Effects of Woody Mulches and Dimethenamid-P on Container Grown *Ligustrum japonicum* and *Viburnum macrocephalum*[1]

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Abstract

Current weed control practices in nursery container plant production consist primarily of hand weeding and application of preemergence herbicides. Non-chemical weed control methods, such as mulches, could reduce herbicide use, reduce potential environmental concerns from offsite herbicide movement, and decrease the expense of weed control. Before implementation, alternative methods of weed control must be evaluated for effects on the growth of common container-grown species. Mulches made from readily available tree species, including eastern red cedar (*Juniperus virginiana*), ground whole loblolly pine (*Pinus taeda*), Chinese privet (*Ligustrum sinense*), and sweetgum (*Liquidambar styraciflua*), were evaluated at multiple depths with and without the herbicide dimethenamid-P (Tower®). Wax-leaf ligustrum (*Ligustrum japonicum*) and snowball viburnum (*Viburnum macrocephalum*) treated with dimethenamid-P, averaged over mulch treatments, had up to 7% less growth compared to non-herbicide treated plants, but marketability was not affected. Mulch species and depth had no effect on plant growth. Results indicate that these readily available mulch species can be applied at depths up to 10.2 cm (4 in) for weed control in container plant production.

Index words: Chinese privet, eastern red cedar, herbicide, loblolly pine, mini-nuggets, nursery production, pine bark, Tower, weed control.

Chemicals used in this study: dimethenamid-P (Tower) (*S*)-2-Chloro-*N*-(2,4-dimethyl-3-thienyl)-*N*-(2-methoxy-1-methylethyl) acetamide.

Species used in this study: eastern red cedar (*Juniperus virginiana* L.); Chinese privet (*Ligustrum sinense* Lour.); wax leaf ligustrum (*Ligustrum japonicum* Thunb.); sweetgum (*Liquidambar styraciflua* L.); loblolly pine (*Pinus taeda* L.; snowball viburnum (*Viburnum macrocephalum* Fort.).

Significance to the Horticulture Industry

Mulches made from various tree species may be effective for weed control in container production. Mulches made from eastern red cedar, loblolly pine, Chinese privet, and sweetgum did not adversely affect the growth of wax leaf ligustrum or snowball viburnum. Addition of the herbicide dimethenamid to these mulches, however, did result in a slight growth reduction of these two species. The economics of available weed control options for large container production should be considered when deciding on which method of weed control should be used.

Introduction

Weeds become pests in container plant production by reducing crop value through competitive effects (Berchielli-Robertson et al. 1990) and reducing marketability due to demands for weed-free plants (Simpson et al. 2002). Their effects on container-grown ornamentals are amplified due to limited space and resources restricted by the container. Many researchers have recorded the negative effects of weeds on container grown ornamentals (Berchielli-Robertson et al. 1990, Fretz 1972, Walker and Williams 1989). Although the competitive effect of a weed is highly variable depending on the species of both the ornamental plant and weed, reductions in growth and shoot weight of the container grown ornamental have been reported at 47% and greater (Berchielli-Robertson et al. 1990, Fretz 1972, Walker and Williams 1989).

Weed control practices may differ depending on the container size and the species grown. Increased container spacing for larger container production may render common weed control practices inefficient and be a potential cause for environmental concern. The cost of manual weed control ranges from $0.15 to $0.53 per pot (Amoroso et al. 2007). Since manual removal is costly, many growers rely on multiple applications of preemergence herbicides to reduce weed density. The use of herbicides has been associated with some environmental concerns, specifically from non-target loss. This problem is further compounded by increased container spacing at the time of application. Porter and Parish (1993) showed 12 and 23% non-target loss on 4 L (trade gallon) containers when configured in a hexagonal pot to pot configuration and square pot to pot configuration, respectively. Gilliam et al. (1990) reported similar results in that non-target losses ranging from 51 to 80% when herbicides were applied to 4 L (trade gal) containers spaced 18 to 30 cm (7 to 12 in) on center. In many applications, the fate of herbicide granules subjected to non-target loss results in significant herbicide spikes in recapture ponds shortly after herbicide applications (Keese et al. 1994, Riley et al. 1994, Riley 2003). In one study, the herbicide residue spike found in a recapture pond was attributed to an estimated 15% of the total amount of herbicide applied (Riley 2003).

