Research Reports:

Chemical Modification of *Photinia* × *fraseri* Plant Size and Lateral Branching[1]

Allen D. Owings[2] and Steven E. Newman[3]
Department of Horticulture
Mississippi Agricultural and Forestry Experiment Station
P.O. Drawer T
Mississippi State, MS 39762

Abstract

Five plant growth regulators were applied to container-grown *Photinia* × *fraseri* as foliar sprays to determine their influences on plant size and lateral branching. Height, width, and lateral branch number were determined at three month intervals over one year. Treated plants generally were shorter than control plants in response to uniconazole, paclobutrazol, and benzylaminopurine (BA) and were taller than controls when BA was applied with gibberellins A_{4+7}. Each growth regulator altered one or more growth factors dependent on the time after application. Paclobutrazol and uniconazole reduced shoot width 3 months after application (MAA) and 3 to 6 MAA, respectively compared to the control plants. Higher rates of uniconazole and paclobutrazol were responsible for shoot width reductions 12 MAA. Lateral branching was increased 3 MAA by dikegulac-sodium and paclobutrazol at the highest rates only and was reduced by uniconazole 12 MAA. Uniconazole reduced shoot dry weight 12 MAA.

Index words: growth retardant, plant growth regulators

Growth regulators used in this study: uniconazole, (E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-penten-3-ol; paclobutrazol, (2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1H-1,2,4-triazol-1-yl) penten-3-ol; dikegulac-sodium, sodium salt of 2,3:4,6-bis-0-(1-methylethylidene)-α-L-xylo-2-hexulofuranosonic acid; benzylaminopurine (BA), (N-(phenylmethyl)-1H-purin-6-amine); gibberellins A_{4+7} (GA).

Species used in this study: *Photinia* × *fraseri* Dress

Significance to the Nursery Industry

Photinia × *fraseri* is a fast growing woody landscape shrub with a strong apical dominance, which requires several prunings per growing season to obtain a desirable shape. A few growers use foliar applications of growth regulators to achieve results similar to pruning or to control plant size. The normal perception is that some of these chemicals modify branching and growth habit for only a short period of time (3–4 months) following application. Our research indicates that the length and magnitude of response of container-grown *Photinia* × *fraseri* to growth regulators is dependent upon foliar application rate. When applied at rates equal to or greater than 90 and 140 mg/liter (ppm), respec-

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[2]Present address: Calhoun Research Station, LSU Agricultural Center, P.O. Box 539, Calhoun, LA 71225.

[3]Associate Professor of Horticulture.

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tively, the effects of uniconazole and paclobutrazol on plant size may be evident for at least 12 months following application. Increased lateral branching occurred in response to dikegulac-sodium and paclobutrazol. BA rates of 750–1000 mg/liter (ppm) resulted in height reductions and width increases, but did not affect lateral branching.

Introduction

In recent years, several growth regulators have been experimentally applied to container-grown *Photinia* × *fraseri* to study their influence on plant growth and development (1, 2). Paclobutrazol, uniconazole, dikegulac-sodium, flurprimidol, and benzylaminopurine (BA) alone or in combination with gibberellins $A_{(4+7)}$ (GA) have all been shown to modify some *Photinia* × *fraseri* growth characteristics (1, 2, 3, 4, 6, 7, 8). The application of GA alone has not been studied in the growth control of container nursery crops. Since GA plays a major role in cell elongation (10), height increases may occur in response to GA application. Of the chemicals used in this research, only dikegulac-sodium is currently labeled for use on *Photinia*. Paclobutrazol decreased *Photinia* growth and increased axillary branching (2). Dry weight of *Photinia* was also decreased by paclobutrazol, but only at rates greater than 250 mg/liter (ppm) (2). Dikegulac-sodium, BA, and BA + GA also increased branching of *Photinia* (1, 4, 8). Ryan (8) reported that BA applied with methyl esters of fatty acids increased lateral branching.

