Mulch Type and Depth Influences Weed Control on Three Major Weed Species in Nursery Container Production©[1]

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SIGNIFICANCE TO THE INDUSTRY

A number of factors over the past several years have forced container-grown plant producers to alter production practices. Increasing labor cost and new immigration laws have forced growers to rely more on herbicides for weed control. Problems associated with herbicide use in container production include non-target loss, achieving correct calibration, and the expense of repeat applications a year (Case and Mathers, 2006). Non-chemical weed control methods could diminish non-target herbicide loss and reduce potential environmental concerns. Data from this study reveals that one application of various mulch species at a depth of at least 5 cm (2 in.) will provide long-term control of spotted spurge, phyllanthus, and eclipta.

INTRODUCTION

Weeds have been noted to cause major problems in container crop production by reducing the crop value through competitive effects (Berchielli-Robertson et al., 1990) and reducing marketability due to demands for weed free plants (Walker and Williams, 1989). Numerous researchers have reported that only one weed in a small container (trade gal. or 1-gal.) could affect the growth of a container crop (Berchielli-Robertson et al., 1990; Fretz, 1972; Walker and Williams, 1989) but this is highly variable depending on both the crop and weed species. Fretz (1972) reported that one planted red-rooted pigweed (*Amaranthus retroflexus*) resulted in 47% reductions in growth of a trade-gallon container-grown *Ilex crenata* 'Convexa' and one-trade-gallon container-grown *I. crenata* 'Convexa' and one crabgrass (*Digitaria sanguinalis*) reduced the growth of *I. crenata* 'Convexa' up to 60% when compared to the weed free control. One eclipta plant (*Eclipta prostrata*) was observed to have the ability to reduce the shoot dry weight of *Rhododendron* 'Fashion' (Berchielli-Robertson et al., 1990). With the extent of loss from weeds plainly observed and researched, it comes without questioning why concerned nurseries sometimes spend as much as $4000 per acre to control weeds (Pellet and Heleba, 1995). This seems like an egregious amount of money; however, marketability for container crops can be directly associated with the demand for weed-free plants (Simpson et al., 2002).

The necessity to control weeds in container production has driven two practices in container production, hand pulling and herbicide applications. Hand weeding is an increasingly expensive option to do increasing labor cost (Gilliam et al., 1990) and further complicated by new immigration reforms. To reduce the need for hand pulling, nursery growers typically apply preemergence herbicides 3 to 5 times annually. Problems associated with herbicide applications in container production include non-target herbicide loss (Case and Mathers, 2006). This problem is further convoluted with increased container spacing at the time of application. Porter and Parish (1993) showed 12 and 23% non-target loss on 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 trade-gal containers spaced 18 to 30 cm on center. Increasing demand for instant landscapes and large container production has led to many growers to begin producing more crops in 7-gal containers and larger. Weed control practices differ from that used in smaller container production. Increased herbicide non-target loss between the large spacing required for large container production renders herbicide

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applications inefficient and raises environmental concerns.

Mulches have proven to be an effective non-chemical alternative for weed control in large containers. Several criteria must be met in order for a mulch to be considered effective. Effective mulches must be readily available, inexpensive, and acceptable to consumers. Waste products were a focus for many years in mulch research. Products that would normally be sent to a landfill such as newspaper or tires have been evaluated as mulches (Pellet and Heleba, 1995). Smith et al. (1997) reported that newspaper pellets at 2 in. depth controlled spurge in the landscape for at least 60 days. However, waste paper has been shown to reduce available nitrogen when applied to a container's surface as mulch (Glenn et al., 2000). Ground tires were used in a separate study to provide good initial control, but weeds gradually began to penetrate the barrier after 2 months (Calkins et al., 1996). Fabric disk over various materials have also been researched but have found limited success do to voids around the seams or being blown away by winds (Appleton and Derr, 1990). For the most part, waste product mulches have been deemed ineffective due to limited availability and consumer acceptability.

Tree derived mulches such as chipped cedar, pine-bark mini-nuggets, and Douglas fir have widespread availability, reasonable consistency, and acceptable by consumers (Llewellyn et al., 2003). Pine-bark mini-nuggets, as with other tree-derived mulches, create an environment that is not conducive to weed germination due to low fertility, large particle size, and hydrophobic properties (Richardson et al., 2008). Case and Mathers (2003) reported good long container term weed control mulched with Douglas fir and pine-bark nuggets in combinations with either acetochlor applied at 2.5 lbs ai/A, flumioxazin at 2.0 lbs ai/A, or oryzalin at 2.0 lbs. ai/A. Neither oryzalin nor flumioxazin provided long term control when applied alone, but pine-bark nuggets did provide good long term control. Other readily available tree-derived mulch species such as Chinese privet, sweetgum, and eastern red cedar could be used as mulch in container production in lieu of commercialized pine bark mini-nuggets.

The objective of this study was to evaluate four readily-available mulch species at multiple depths for long term weed control and phytotoxicity in nursery crops grown in large containers. The four species tested were Eastern red cedar (*Juniperus virginiana*), ground whole loblolly pine (*Pinus taeda*), Chinese privet (*Ligustrum sinense*), and sweetgum (*Liquidambar styraciflua*). Mulch treatments were evaluated with and without dimethenamid-p herbicide (Tower®).

