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Influence of Mulches on Weed Control, Soil pH, Soil Nitrogen Content, and Growth of *Ligustrum japonicum*[1]

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Abstract

Four organic mulches, screened pinebark, hardwood (primarily oak), cypress and decorative pinebark nuggets, applied at depths of 0, 5, 10, and 15 cm (0, 2, 4, 6 in) with or without an inorganic weed barrier fabric, were tested in field and container studies to determine their effect on weed suppression, soil pH, soil nitrogen content, and growth of *Ligustrum japonicum*. Results indicated that mulch applied at shallower depths, in combination with a weed barrier, provided optimal weed control without tying up soil nitrogen or reducing plant growth. Coarser mulches out-performed finer-textured materials. Most effective weed control was obtained with decorative pinebark nuggets with weed barrier fabric at a 15 cm (6 in) depth of application when compared to unmulched controls. As the depth of mulch was increased, soil pH, soil nitrogen content, and visual rating of plant growth decreased. Mulches over 10 cm (4 in) deep tended to inhibit plant growth, although optimum depth was dependent on the mulch material used.

Index words: wax leaf ligustrum, weed barrier fabric, woven polypropylene, low-maintenance landscaping, geotextile, *Ligustrum japonicum*, weed control, mulch

Introduction

Weed control in landscape plantings is an important cultural problem facing the industry. Weeds detract from the aesthetic quality of landscape plantings and compete with landscape plants for water, nutrients, light, oxygen, and space (6, 12). Homeowners, municipalities, and other public and private agencies need landscape maintenance practices that maximize plant survival and reduce costs. Weed control by cultivation is laborious, expensive, and can be harmful to established plantings. Emphasis on environmental protection has increased interest in alternatives to chemical weed control. One alternative is the use of mulch. Little is known about the combined effects of organic mulch, inorganic weed barrier fabrics, and depth of mulch application to control weed growth in landscape plantings. The purpose of this study was to determine the influence of selected mulching practices on weed control, soil pH, soil nitrogen content and growth of *Ligustrum japonicum*.

Materials and Methods

Field Study. A field study was conducted on a prepared bed of Lufkin fine sandy loam soil. Plots prepared on June 19, 1987, were 1.5 m^2 (16 ft^2) and treatments were: mulching materials of control (no mulch), screened pinebark (0.5–0.75 in, 0.6–0.9 cm), hardwood (primarily oak, 0.5–3 in, 0.6–7.5 cm), cypress (0.5–3 in, 0.6–7.5 cm) and decorative pinebark nuggets (3–4 in, 7.5–10 cm); mulching depths of 5, 10 and 15 cm (2, 4, 6 in); no fabric and with a woven polypropylene fabric (DeWitt Landscape Pro 5). Simulated bed borders were constructed of 2.5 × 15 cm (1 × 6 in) untreated cedar lumber. Plots were irrigated as needed by drip irrigation.

Prior to mulching, 10 purple nutsedge (*Cyperus rotundus* L.) tubers and 50 crabgrass (*Digitaria sanguinalis* (L.) Scop) seeds were planted 1.3 cm (0.5 in) and 0.63 cm (0.25 in) deep, resp., in each treatment. Nutsedge, crabgrass, pigweed (*Amaranthus retroflexus* L.), purslane (*Portulaca oleracea* L.) and other miscellaneous weed seedlings were counted at weekly intervals. After 6 weeks, all weeds were harvested and dry weights were determined.

Six months after planting, soil samples were taken from the upper 5 cm (2 in) of each plot and analyzed for total N and pH by the soil testing laboratory in the Department of Soil and Crop Science at Texas A&M University. Similar soil samples were also placed in 225 cm^2 (35 in^2) flats to conduct a standard bioassay (4) to test for allelopathic effects of mulching. Four tubers of purple nutsedge and 20 seeds each of crabgrass, johnsongrass (*Sorghum halepense* (L.) Pers.), velvetleaf (*Abutilon theophrasti* Medic.) and radish (*Raphanus sativus* Linn. 'Cherry Bell') were planted in each flat. Seedling emergence was counted after 3 weeks.

Container Study. Wax leaf ligustrum (*Ligustrum japonicum* Thunb.) plants initially grown in 3.8 l (1 gal) containers were planted in 19 l (5 gal) containers on August 10, 1987, and again on January 20, 1988. The growth medium of composted pine bark: sand (3:1 by vol.) was amended with 3 kg/m^3 (6.62 lb/yd^3) 18N-6P-12K, 3kg/m^3 (6.62 lb/yd^3) gypsum and 3kg/m^3 (6.62 lb/yd^3) dolomitic limestone. An experimental unit consisted of one container plant. Treatments of mulching materials, mulching depths, and inorganic weed barrier (with or without polypropylene fabric) were applied to the media surface of each container. Ten nutsedge tubers and 20 seeds each of crabgrass, johnsongrass and velvetleaf were planted in each container prior to mulching. Containers were hand irrigated as needed.