Despite research efforts, there is still no general consensus on growth regulator application rates that will provide the most desirable growth habit on several nursery crops. Norcini and Knox (6) reported that uniconazole should be applied to *Photinia* as a 5 mg/pot drench, yet later reported that 1 to 2.5 mg/pot drench or a 50 mg/liter (ppm) spray should be used for the most desirable plants (7). Additionally, little research has verified the relationship between application rate and duration of responses. Keever *et al.*, (2) reported that degree and duration of growth inhibition due to paclobutrazol was influenced by the method of application. Therefore, it is necessary to continue evaluation of these materials to determine appropriate application rates, which will result in the most desirable growth habit without severe retardation of subsequent growth. The objective of this research was to determine lateral branching and plant size of container-grown *Photinia* × *fraseri* at three month intervals following application of five growth regulators in six formulations, which are being marketed to the nursery industry.

Materials and Methods

Two soft-pinched *Photinia* × *fraseri* liners were transplanted into 11.4 L (#3) black polyethylene nursery containers March 28, 1989 containing fresh recently milled pine bark medium amended with 0.89 kg/m^3 (1.5 lb/yd^3) trace elements (Micromax) and 2.38 kg/m^3 (4 lb/yd^3) granular dolomite. Slow release fertilizer 18N-2.6P-10K (18-6-12 Osmocote) was top-dressed at the rate of 108 g/pot (3.8 oz/pot) immediately after planting. Plants were grown on an unshaded concrete slab from potting through May 1990, except from December 1989 through February 1990 when they were over-wintered in an unheated quonset frame covered with white polyethylene. Irrigation by hand watering was applied as needed, to 10% leaching.

Five growth regulators in six formulations were applied at four rates May 16, 1989. The growth regulators were applied at approximately ½, 1, 1½ and 2 times the label rate: paclobutrazol (Bonzi™) at 60, 100, 140, and 180 mg/liter (ppm); uniconazole (Sumagic™) at 30, 60, 90, and 120 mg/liter (ppm); dikegulac-sodium (Atrimec™) at 1500, 3000, 4500, and 6000 mg/liter (ppm); BA (Pro-Shear™) at 250, 500, 750, and 1000 mg/liter (ppm); GA (Pro-Gibb™) at 250, 500, 750, and 1000 mg/liter (ppm); and BA + GA (Promalin™) at 250 mg/liter BA plus 250 mg/liter GA, 500 mg/liter BA plus 500 mg/liter GA, 750 mg/liter BA plus 750 mg/liter GA, and 1000 mg/liter BA plus 1000 mg/liter GA. A foliar control [0 mg/liter (ppm)] application was included. Foliar spray treatments were applied at mid-day with a CO_2 pressure sprayer at 2.11 kg/cm^2 (30 psi). Spray coverage was 0.21 liter/m^2 (2 qt/100 ft^2). Each treatment in the completely randomized design was replicated six times with a single container as an experimental unit.

Plant size data were collected following growth regulator applications on August 14, 1989, November 15, 1989, February 23, 1990, and May 17, 1990 [3, 6, 9, and 12 months after application (MAA)]. Height was determined from the medium level to the apex of the tallest shoot. Width was determined by averaging two perpendicular linear extents, one representing the greatest width. The number of lateral branches greater than 0.5 cm (0.2 in) in length, were also recorded. Dry weight of leaves and stems was determined after experiment termination (May 17, 1990) following drying at 60°C (140°F) for 72 hours. Data were analyzed using general linear models to determine linear, quadratic and cubic regression responses.

Results and Discussion

Photinia plants were shorter when paclobutrazol and uniconazole were applied (Fig. 1). Height was effectively reduced with 60 to 100 mg/liter paclobutrazol and with 30 to 60 mg/liter uniconazole (Fig. 1). Paclobutrazol applied at 140 mg/liter or greater resulted in excessive height suppression 3 to 9 MAA. Uniconazole applied at 90 mg/liter or greater, as with paclobutrazol, was also excessive in height control. Unlike paclobutrazol, uniconazole activity on height suppression was still present 12 MAA. Stems of uniconazole-treated *Photinia* were visually weakened and resulted in a less vertical growth habit by 9 MAA. This growth habit development influenced height and width 9 and 12 MAA.