Mulches have proven to be an effective non-chemical alternative for weed control in both the landscape and the nursery container industry. Tree-derived mulches such as chipped eastern red cedar, pine bark mini-nuggets (*Pinus* spp.), and douglas fir [*Pseudotsuga menziesii* (Mirb.) Franco] have widespread availability, reasonable consistency, and are acceptable by consumers (Llewellyn et al. 2003). In landscape studies conducted on tree-derived mulches, weed control was deemed acceptable and greater than nontreated control plots (Billeaud and Zajicek 1989, Greenly and Ra-

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kow 1995, Broschat 2007). Tree-derived mulches have also been shown to be effective at weed suppression in container nursery production, providing effective long term control of several weed species (Richardson et al. 2008, Wilen et al. 1999). In other container studies, combinations of herbicides and mulches were deemed most effective. Case and Mathers (2003) reported good long-term weed control when containers were mulched with douglas fir and pine bark nuggets in combinations with either acetochlor applied at 2.8 kg a.i.·ha^{-1} (2.5 lb a.i.·A^{-1}), flumioxazin at 2.2 kg a.i.·ha^{-1} (2.0 lb a.i.·A^{-1}), or oryzalin at 2.2 kg a.i.·ha^{-1} (2.0 lb a.i.·A^{-1}). Neither oryzalin nor flumioxazin provided long-term control when applied alone, and pine bark nuggets and douglas fir provided only partial long-term control.

Research has shown that mulching, in both the landscape and container production, provides improved weed control with increasing depths of mulch (Richardson et al. 2008, Greenly and Rakow 1995). However, Billeaud and Zajicek (1989) reported decreased plant growth of *Ligustrum japonicum* with increasing mulch depths in landscape trials. Richardson et al. (2008) reported no effect on growth of various ornamental species with increasing mulch depth [up to 7.62 cm (3 in)] in a container trial.

The objective of this study was to evaluate mulches derived from four readily-available species at multiple depths, with and without herbicide application, to determine any potential phytotoxic effects on *Ligustrum japonicum* and *Viburnum macrocephalum* in container production. The four mulches tested were eastern red cedar, ground whole loblolly pine, Chinese privet, and sweetgum. These species were selected due to their relative abundance and low value in many southeastern areas of the US. Mulch treatments were evaluated with and without dimethenamid-P herbicide.

Materials and Methods

This study was conducted at the Paterson greenhouse complex at Auburn University in Auburn, AL. The experiment was initiated April 19, 2014, and repeated again beginning on March 17, 2015. Each year, eastern red cedar, loblolly pine, Chinese privet, and sweetgum trees were harvest at a size of 10 to 20 cm (4 to 8 in) in diameter measured at 30.5 cm (12 in) from the soil. Only the trunk portions (bark included) of these trees were used to provide mulch. Trees were chipped (Vermeer BC1400 XL, Vermeer Manufacturing Company, Pella, IA) one week after harvest. Chipped mulches were left on nursery pads for approximately one month. Along with these four mulches, pine bark mini-nuggets were included (Pine Bark Mini-Nuggets Landscape, Garick, LLC, Cleveland, OH) to provide a commercially comparable mulch treatment.

Particle size distribution was determined for each mulch species. Samples were collected randomly from the pile, mixed by hand in a drum, and dried for one week at 80 C (176 F). Three, five pound samples for each mulch species were hand shaken for 3 minutes through a series of 60 by 60 cm wire screens [5.1, 2.5, 1.3, and 0.6 cm (2, 1, 0.5, 0.25 in)]. The contents retained in each screen were weighed and means of the percent total retained in each sieve for each mulch species were calculated (Fig. 1).