Weed seedlings were counted and harvested as previously described. After 4 months, plant quality, number of new shoots, and shoot and root dry weights were determined. Plant quality of the wax leaf ligustrum was obtained from visual ratings using a scale of 5 to 0 with 5 being a high quality container plant with excellent color and aesthetic appearance and 0 very poor quality. The number of new terminal shoots was also determined on a similar scale.

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A split-split plot design was used for both studies, with mulching materials as the main plot (replicated 3 times), weed barrier fabric as the split plot and mulching depth as the split-split plot effect. A multivariate analysis was performed on all variables using a Duncan's multiple range test for mean separation. LS means and Tukey's mean separation procedures were used for 2-way and 3-way interactions.

Results and Discussion

Field Study. Similar results were apparent throughout the weekly weed counts, therefore only results from the final weed count at harvest are reported.

Weed Count. Decorative pinebark nuggets significantly reduced weed number compared to the pinebark mulch and the control treatments (Table 1). A trend was observed in which decorative pinebark nuggets, with the coarsest, largest particles compared to the other mulches provided the best overall weed control.

The interaction between weed barrier and depth of mulch was significant for weed count and weed dry weights (Table 2). The non-mulched control contained more weeds than any other treatment. The use of the weed barrier fabric alone reduced weed count more effectively than mulching at depths of 5 cm (2 in) or 10 cm (4 in) without a weed barrier. This may be due to excessive heat buildup under the black fabric and/or lower soil moisture content due to greater evaporation when mulch was absent. These factors may have contributed to inhibition of weed seed germination and subsequent seedling growth. Weed control by the 5 cm (2 in) and 10 cm (4 in) mulch treatments with and without a weed barrier were similar, with weed control being slightly better with the use of a weed barrier fabric. With 15 cm (6 in) of mulch, weed control was greater with no differences appearing with or without a weed barrier.

Soil pH. All of the types of mulch material tested reduced the pH of the underlying soil (Table 3). The pH of soil under the hardwood mulch was higher than the pH under the cypress mulch. The decorative nuggets and pinebark mulch treatments were intermediate. These findings agree with past research which reported an increase in soil acidity due to mulching with organic mulches (3, 11).

Mulching at all depths reduced the soil pH (Table 4). Lowest pH readings were obtained with mulch depths of 10 cm (4 in) and 15 cm (6 in).

Soil Nitrogen. Soil in plots with a weed barrier fabric maintained a higher nitrogen content (2.54 ppm) than soil without a weed barrier fabric (1.37 ppm). Since the organic mulch materials were not in direct contact with the soil, microorganisms were apparently prevented from using available nitrogen in decomposition thereby reducing soil N content.

Soil nitrogen content was also decreased regardless of the depth of mulch applied (Table 4). Other researchers have reported similar results indicating that the small amount of nitrogen supplied by a decomposing mulch material is readily absorbed and assimilated by soil microorganisms (2, 8, 9, 10, 13).

Weed Seed Germination. The response between mulch type and weed species on weed emergence was significant for crabgrass. In the presence of cypress mulch leachate, mean germination was significantly lower (44.58%) compared to hardwood, decorative nuggets, and pinebark (63.70%, 60.83%, 60.41% respectively). This may be due to the lower pH of the soil mulched with cypress. Emergence

Table 1. Effect of mulch type on weed count[z]. Field study.

Mulch	Mean weed count[y]
Control	15.03 a
Pine	10.36 ab
Cypress	5.63 bc
Hardwood	4.20 bc
Pinebark nuggets	1.42 c

[z]Field plot data taken 6 weeks after planting.
[y]Data pooled over all depths with and without a weed barrier. Mean separation in column by Duncan's multiple range test, 5% level.

Table 2. Two-way interaction between weed barrier x_z depth of mulch on weed count and weed dry weight[z]. Field study.

Barrier[y]	Mulch Depth (cm)	Mean weed count[x]	Mean dry wgt. (g)
−	0	29.35 a	93.78 a
+	0	0.71 d	1.37 b
−	5	8.60 b	4.60 b
+	5	5.33 bcd	1.34 b
−	10	7.10 bc	2.10 b
+	10	4.85 bcd	1.44 b
−	15	2.55 cd	0.59 b
+	15	2.25 d	0.52 b

[z]Field plot data taken 6 weeks after planting.
[y]−, + without weed barrier fabric, with weed barrier fabric, respectively.
[x]Data pooled over all mulch types. Mean separation within columns by Tukey's procedure, 5% level.