BA application alone resulted in shorter plants 3 and 9 MAA, but BA applied in combination with GA resulted in taller plants 12 MAA (Fig. 1). Keever and Foster (1) noted that BA + GA rates of 2000 to 5000 mg/liter increased *Photinia* plant height 11 weeks after application. Our application rates ranged from 0 to 1000 mg/liter, thus higher rates may have been required to elicit an earlier height response. GA alone and dikegulac-sodium did not alter shoot height at the rates tested (data not shown).

Shoot width was affected by increased application rates of all growth regulators (Figs. 2 and 3). Uniconazole reduced shoot width 3 and 6 MAA, but increased width 12 MAA (Fig. 2). Plants treated with the highest rates of uniconazole and paclobutrazol were shorter and wider than all other treatments 12 MAA. Branches of these plants tended to be more horizontal than upright, laying over in the pot.

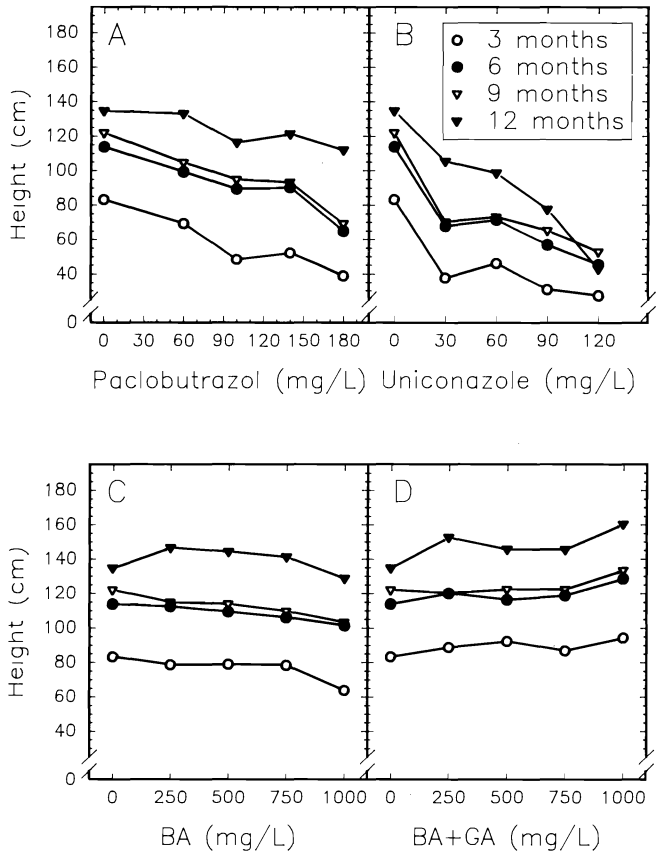

Fig. 1. Regression analyses of plant growth regulator applications on height of *Photinia* × *fraseri* 3, 6, 9, and 12 months after application. (A) Paclobutrazol: 3 months, $y = 83.8-0.35x + 0.0008x^2-9.04\cdot10^{-7}x^3$, $R^2 = 0.92$; 6 months, $y = 114-0.58x + 0.006x^2-0.00003x^3$, $R^2 = 0.96$; 9 months, $y = 122-0.61x + 0.006x^2-0.00002x^3$, $R^2 = 0.98$; 12 months, $y = 135-0.025x + 0.002x^2-0.00001x^3$, $R^2 = 0.81$. (B) Uniconazole: 3 months, $y = 81.6-1.98x + 0.028x^2-0.00013x^3$, $R^2 = 0.90$; 6 months, $y = 112-2.09x + 0.03x^2-0.00014x^3$, $R^2 = 0.96$; 9 months, $y = 121-2.53x + 0.038x^2-0.00018x^3$, $R^2 = 0.98$; 12 months, $y = 134-1.33x + 0.018x^2-0.00011x^3$, $R^2 = 0.99$. (C) Benzylaminopurine (BA): 3 months, $y = 83.3-0.047x + 0.00013x^2-1.02\cdot10^{-7}x^3$, $R^2 = 0.99$; 6 months, not significant; 9 months, $y = 121-0.017x$, $R^2 = 0.95$; 12 months, not significant. (D) Benzylaminopurine plus Gibberellins$_{(4+7)}$ (GA + BA): 3, 6, and 9 months, not significant; 12 months, $y = 139-0.018x$, $R^2 = 0.53$.

