HortScience 19(1):127–129. 1984.

Effects of Supplemental N on Plant Growth in Fresh and Aged Pine Bark

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Additional index words. *Euonymus japonica* 'Microphylla', *Ilex crenata* 'Compacta', dwarf Japanese euonymus, Japanese holly, nutrition, growing media

Abstract. **Dwarf Japanese euonymus (*Euonymus japonica* Thunb. 'Microphylla') and Japanese holly (*Ilex crenata* Thunb. 'Compacta'), grown in fresh or aged (1 year) pine bark amended with a slow-release complete fertilizer, were supplied with NH_4NO_3 weekly at 0, 100, 200, or 300 ppm N. Plant growth, foliar color, leaf tissue N, and leachate soluble salts increased with increasing levels of supplemental N while tissue K, Ca, and Mg decreased. Plant growth, foliar color, and leaf tissue N, P, Ca, and Mg in fresh pine bark equaled or exceeded that in aged pine bark at all levels of supplemental N. Leachate soluble salts, pH, and leaf tissue K was higher in aged pine bark.**

Pine bark is a common growing medium or medium component for container-grown ornamentals. Many growers use aged or composted bark because poor plant growth has been observed in fresh softwood bark (7, 9). Allison (2) suggested that the basis for poor plant growth in fresh bark is an unfavorable C/N ratio that requires supplemental N to supply microbial and plant needs. Plants are poor competitors with microflora when the inorganic N level is inadequate for optimal development (1). Nitrogen limitations on plant growth are even more likely to occur when hardwood barks are utilized (3) due to a higher C/N ratio and more rapid decomposition compared to softwood barks (2). Other potential causes of poor growth in fresh pine bark are phytotoxins or pathogenic organisms that may be leached or destroyed with aging (6). Phytotoxicity has been demonstrated with hardwood barks (10) and with some softwood barks (2, 6); however, *Pinus taeda* L. and *P. elliottii* Engelm. barks have been reported to be nonphytotoxic (2). Limited research supports the use of fresh instead of aged pine bark when adequate N is supplied (8), although plant response varied with species (5). This study was initiated to evaluate effects of supplemental N on growth of selected woody ornamentals in fresh and aged pine bark.

Fresh pine bark from *P. taeda* and *P. elliottii*, milled through a 25.4-mm screen, was obtained from a local supplier and aged in an unprotected outdoor location. Fresh bark from the same species was obtained one year later. Both aged and fresh barks were hammermilled through a 19-mm screen and amended with dolomitic limestone (5.9 kg m^{-3}), ordinary superphosphate (1.2 kg m^{-3}), gypsum (1.2 kg m^{-3}), Micromax (0.9 kg m^{-3}), and Osmocote 17N–3P–10K (12- to 14-month formulation; 5.9 kg m^{-3}). Barks were moistened during mixing; no wetting agent was added.

Bulk densities were calculated from weights of oven-dried (105°C for 24 hr) volumes of unamended bark (Table 1). Particle size distributions for the 2 bark media were obtained by sieving 50 cc of air-dried bark for 20 min with a Ro-tap shaker (W.S. Tyler, Inc., Mentor, OH 44060). Carbon and total N of bark samples were determined with a carbon analyzer (LECO WR 12 Carbon Determinator, Leco Corp., St. Joseph, MI 49085) and the micro-Kjeldahl procedure.

Uniform *Euonymus japonica* 'Microphylla' and *Ilex crenata* 'Compacta' liners (8-cm height) were planted one to a 3-liter plastic container on 25 Aug. 1981 and grown in full sun. Irrigation was provided as needed by overhead impulse sprinklers. Treatments included fresh or aged pine bark irrigated weekly with NH_4NO_3 solutions at 0, 100, 200, and 300 ppm N. The factorial experiment was arranged in a completely randomized design with 4 replicates of 4 plants each within each species.

Foliar color ratings and growth indices (height + width/2) were determined after 3 months. The most recently matured leaves were analyzed for N, P, K, Mg, and Ca using the double-acid extraction procedure. Total N was determined by a modified micro-Kjeldahl method. Potassium, Mg, and Ca were determined spectrophotometrically and P colorimetrically. After sampling of tissue, plants were severed at the soil line, dried at 80°C for 72 hr, and weighed.