Table 3. Effect of mulch type on soil pH. Field study[z].

Mulch	Mean Soil pH
Control	7.05 a
Hardwood	6.77 b
Pinebark nuggets	6.66 bc
Pine	6.63 bc
Cypress	6.55 c

[z]Field plot data taken 6 months after mulching.
[y]Data pooled over all depths with and without a weed barrier. Mean separation in column by Duncan's multiple range test, 5% level.

Table 4. Effect of mulch depth on soil pH and soil nitrogen content[z]. Field study.

Mulch Depth (cm)	Mean soil pH[y]	Mean nitrogen (ppm)[y]
0	7.05 a	3.16 a
5	6.65 b	1.66 b
10	6.48 c	1.29 b
15	6.43 c	1.70 b

[z]Field plot data taken 6 months after mulching.
[y]Data pooled over all mulch types with and without a weed barrier. Mean separation in columns by Duncan's multiple range test, 5% level.

Table 5. Effect of mulch type on visual rating[z] and dry weight (g)[y] of *L. japonicum*, container study.

Mulch	Mean visual rating[x]		Mean dry weights (g)[x]	
	Appearance	Growth	Shoot	Root
Control	4.38 a	4.13 a	132.36 a	58.84 a
Cypress	4.50 a	3.92 a	141.04 a	57.88 a
Pinebark nuggets	4.67 a	3.92 a	130.52 a	58.23 a
Hardwood	4.67 a	4.09 a	145.50 a	56.06 a
Pine	3.33 b	2.50 b	94.45 b	45.39 a

[z]Rated 0 to 5: 5 = Excellent, 0 = Poor.

[y]Container data taken 4 months after planting.

[x]Data pooled over all depths with and without a weed barrier. Mean separation within columns by Duncan's multiple range test, 5% level.

of other weed species or radish was not affected by either mulch type or depth.

Container Study. Results from the container study were similar to those of the field study for both weed count and weed dry weight (data not shown), except that the control treatment in containers had fewer weeds than containers with mulches. This may be due to the confounding effects of excessive heat buildup in the black containers and the low moisture content available for weed emergence.

Ligustrum japonicum Visual Rating. Mulch type influenced the appearance, new growth, and dry weights of *L. japonicum* (Table 5). Pinebark mulch treated plants rated lower in appearance and growth, and shoot dry weight compared to the controls or those mulched with hardwood, decorative nuggets or cypress. It has been reported that conifer bark contains phytotoxic substances such as tannins, polyphenols or volatile oils which may be leached in the form of allelochemics harmful to plant growth (1, 5, 7, 14).

Depth of mulch applied also affected the new growth rating of *L. japonicum*. As the depth of mulch increased, new growth decreased. Controls (no mulch or weed barrier) rated significantly higher (mean new growth rating = 4.12), than the 10 and 15 cm (4 and 6 in) treatments (3.50 and 3.43 resp.). High soil moisture conditions and lack of soil aeration due to the depth of mulch may have been detrimental to plant growth.

Significance to the Nursery Industry

Mulching has been proven to reduce weed growth, conserve water, moderate soil temperature, aid in plant establishment, growth and survival, and reduce maintenance requirements in many studies. The results from these studies will aid the landscape industry with its mulching practices. Weed control was most effective with just the weed barrier fabric and no mulch, but additional research is necessary to determine if high temperatures occurring under these fabrics may be detrimental to root development of landscape plants. Organic mulches were effective when applied at a depth of 15 cm (6 in), however, the corresponding effect on a landscape plant may be detrimental to the establishment and growth of the plant. Excessive mulching may reduce oxygen and water penetration into the soil or introduce saturated soil conditions resulting in decline and death of many shallow rooted shrubs and trees.

Mulch applied at the shallower depths in combination with a barrier can provide excellent weed control without the disadvantages of tying up nitrogen or reducing plant growth. Decorative nuggets gave the best weed control, highest visual plant rating and greatest dry weight of *L. japonicum*. The size of the mulch particles may have had a direct influence on the results obtained in these studies. Conversely, the denser, smaller-sized particles of pinebark mulch gave the poorest weed control, visual plant rating and lowest *L. japonicum* dry weight.

Both mulches, and herbicides can be used effectively to control weeds in planting areas and have a place in landscape maintenance. However, the many additional benefits derived from the use of mulches make them an attractive alternative to chemical weed control.

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