Application of GA, alone or combined with BA, consistently reduced shoot width throughout the study period (Fig. 3). This was partly attributable to upright orientation of shoots. Increases in dikegulac-sodium application rates reduced width 12 MAA only (Fig. 2). Shoot width responded quadratically to BA rates 6 MAA (Fig. 3).

Lateral branching was increased 3 MAA by paclobutrazol, while uniconazole reduced lateral branching 12 MAA (Fig. 4). Triazole compounds, such as paclobutrazol and uniconazole, have been previously associated with increased lateral branching (2, 5). Dikegulac-sodium increased lateral branching 3 MAA, but no increase in lateral branching was detected at later dates. This increased branching was primarily observed at the 4500 and 6000 mg/liter application rates. Repeat applications or higher application rates of dikegulac-sodium or paclobutrazol may be necessary to achieve improved budbreak later in the production period.

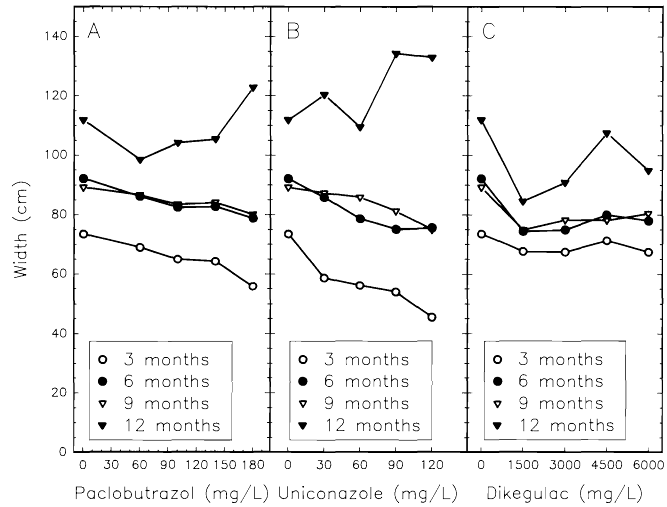

Fig. 2. Regression analyses of plant growth regulator applications on width of *Photinia* × *fraseri* 3, 6, 9, and 12 months after application. (A) Paclobutrazol: 3 months, $y = 73.5-0.16x + 0.0015x^2-0.00001x^3$, $R^2 = 0.98$; 6 and 9 months, not significant; 12 months, $y = 111-0.32x$, $R^2 = 0.94$. (B) Uniconazole: 3 months, $y = 73.3-0.77x + 0.011x^2-0.00006x^3$, $R^2 = 0.99$; 6 months, $y = 90.1-0.15x$, $R^2 = 0.89$; 9 months, not significant; 12 months, $y = 110 + 0.19x$, $R^2 = 0.53$. (C) Dikegulac-sodium: 3 months, not significant; 6 months, not significant; 9 months, not significant; 12 months, $y = 112-0.038x + 0.00002x^2-1.56\cdot10^{-9}x^3$, $R^2 = 0.99$.

