method (16) from 6 sub-samples of English boxwood per treatment. Solutions were analyzed for EC, ammonium-N, nitrate-N, P, K, and pH. Nitrogen was determined by colorimetric flow injection analysis, and P and K were determined by inductively coupled plasma (ICP) spectrometry. The experiment was terminated 35 weeks after treatment initiation, and at this time, approximately 2.0 g (0.07 oz) of uppermost mature leaf tissue and all remaining shoot growth was removed from each plant and dried to a constant weight at 65C (150F) and weighed. Leaf tissue was ground in a 40-mesh Cyclone Sample Mill (U.D. Corp., Boulder, CO) and weighed. Tissue was digested as described by the Kjeldahl-Block Digestor Method (11) and analyzed for total nitrogen by colorimetric flow injection analysis. All data were submitted to regression analysis (SigmaPlot for Windows, Version 5.0, SPSS, Chicago, IL). Electrical conductivity, NO_3-N, NH_4-N, P, K and pH in leachate data and N in leaf tissue data were transformed using a natural log transformation (13).

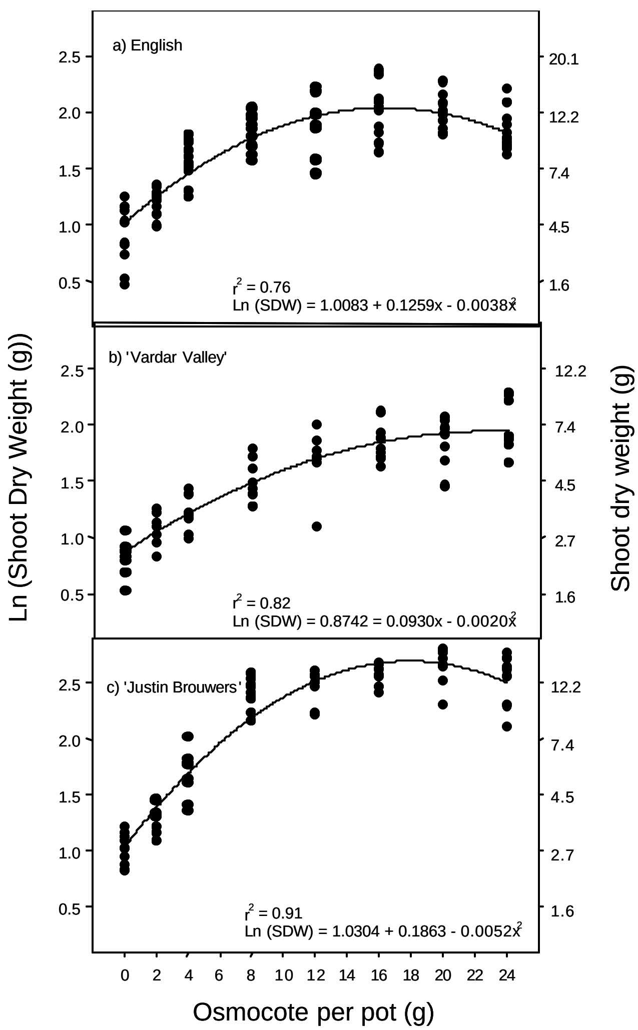

Fig. 1. **Influence of Osmocote application rate on shoot dry weight (SDW) of a) English, b) 'Vardar Valley,' and c) 'Justin Brouwers' boxwood 35 weeks following treatment initiation ($p < 0.0001$).**

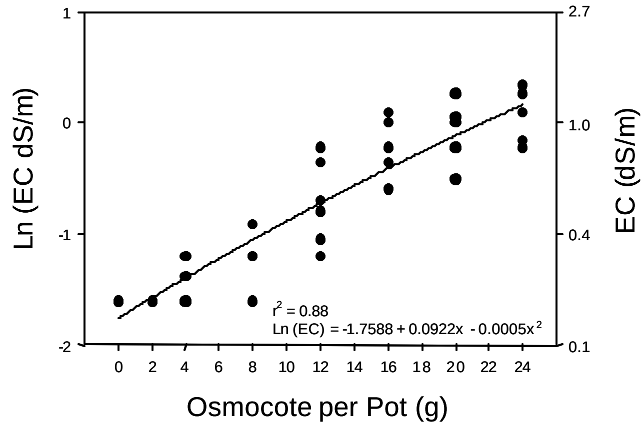

Fig. 2. **Influence of Osmocote application rate on electrical conductivity (EC) in leachate collected from 'Vardar Valley' boxwood 24 weeks following treatment initiation ($p < 0.0001$).**