Growing medium samples were analyzed at the same time for NO_3-N, P, K, Mg, and Ca, using the double-acid extraction procedure. Medium NO_3-N was determined by the phenoldisulfonic acid method, and P, K, Mg, and Ca as described previously. Pine bark leachates were collected just prior to liquid fertilization by applying 250 ml of deionized water to the surface of each container medium and collecting the leachate for 10 minutes. Leachates were analyzed for soluble salts and pH. Data were subjected to statistical analysis using an analysis of variance (ANOVA) and regression.

Table 1. Particle size distribution (retained by screen), bulk density, and C/N ratio of fresh and aged pine bark.

N.B.S.[z] screen no.	Opening (mm)	Particle size distribution (% by wt) Fresh bark	Aged bark
4	4.76	37.1	20.8
8	2.38	20.9	20.7
10	2.00	7.0	6.5
18	1.00	17.3	17.7
20	0.84	4.1	4.4
30	0.60	5.3	7.1
40	0.42	3.5	6.2
Pan	0.42	4.8	16.6
Bulk density (g/cc)		0.30	0.31
C/N ratio		274	265

[z]National Bureau of Standards.

Due to similar response by species, only data for euonymus are presented. Growth indices, shoot dry weights, and plant quality as indicated by foliar color rating increased with increasing levels of supplemental N (Fig. 1). Growth indices, shoot dry weights, and foliar color ratings at all supplemental N levels, except foliar color at 200 and 300 ppm, were higher in fresh bark compared to aged. The increase in shoot growth as rate of supplemental N increased suggests that the rate of supplemental N necessary for optimal growth with this fertilizer regime was at least 300 ppm N weekly.

Equal or better plant growth index and dry weight in fresh bark compared to aged, even without supplemental N, suggests a low demand by microorganisms in both barks. Pokorny (8) reported that 0.15 kg N m^{-3} was adequate to meet the needs of microorganisms in a pine bark medium. In our study, Osmocote (17N–3P–10K), was incorporated at the rate of 1.0 kg N m^{-3} prior to planting. Excellent growth in fresh pine bark contrasts with the findings of Laiche (5) who observed lower plant quality in fresh bark with *Juniperus, Pyracantha*, and 2 *Ilex* spp. He attributed the lower quality to difficulty in maintaining adequate moisture levels, especially during the first 2–3 months after transplanting. While no difficulty was encountered in wetting the fresh pine bark medium in our study, this does emphasize the importance of thoroughly wetting the growing medium prior to planting, possibly with the aid of a chemical wetting agent. No symptoms of phytotoxicity were observed on plants in fresh or aged pine barks.

Received for publication 14 June 1983. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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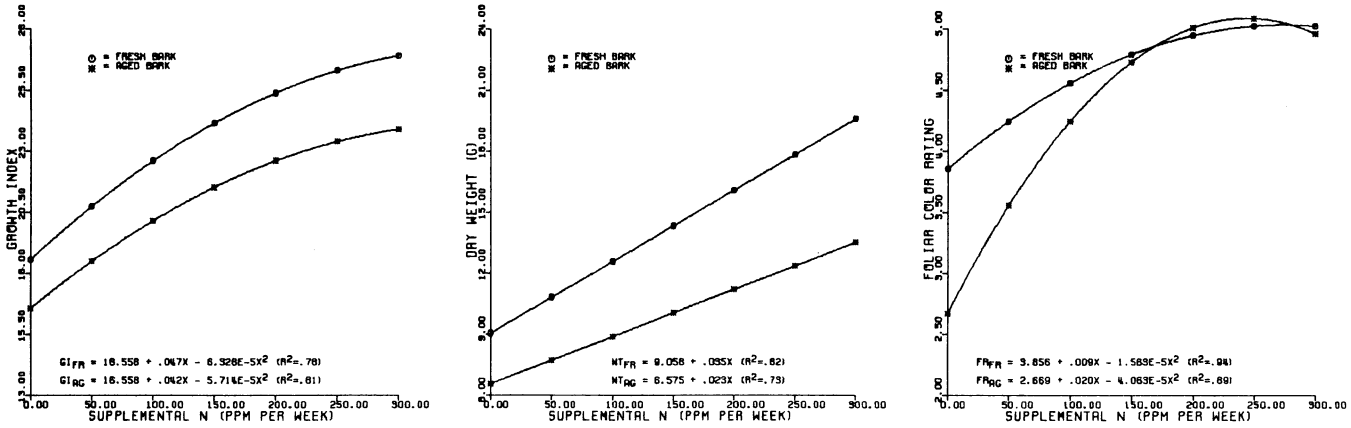