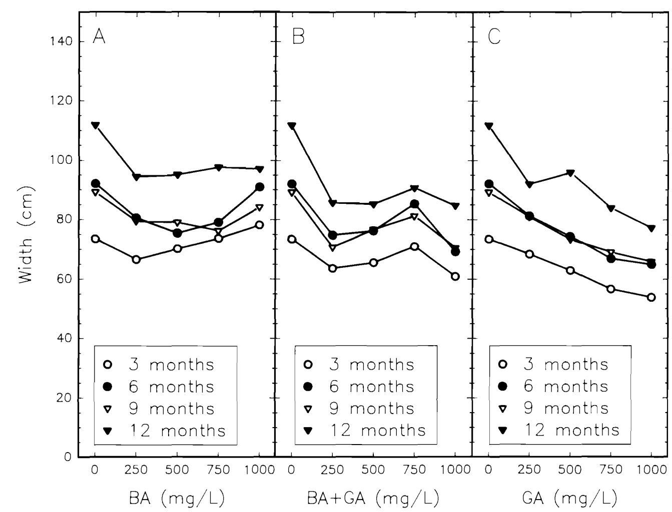

Fig. 3. Regression analyses of plant growth regulator applications on width of *Photinia* × *fraseri* 3, 6, 9 and 12 months after application. (A) Benzylaminopurine (BA): 3 months, not significant; 6 months, $y = 92.2-0.65x + 0.00006x^2$, $R^2 = 0.99$; 9 months, not significant; 12 months, not significant. (B) Benzylaminopurine plus Gibberellins$_{(4+7)}$ (BA + GA): 3 months, $y = 73.6-0.089x + 0.0002x^2-1.46\cdot10^{-7}x^3$; 6 months, $y = 92.3-0.15x + 0.0004x^2-2.34\cdot10^{-7}x^3$, $R^2 = 0.98$; 9 months, $y = 88.9-0.14x + 0.0003x^2-2.11\cdot10^{-7}x^3$, $R^2 = 0.99$; 12 months, $y = 112-0.179x + 0.0003x^2-1.98\cdot10^{-7}x^3$, $R^2 = 0.99$. (C) Gibberellins$_{(4+7)}$ (GA): 3 months, $y = 73.3-0.013x + 0.00003x^2-2.13\cdot10^{-8}x^3$, $R^2 = 0.99$; 6 months, $y = 91.8-0.04x + 0.00001x^2-8.00\cdot10^{-9}x^3$, $R^2 = 0.99$; 9 months, $y = 89.2-0.038x + 0.0002x^2-9.87\cdot10^{-9}x^3$, $R^2 = 0.99$; 12 months, $y = 111-0.096x + 0.0002x^2-9.87\cdot10^{-8}x^3$ $R^2 = 0.92$.

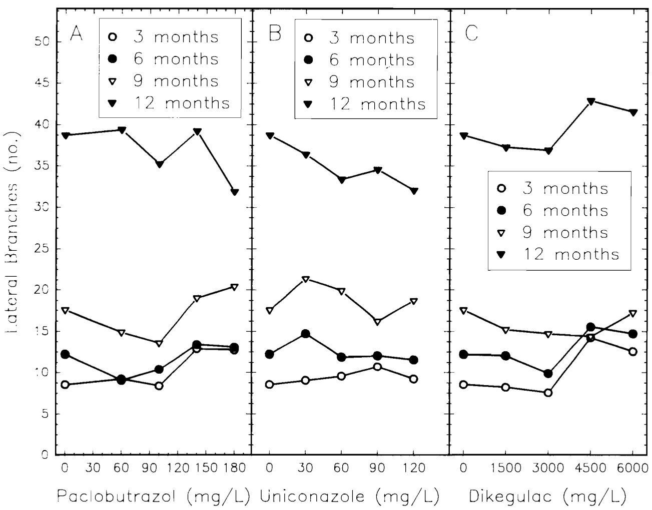

Fig. 4. Regression analyses of plant growth regulator applications on lateral branching of *Photinia* × *fraseri* 3, 6, 9, and 12 months after application. (A) Paclobutrazol: 3 months, $y = 7.76 + 0.026x$, $R^2 = 0.67$; 6, 9, and 12 months, not significant. (B) Uniconazole: 3, 6, and 9 months, not significant; 12 months, $y = 38.6\text{-}0.087x$, $R^2 = 0.88$. (C) Dikegulac-sodium: 3 months, $y = 8.83\text{-}1.93 \cdot 10^{-6}x\text{-}1.98 \cdot 10^{-10}x^2$, $R^2 = 77$; 6, 9, and 12 months, not significant.

BA, GA, or their combination did not affect branch numbers (data not shown).