Liquid fertilizer rate. Liter (1 qt) sized liners of *B. sinica* var. *insularis* 'Justin Brouwers' were potted on March 22, 2001, one per pot, into 3 liter (#1) black plastic containers with a pine bark media amended per cu m (cu yd) with 3.6 kg (6 lb) dolomitic limestone and 0.9 kg (1.5 lb) Micromax. A 10N–1.7P–4.9K (10N–$4P_2O_5$–$6K_2O$) liquid fertilizer was applied with each irrigation [250 ml (8.5 oz)/pot] at a rate of either 0, 25, 50, 75, 100, 125, or 150 ppm N. Nitrogen was applied as NH_4NO_3, P as H_2PO_4, and K as KCl. Treatments were assigned in a completely randomized design with four replications per treatment and two plants per experimental unit beginning March 29, 2001, and continued for 28 weeks under natural photoperiod and day/night temperatures of approximately 26/21C (79/70F). At 16 weeks following treatment initiation, nutrients were extracted via the pour-through method (described above). Leachate was filtered and analyzed for electrical conductivity, NO_3-N, NH_4-N, P, K, and pH as above. At week 28 total shoot dry weights were recorded and leaf tissue was prepared and analyzed for N, P, and K as above. All data were analyzed as above. Electrical conductivity, NO_3-N, NH_4-N, P, and K in leachate data, and pH data were transformed using a natural log transformation (13).

Results and Discussion

Osmocote rate. Despite an increase in shoot dry weight in response to increasing fertilizer levels (Fig. 1), no budbreak or shoot growth and elongation was visible following the first spring flush for English boxwood and 'Vardar Valley'. However, at higher fertility levels 'Justin Brouwers' continued to exhibit budbreak and shoot elongation throughout the length of the experiment indicating this species does not exhibit summer 'dormancy' when grown at optimal fertility. The three cultivars reached optimal shoot dry weight at Osmocote 15–9–12 applications of 12 to 16 g (0.42 to 0.56 oz) per 3 liter (#1) pot. This range is consistent with the manufacturer's recommendation for nursery stock, 12 to 21 g (0.42 to 0.74 oz) per 3 liter (#1) pot.

As testing substrate leachate for EC and nitrate-N levels is frequently done to assess nutrient availability, the leachate and plant tissue analysis from these experiments can provide guidance to commercial growers in assessing the nutrient status of container-produced boxwood. Leachate EC levels