Ligustrum japonicum and *Viburnum macrocephalum* were potted up from 3.8 L (1 gal) containers to 26.5 L (7 gal) containers (C2800, Nursery Supplies, Inc., Kissimmee, FL) on May 31, 2014, and April 14, 2015, to determine if the mulch species or depth caused phytotoxic injury or growth suppression. The 3.8 L container plants were transplanted in 26.5 L containers 29.2 cm (11.5 in) tall filled with substrate, leaving 10.2 cm (4 in) from the top of the containers. Substrate used was 6:1 (v:v) pine bark:sand amended per cubic meter with 2.5 kg (5.5 lb) dolomitic lime, 7 kg (15.25 lb) of Polyon 18-6-12 (Pursell Technologies, Sylacauga, AL) and 0.76 kg (1.6 lb) MicroMax (Scotts Co., Maryville, OH). All plants were placed on a nursery pad and irrigated twice daily with 1.25 cm (0.5 in) of water each irrigation event. An emulsifiable concentrate formulation of dimethenamid-P (Tower®, BASF Professional & Specialty Solutions, Research Triangle Park, NC) was then applied as a directed spray to the substrate surface at 1.6 kg a.i.·ha^{-1} (1.4 lb a.i.·A^{-1}) to the herbicide designated containers as a liquid application [280 L·ha^{-1} (30 gal·A^{-1})] with a CO_2 pressure backpack sprayer on June 2, 2014, and April 16, 2015. Containers were then mulched with the designated mulch treatments on the same day.

Treatments consisted of a factorial arrangement of the aforementioned five mulches, two mulch depths [5.1 and 10.2 cm (2 and 4 in)], and two levels of dimethenamid-P (no herbicide and herbicide), for each of the two ornamental species. In total, there were 22 treatments (including a no mulch no herbicide control and an herbicide with no mulch treatment). Each treatment was replicated five times and arranged in a completely randomized design within each ornamental species.

Phytotoxicity ratings were taken by two researchers and their ratings averaged. The rating scale was numbered 0 to 10 with 0 being no observed injury and 10 being a dead plant. Ratings were taken at 30, 60, 90, and 120 days after treatment (DAT). At 120 DAT, plant size indices (height times width × perpendicular width) were also recorded. Data were subjected to analysis of variance which reflected the factorial treatment arrangement (SAS 9.3, SAS Institute, Cary, NC).

Results and Discussion

Ideal mulches are those that provide a physical barrier, quickly dry out, and are void of nutrients. The concern with

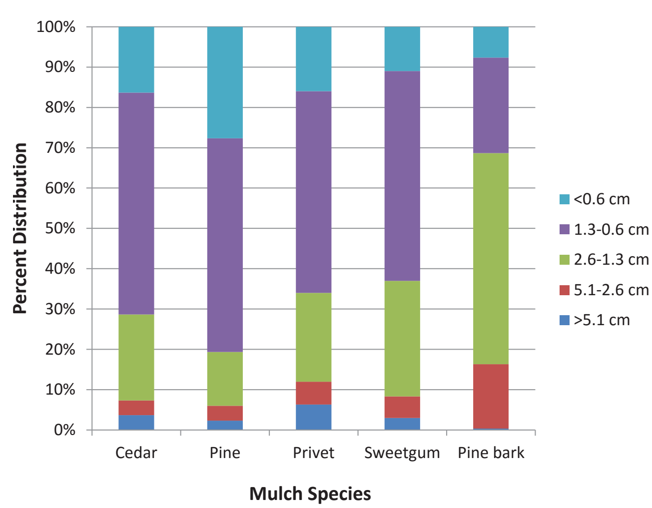

Fig. 1. Mulch particle size distribution of four chipped tree species that were compared to commercial pine bark mini-nuggets in container trials. The four species used for mulch were eastern red cedar, loblolly pine, Chinese privet, and sweetgum.

deep applications of mulch is the retention of water along the stem(s), providing favorable conditions for inoculation of a pathogen to occur (Chalker-Scott 2007). All self-manufactured mulches had relatively consistent particle size distributions with 70 to 90% of the mass of particles retained in a 0.6 cm (0.24 in) sieve (Fig. 1). The screening process involved in refining commercially available pine bark mini-nuggets resulted in a larger percentage of mass retained in the 1.3 cm (0.5 in) sieve (69%) compared to the self-manufactured mulches. Since no adverse effects of growth were observed across mulch depth or species, it can be concluded that the ornamental species trialed were not as susceptible as other ornamentals may be to mulch piled against the stems, or the particle distribution of these mulches allowed sufficient drainage as to reduce the level of moisture against the stem(s).

Neither species were affected by mulch type or depth, but both were affected by herbicide treatment (Table 1). Wax-leaf ligustrum and snowball viburnum had less growth over 120 DAT when dimethenamid-P was applied as a directed spray than plants with no herbicide treatment. Dimethenamid-P affected the size indices (SI) in ligustrum by an average of 4 cm (1.5 in) and viburnum by an average of 5 cm (2 in) in 2014. In 2015, ligustrum and viburnum treated with herbicide had a smaller SI by an average of 10 and 6 cm (4 and 2.4 in), respectively. Differences in growth did not affect plant marketability. If adding dimethenamid to the mulches improved weed control, it may be a preferred treatment over mulch alone.