Fig. 1. Growth index (width + height/2), dry weight, and foliar color rating (1 = chlorotic, 5 = dark green) for euonymus grown in fresh and aged pine barks with different rates of supplemental N.

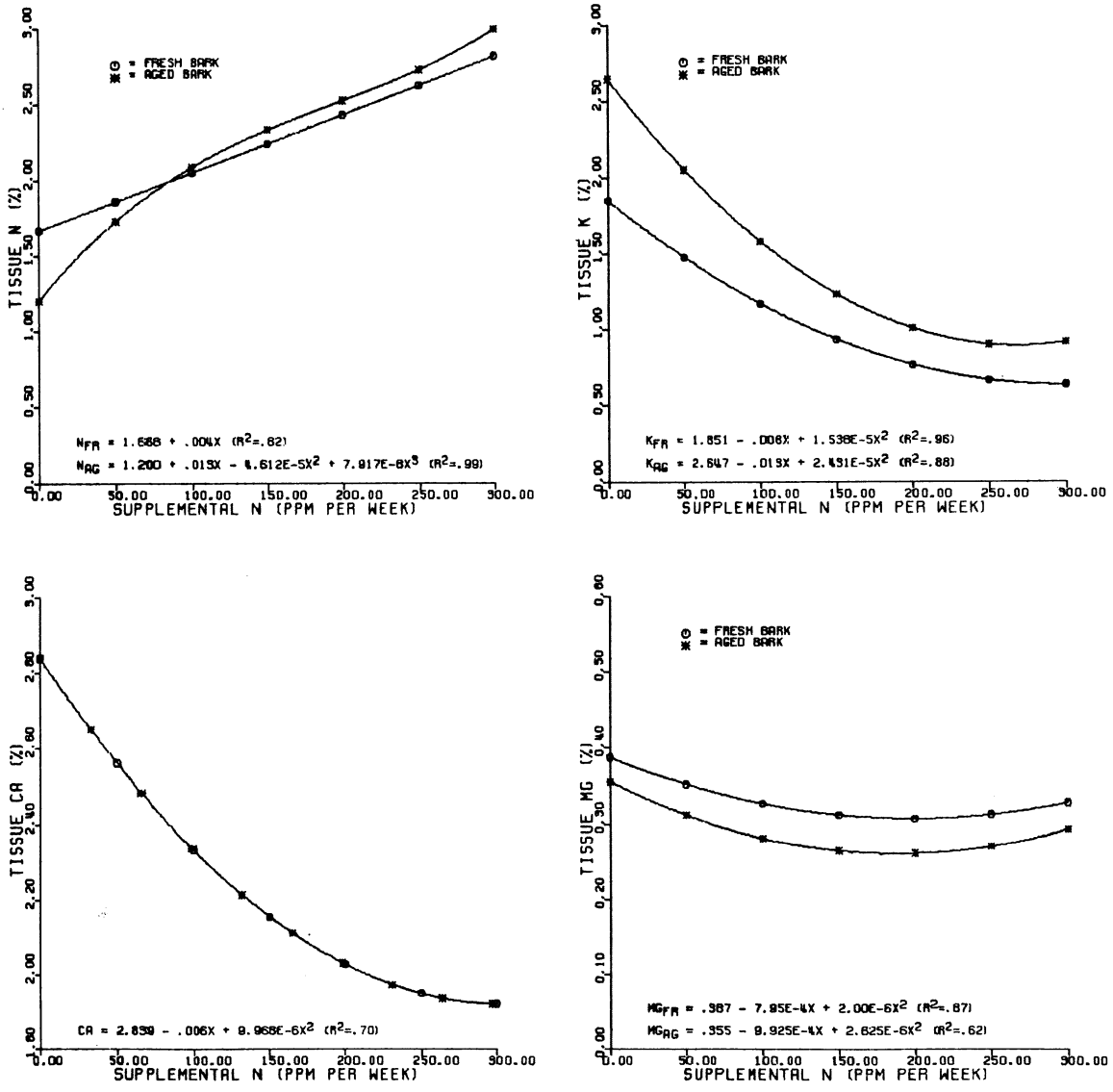

Fig. 2. Leaf tissue N, K, Ca, and Mg levels of euonymus grown in fresh and aged pine barks with different rates of supplemental N.