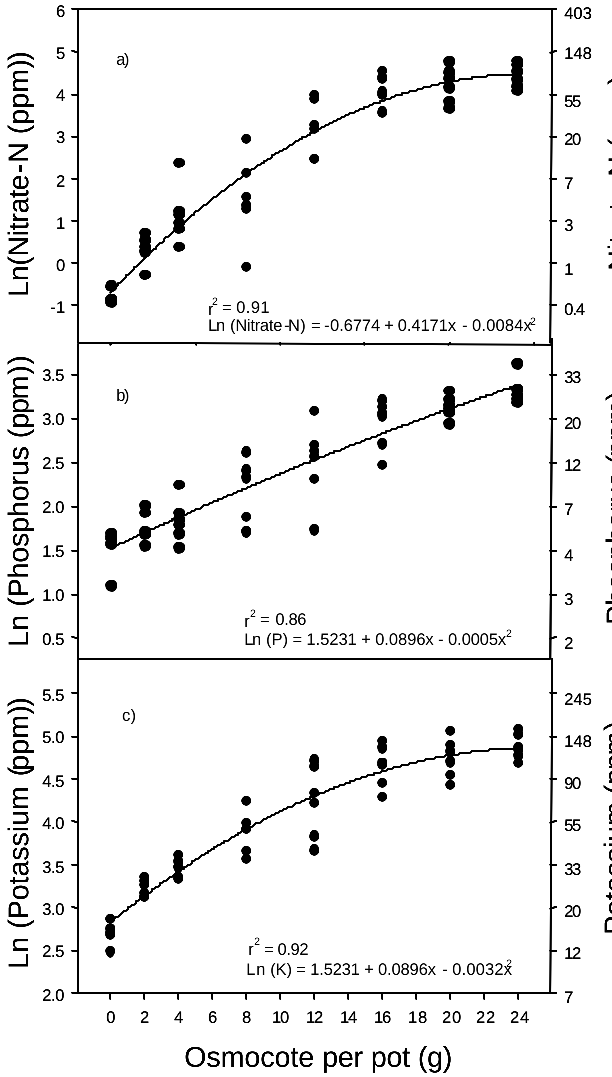

Fig. 3. Influence of Osmocote application rate on a) nitrate-N, b) phosphorus, and c) potassium in leachate collected 24 weeks following treatment initiation from 'Vardar Valley' boxwood ($p < 0.0001$).

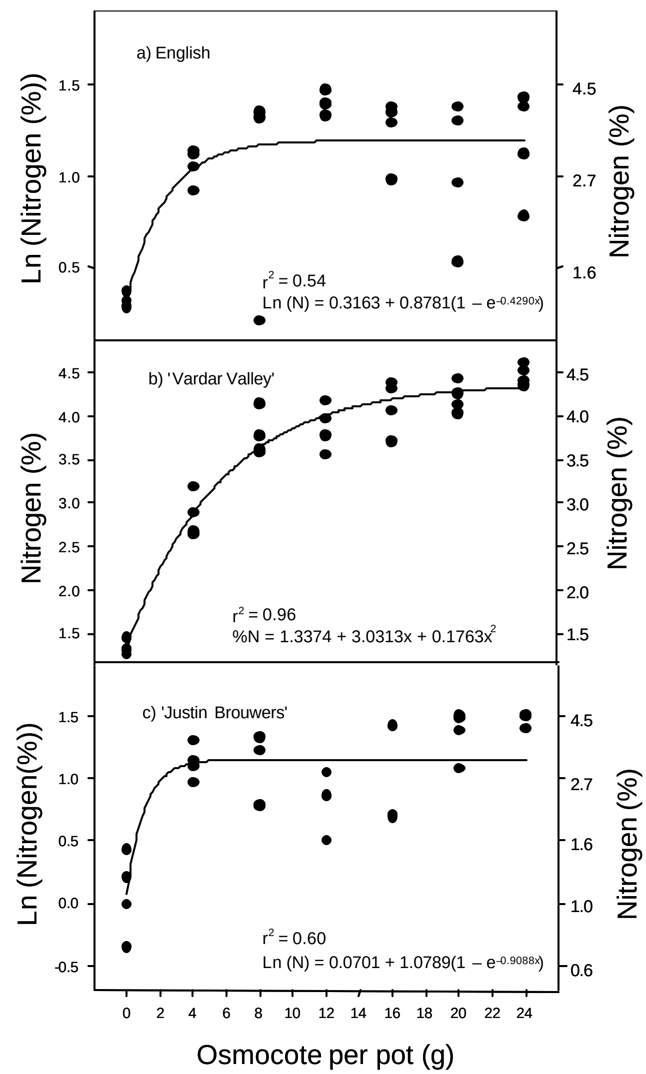

Fig. 4. Influence of Osmocote application rate on nitrogen level in leaf tissue samples collected 35 weeks following treatment initiation from a) English, b) 'Vardar Valley,' and c) 'Justin Brouwers' boxwood ($p < 0.0001$).

corresponding to optimal shoot dry weight (12 to 16 g Osmocote) ranged between 0.5 to 0.7 dS/m (Fig. 2). These EC levels are lower than the EC level of 2.0 dS/m used by Huett (5), but consistent with other broad leaf evergreens such as *I. crenata* 'Helleri' which has been shown to require reapplications of liquid fertilizer when EC values fell below 0.5 to 1.0 dS/m (12). Nutrient levels in leachate corresponding to optimal shoot dry weight were 20 to 50 ppm NO_3-N (Fig. 3a), 1.1 to 2.2 ppm NH_4-N (data not shown), 12 to 15 ppm P, and 70 to 100 ppm K, (Fig. 3b and 3c, respectively).