Increasing uniconazole rates resulted in reduced shoot dry weight of *Photinia* (Fig. 5). Other growth regulators did not affect shoot dry weight. Norcini and Knox (6) also reported that uniconazole decreased dry weight of *Photinia* shoots. Paclobutrazol application rates from 0 to 2000 mg/liter have been reported to decrease shoot dry weight for extended periods (2), but these reductions were not observed at rates of 0 to 180 mg/liter. Ideally, plant growth regulators should redistribute plant growth without sacrificing dry weight accumulation.

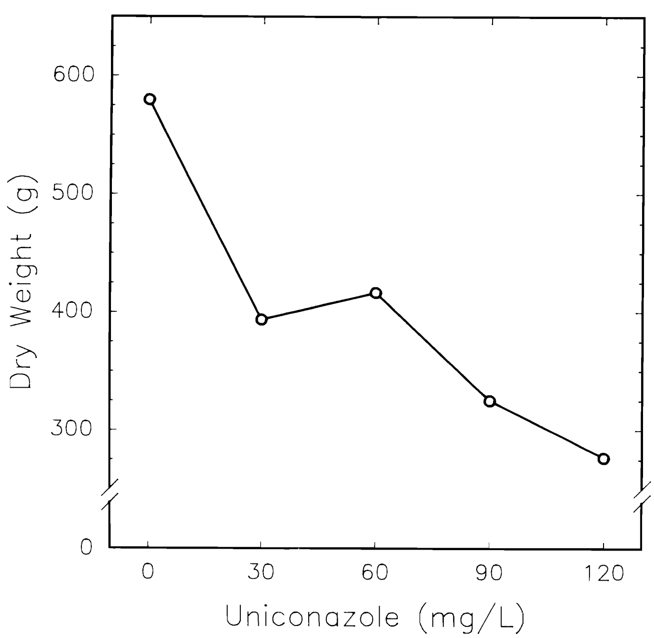

Fig. 5. Regression analysis of uniconazole applications on dry weight of *Photinia* × *fraseri* 12 months after application ($y = 572\text{-}7.76x + 0.105x^2\text{-}0.0005x^3$, $R^2 = 0.94$).

Paclobutrazol and uniconazole at the highest rates resulted in plants with a horizontal growth habit, which was unacceptable. Horizontal growth habits from high rates of uniconazole applied to *Hibiscus* have been previously reported by Newman *et al.* (1989) and Wang and Gregg (1989). This response appears to be a result of incomplete xylem formation (Wang and Gregg, 1989). Paclobutrazol (60 to 140 mg/liter) effectively controlled plant height up to 9 MAA; uniconazole (30 and 60 mg/liter) effectively controlled plant height up to 12 MAA. BA slightly decreased plant height up to 9 MAA. BA applied in combination with GA increased plant height. GA and BA with GA decreased shoot width. Paclobutrazol and dikegulac-sodium were the only growth regulators that increased lateral branching, but this effect was only evident 3 MAA. Uniconazole decreased lateral branching and dry weight 12 MAA. No other growth regulator used affected dry weight.

The growth retarding products, paclobutrazol and uniconazole, each gave satisfactory control at the ½ label rate, 60 and 30 mg/liter, respectively. This effect was evident with paclobutrazol for up to nine months and after this point growth regulating effects were only evident at the higher rates. Keever *et al.* (2) used paclobutrazol at rates of 250 mg/liter or greater. Any application of uniconazole greater than 30 mg/liter was considered excessive as evidenced by stunted plants with horizontal branches. These effects were evident for the duration of the study. Similar results at these rates were reported by Norcini and Knox (7) with uniconazole.

Paclobutrazol and dikegulac-sodium were the only products that increased branching. Similar results with paclobutrazol were reported by Keever *et al.* (2). Increased branching with uniconazole as reported by Newman *et al.* (5) was not observed. Slight increases in branching resulted from applications of dikegulac-sodium at 4,500 mg/liter, which was roughly 1.5 times rates reported by Ryan (8) and was only evident for three months. None of the compounds containing BA increased branching as reported by Keever and Foster (1) or Ryan (8); however, they added a phosphate buffer to prevent precipitation, which we did not use.