Table 1. Effect of mulch species, depth, and herbicide on size index of wax-leaf ligustrum (*Ligustrum japonicum*) and snowball viburnum (*Viburnum macrocephalum*) grown in containers[z].

		Wax-leaf ligustrum	Snowball viburnum
		Size index (cm^3)[y]	
2014	With dimethenamid-P[x]	112b[x]	82b
	Without dimethenamid-P	116a	87a
	P-value	0.04	0.02
	Percent difference	3%[w]	6%
2015	With dimethenamid-P	141b	132b
	Without dimethenamid-P	151a	138a
	P-value	0.0004	0.007
	Percent difference	7%	4%
		***P*-value**	
2014	Mulch species	0.31NS[v]	0.22NS
	Mulch depth	0.42NS	0.68NS
2015	Mulch species	0.46NS	0.07NS
	Mulch depth	0.52NS	0.85NS

[z] Means within column and year followed by the same letter are not significantly different based on analysis of variance at α = 0.05 (n=55).

[y] Size Index = plant height + width + perpendicular width / 3.

[x] Active ingredient: dimethenamid-p. Tower® applied as a directed spray to substrate surface prior to mulch applications at 2.1 L-product/ha or 1.57 kg a.i./ha (30 fl oz-product/A or 1.40 lb a.i./A).

[w]Percent Difference = ((SI With Tower / SI Without Tower) x 100) – 100.

[v]NS= nonsignificant.

Dimethenamid-P is a chloroacetamide herbicide belonging to the herbicide mechanism of action Group 15. This mechanism of action is thought to target active growing points such as meristematic sites by inhibiting a cell's ability to produce very long chain fatty acids (VLCFA). A major role of these long chain fatty acids is in the production of cutin, the waxy substance that coats the leaf surfaces for water retention. Since translocation in established plants is irrelevant to the mechanism of action, directed application of the chloroacetamide herbicides to the substrate surface would not be expected to have a phytotoxic effect on the foliage of established woody plants. However, VLCFAs are also implicated in mitosis, specifically the formation of the cell plate that separates newly-divided cells. Thus, it is conceivable that soil applied dimethenamid-P could inhibit root growth despite being highly absorbed by organic material. However, *Ligustrum japonicum* and *Viburnum macrocephalum* are labeled for use with either over the top or directed spray applications of dimethenamid. Dimethenamid-P may not cause visible signs of injury but may inhibit growth in a manner that is still deemed acceptable, as observed in this study.

As reported in a previous study showing mulch treatments were non-injurious to ornamentals in container production (Richardson et al. 2008), no phytotoxicity was observed on either wax-leaf ligustrum or snowball viburnum through 120 DAT. These results come contrary to the results found in the Billeaud and Zajicek's (1989) study which reported decreased plant growth of *Ligustrum japonicum* with increasing mulch depths in their landscape trial. This difference may be attributed to the greater pore space and gas exchange capability of container substrates compared to those of field soil. Oxygen levels in the soil decreases at increasing soil depths. The addition of deep mulch layers may also affect oxygen concentrations in the root zone (Billeaud and Zajicek 1989). However, one study observing the effects of mulch depth on oxygen concentrations showed no effect in soil oxygen levels at varying mulch depths (Greenly and Rakow 1995).

Similar to the results observed in other landscape and container studies, the results from this study indicate that mulches of varying species can be applied for weed control in container production of two common ornamental species. Specifications for large container production should be considered when deciding on which method of weed control should be used. Large spacing required for larger plants may render preemergence herbicide to be costly, inefficient, and potentially an environmental concern due to offsite movement. The practicality of mulch weed control will greatly vary from grower to grower. The economics of the practice will depend on many variabilities such as available time, nursery layout, location and availability of resources, equipment, etc. Ideal conditions (proper equipment, nearby resources, time) may support mulch weed control practices over conventional methods. Similarly, detrimental conditions for conventional methods of weed control may force alternative practices to be used; for instance, the nursery is located in close proximity to a water supply source. Regardless of the economical parameters a producer finds itself, these data support the safety and practicality of mulches for weed control use in nursery container production.

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