Nutrient status of containerized plants may also be assessed based on plant tissue analysis. Leaf tissue nitrogen levels for the three cultivars corresponding to optimal shoot dry weight spanned from 3.1 to 4.3% (Fig. 4). *I. crenata* 'Helleri' showed optimal growth correlated with shoot dry weight at 2.3% N in leaf tissue by Schiflett et al. (12) and at 2.4% N by Wright and Niemiera (15). *Rhododendron* L. 'Fashion' has a survey range of 1.37 to 1.81% N in leaf tissue, and *Pyracantha koidzumii* (Hayata) Rehd. has a survey average of 2.2% N in leaf tissue (8). It appears that the tissue N levels for optimal growth (dry weight accumulation) seem to be higher than for other woody ornamental species.

Liquid fertilizer rate. Optimal shoot dry weight of 'Justin Brouwers' was reached by fertigating at 100 to 150 ppm N (Fig. 5a). These liquid fertilizer application levels are slightly higher than those that produce optimal growth of many woody ornamentals. *Ilex crenata* 'Helleri' produced maximum shoot dry weight in sand culture at 75 to 100 ppm N (9) and in pine bark media: sand (9:1 v:v) substrate, optimal growth occurred at 50 to 100 ppm N (12).

Electrical conductivity levels from media leachate corresponding to optimal shoot dry weight ranged from 0.7 to 1.5 dS/m (Fig. 5b). The higher EC levels for optimal growth in this case compared to the Oscomote experiment 1 are consistent with Catanazaro's (2) results that leachate EC was lower in a peat-based media fertilized with two slow-release fertilizers (14N–1.7P–4.9K tablet and 12N–4.3P–14.1K resin-coated) than in the same media fertilized with two liquid fertilizers (15N–4.3P–24.9K alternating with tap water irriga-

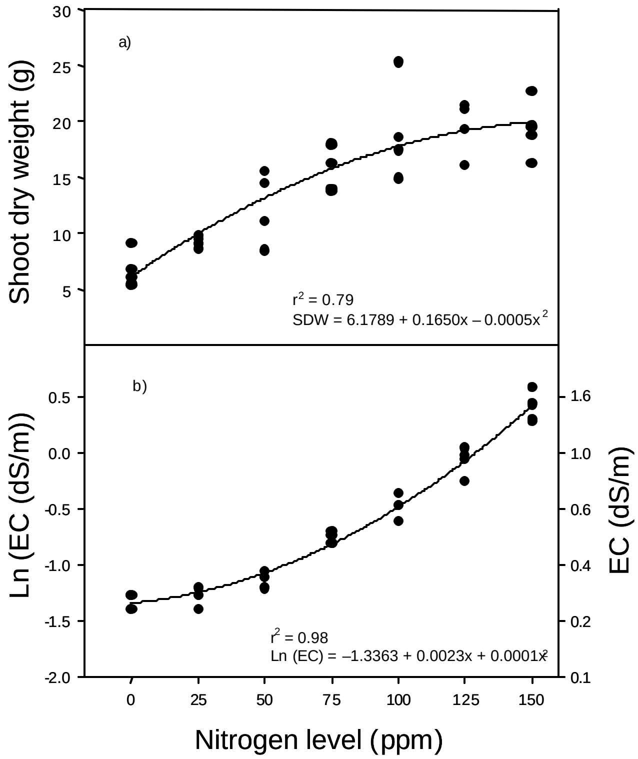

Fig. 5. Influence of fertilizer level as ppm N in irrigation water on a) shoot dry weight determined 28 weeks following treatment initiation and on b) electrical conductivity (EC) in leachate collected 16 weeks following treatment initiation from 'Justin Brouwers' boxwood ($p < 0.0001$).

tion and 15N–4.3P–24.9K applied with each irrigation). Leachate nutrient levels corresponding to optimal shoot dry weight ranged from 32 to 105 ppm NO_3-N, 11 to 16 ppm P, and 68 to 132 ppm K (Fig. 6a, 6b and 6c, respectively).