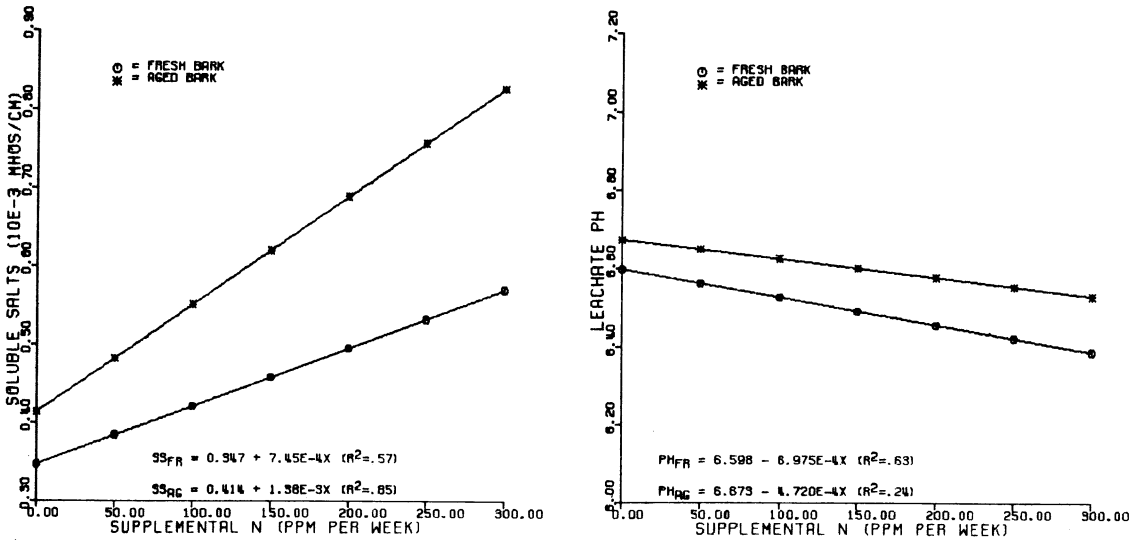

Fig. 3. Medium leachate soluble salts and pH for euonymus grown in fresh and aged pine barks with different rates of supplemental N.

Leaf tissue N increased with increasing levels of supplemental N for euonymus grown in both barks; N was greater in fresh bark only at the 0 supplemental N level (Fig. 2). Leaf tissue K, Ca, and Mg decreased with increasing levels of supplemental N and tissue N for both ages of bark, which may have resulted from growth dilution as the leaves increased in dry weight (4). K was higher in aged bark compared to fresh while Mg was lower in aged bark. These differences in K and Mg levels between fresh and aged barks may reflect plant growth or element availability differences in the 2 bark ages. Calcium did not differ between bark ages. Tissue P decreased as supplemental N fertilization increased from 0 ppm (0.30% P) to 300 ppm (0.19% P), but did not differ between bark ages.

Medium leachate soluble salts from euonymus increased with increasing levels of supplemental N and were higher with aged bark (Fig. 3). Leachate pH values decreased with increasing levels of supplemental N and were higher with aged bark compared to fresh.

Higher levels of Mg were found in samples of aged bark (396 ppm) compared to fresh (347 ppm), but Mg did not differ among supplemental N levels. Medium NO_3-N, P, K, and Ca did not differ between bark ages nor among levels of supplemental N fertilization (data not shown).

Plant growth, foliar color rating, and foliar tissue levels of N, P, Ca, and Mg in fresh pine bark equaled or exceeded that in aged pine bark at all levels of supplemental N. No detrimental effects were observed from using fresh pine bark as a growing medium.

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