(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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Effect of Cover Crops on Soil Erosion in Nursery Aisles[1]

Reed W. Cripps and Herbert K. Bates[2]
School of Agriculture
Tennessee Technological University
Cookeville, TN 38505

Abstract

The effectiveness of soil erosion control of various vegetative aisle covers was evaluated using Universal Soil Loss Equation (USLE) type plots. 'Appalow' sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don 'Appalow'), crimson clover (*Trifolium incarnatum* L.), and perennial ryegrass (*Lolium perenne* L.) aisle treatments and a clean till plot were established on a 5% slope Typic Paleudult soil. Previously established 'Indian Magic' crabapple (*Malus* 'indian magic') and silver maple (*Acer saccharium* L.) were grown parallel to the slope in the center of each plot. Runoff from the clean till aisle resulted in the greatest sediment concentration, runoff volume, and sediment runoff. Crimson clover and perennial ryegrass runoff was similar. The 'Appalow' lespedeza aisle cover had the highest runoff volume of any vegetative aisle cover. However, runoff sediment concentration and sediment runoff were least from 'Appalow' lespedeza covered aisles.

Index words: Runoff, living mulch, soil conservation

Species used in this study: 'Appalow' sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don 'Appalow'); crimson clover (*Trifolium incarnatum* L.); perennial ryegrass (*Lolium perenne* L.); 'Indian Magic' crabapple (*Malus* 'Indian Magic'); and silver maple (*Acer saccharinum* L.)

Significance to the Industry

Increasing consideration of offsite effects of soil erosion might require nurserymen to increase the use of soil conservation practices. Use of winter cover crops such as ryegrass or crimson clover can be easily incorporated into nurserymen's production systems and significantly reduce soil erosion without reducing plant growth or quality. Increased study is needed to develop year round cover crops that can be used as aisle covers without effecting profitability. Low growing crops such as 'Appalow' lespedeza present such a possibility.

Introduction

Nurserymen commonly plant trees with aisles more than 48 inches wide. The aisles require weed control, accomplished by periodic tilling and herbicide application, which result in sediment and chemical runoff. Because many nurseries are located adjacent to streams for easy access to water for irrigation, delivery ratios of sediments and associated pollutants to receiving bodies of water are potentially high.

Use of living mulch in horticulture crops has many benefits including reduced weed competition, soil stabilization, decreased fertilizer and pesticide needs, and increased soil moisture retention (7 and 11). In addition, living mulches increase soil organic matter and reduce leaching (10). Bregger and Brown (3) suggests certain standards in selecting ground covers (living mulch) for orchards that include; adaption to local climatic conditions; capable of growing under the particular environment, shade, and soil; having roots that stay near the upper soil layer and compete minimally with trees for soil moisture; withstand traffic and recover quickly; growing close to the ground; propagate by seeding; grow best when the nursery crop is relatively inactive; and, be commercially available and affordable.

In comparison of mulches as a conservation tool, Hall et al. (5) reported that living mulches reduced erosion better than corn stover residues. The loss of chemicals and sediment in runoff can also be greatly reduced by contour planting and other conservation practices (1, 3, 5, and 6).

Methods and Materials

Universal Soil Loss Equation (USLE) type runoff plots were established on a Mountview silt loam (fine, silty, siliceous, thermic, Typic Paleudult). Plot dimensions were 3.0 m wide by 15.2 m long (10 × 50 ft) and were established parallel to slope. Each plot had 3.0 m (10 ft) × 15.2 (50 ft) cm × 16 gauge galvanized steel strips placed 5–8 cm (2–3 in) deep on the north, south, and west edges to prevent runoff water from crossing into adjacent plots. Runoff was collected in a 3.0 m (10 ft) long trough constructed of 15.3 cm (6 in) diameter, 40 gauge pvc pipe located at the base of the plots. The trough guided the water through a H-flume and across a Coshocton wheel subsampler that allowed 1% aliquots to enter 9.0 l (2.38 gal) glass jars (2).

[1]Received for publication June 29, 1992; in revised form October 5, 1992.
[2]Assistant Professor and former Graduate Student.