Ammonium-N levels in substrate leachate corresponding to optimal shoot dry weight were considerably lower than NO_3-N levels at 1 to 4 ppm (data not shown, $r^2 = 0.84$, $y = –1.4354 + 0.0076x + 0.0001x^2$). The media for the two experiments was amended with lime, and, as nitrification occurs more rapidly at alkaline pH (4, 10, 14), it is logical that higher amounts of NO_3-N were available than NH_4-N. In the liquid fertilizer experiment, leachate collected from 'Justin Brouwers' boxwood had pH ranging from 7.4 at the lowest fertilizer application levels to 6.4 at the highest fertilizer application levels (data not shown).

Leaf tissue nutrient levels corresponding to the 100 to 150 ppm application level had N at 5 to 5.5%, P at 0.48 to 0.57%, and K at 0.8 to 1.4% (Fig. 7). These tissue N levels are higher than those from the previous experiment and also double those of other nursery crops like *I. crenata* 'Helleri' (9, 12). One possible explanation for this result is that boxwood grows much slower (less usable shoot elongation and expansion) than other woody nursery crops, resulting in less dilution of absorbed nutrients.

Leachate EC, NO_3-N, NH_4-N, P, K, and leaf tissue N levels as associated with optimal plant growth were lower for plants receiving Osmocote than plants receiving liquid fertilizer. This difference in nutrient level may be a result of the fact that controlled-release fertilizers such as Osmocote deliver nutrients to the substrate on a continuous basis, and thus

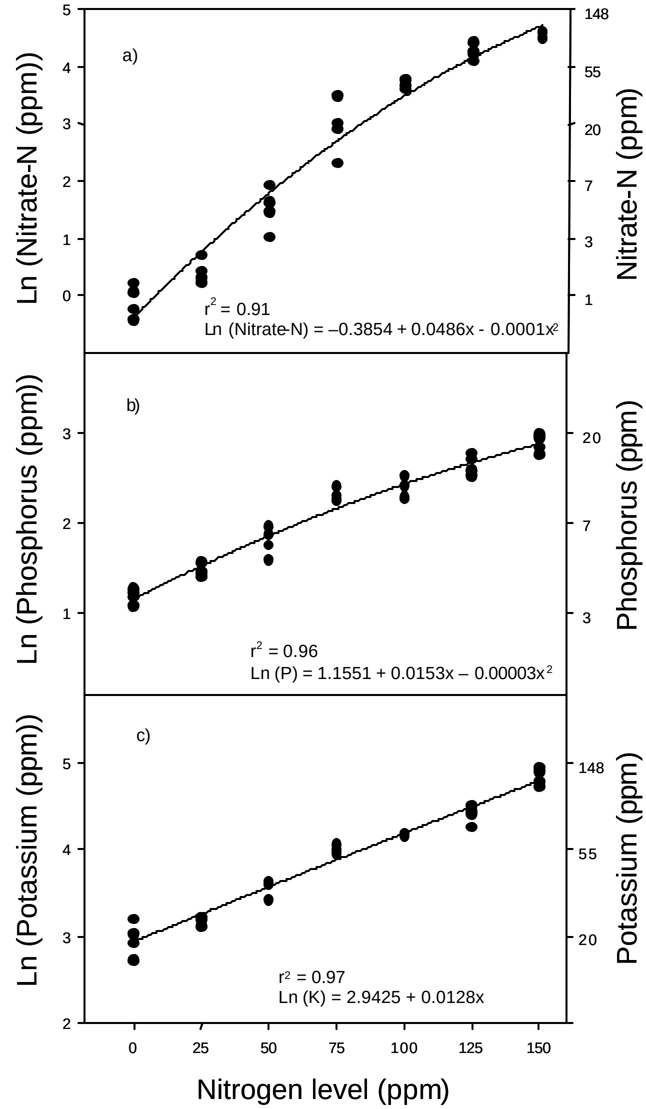

Fig. 6. Influence of fertilizer level as ppm N in irrigation water on a) nitrate-N, b) phosphorus, and c) potassium in leachate collected 16 weeks following treatment initiation from 'Justin Brouwers' boxwood ($p < 0.0001$).

a relatively low nutrient level in substrate solution is sufficient to induce optimal growth. As nutrients provided by liquid fertilizers are applied periodically, a relatively high level of nutrients is required in substrate solution to prevent depletion of nutrients between fertilizer applications. As nutrients in substrate solution from an Osmocote source may be maintained at lower levels relative to those from a liquid fertilizer source, Osmocote may be a preferable nutrient source to liquid fertilizer in terms of limiting environmental contamination from nitrate leaching.

This research demonstrates that *B. sinica* var. *insularis* 'Justin Brouwers' does not appear to exhibit characteristics of summer 'dormancy,' and that summer 'dormancy' of *B. sempervirens* 'Suffruticosa' and *B. sempervirens* 'Vardar Valley' is not related to fertility regime. These findings indicate that *B. sempervirens*, and likely other boxwood cultivars that produce only one growth flush each year, are not nutritionally ecodormant because, despite providing plants with the appropriate nutritional environment, they did not

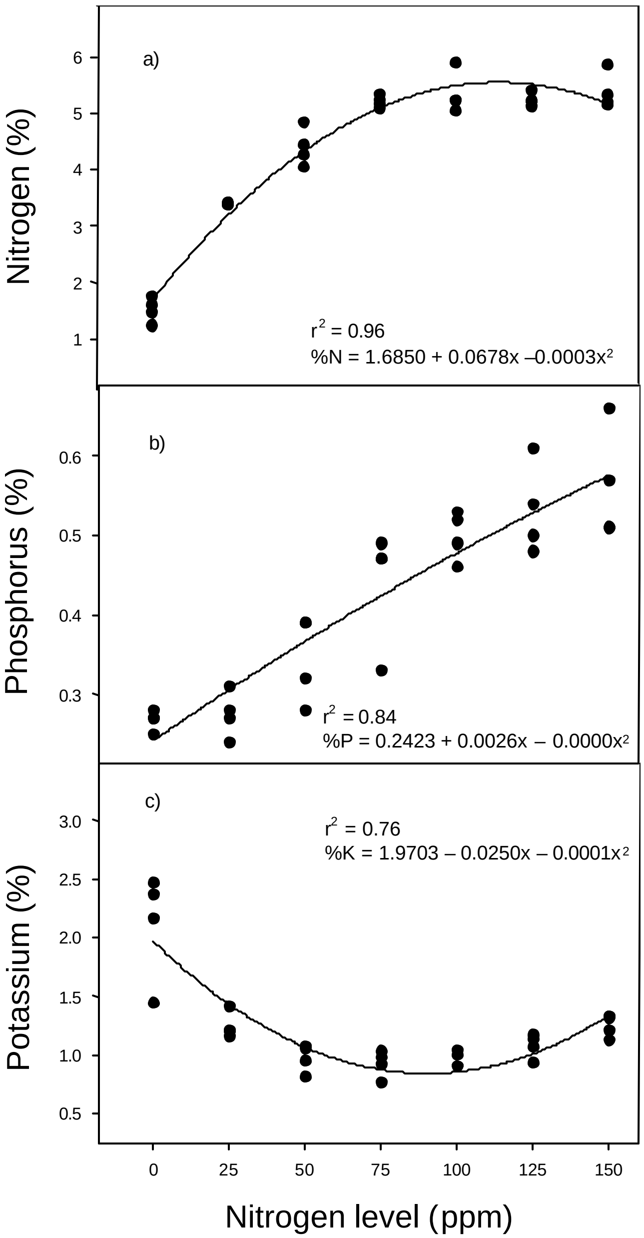

Fig. 7. Influence of fertilizer level as ppm N in irrigation water on a) nitrogen, b) phosphorus, and c) potassium in leaf tissue collected 28 weeks following treatment initiation from 'Justin Brouwers' boxwood ($p < 0.0001$).

produce additional growth flushes. However, despite a lack of subsequent shoot elongation and budbreak from *B. sempervirens*, commercial growers may use the results of this work to assess the nutrient status of boxwood in order to ensure optimal growth (dry mass accumulation) during the current year and promote a more vigorous flush the following spring (7). Furthermore, by providing plants with appropriate but not excessive fertility regime, nursery-induced environmental contamination may be reduced, higher quality plants can be produced, and greater profits may result.

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