MATERIALS AND METHODS

This study is currently being observed at the Paterson greenhouse complex of Auburn University in Auburn, AL. The experiment was initiated 19 April 2014, Eastern red cedar, loblolly pine, Chinese privet, and sweet gum trees, 10 to 20 cm (4 to 8 in.) in diameter measured at 30.5 cm (12 in.) from the soil, were harvested. Only the trunk portions of these trees were used to provide mulch. Harvested trees were chipped with a chipper on 23 April 2014. Along with these four mulches, pine bark mini-nuggets were included (Pine Bark Mini-Nuggets Landscape, Garick, LLC. Cleveland, Ohio) to provide a commercially comparative mulch treatment. Particle size distribution was determined with a series of screens (Fig. 1). Treatments consisted of a factorial arrangement of five mulches (eastern red cedar, loblolly pine, Chinese privet, sweetgum, and pine-bark min-nuggets), three mulch depths (1, 2, and 4 in.), and two herbicidal treatments [No herbicide and dimethenamid-p (Tower)]. Two additional treatments were a non-treated control (no mulch with no herbicide) and a no mulch with herbicide for a total of 32 treatments. Three weed species (long-stalked phyllanthus (*Phyllanthus tenellus*), eclipta (*Eclipta prostrata*), and spotted spurge (*Euphorbia maculata*)) were tested, each receiving all 32 treatments. Each treatment was replicated five times for a total of 60 pots per weeds species (note: there are three mulch depth treatments within each mulched container). The study was arranged in a complete random design within each weed species.

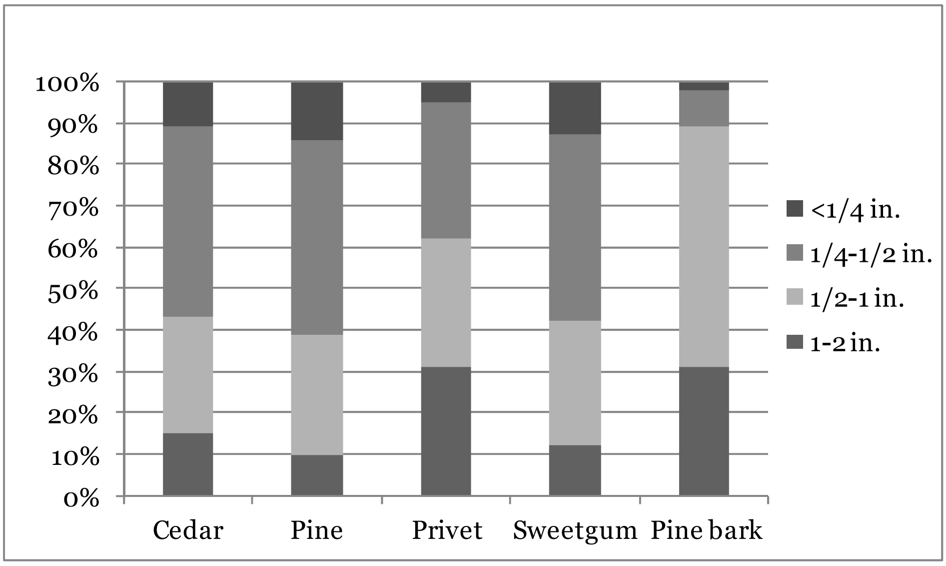

Fig. 1. Particle size distribution by mulch species.

On 26 May 2014, 15-gal containers were filled 12.7 cm (5 in.) from the top with a substrate that was 6 pine bark and 1 sand (v/v) amended per cubic yard with 2.3 kg (5 lbs.) dolomitic lime, 6.4 kg (14 lbs.) of Polyon® 18-6-12 (Pursell Technologies, Sylacauga, Alabama) and 0.7 kg (1.5 lbs.) Micromax® (Scotts Co., Maryville, Ohio). Pots were placed on the nursery pad and irrigated twice daily for 3 days with 2.5 cm (1 in.) of water to allow for settling and accurate adjustment of substrate depth. Tower was then applied at 30 fl. oz./A to the herbicide designated pots as a liquid application (30 gal/A) with a CO_2 pressure backpack sprayer. The space at the top of the pots was to allow space for dividers. These dividers consisted of untreated plywood cut, grooved, and glued to divide the pots into thirds. Each third of the pot was seeded with 10 seeds of long-stalked phyllanthus, eclipta, or spotted spurge applied to the surface of the media on 31 May 2014. The three partitions of each pot were designated one of the three mulch depths so that each pot contained 2.5, 5.1, and 10.2 cm (1, 2, and 4 in.) of mulch. Mulch was spread also on 31 May 2014.

Weeds were allowed to grow for exactly 30 days after seeding. At this time, weeds, if any, were counted, clipped at the mulch or substrate surface, and fresh weights were taken. These data were expressed as percent reduction relative to the non-treated control. Thus, a “0” control indicated equivalency to the control (100 = no weed growth). One week after weed harvest, the containers were sprayed with paraquat dichloride (Gramoxone® Inteon by Syngenta) to kill any remaining weeds. One week after this treatment, pots were reseeded accordingly on top of the mulch with 10 seeds of the designated weed species. To test the longevity of weed control, this process was repeated three times during the summer of 2014. Data was subjected to analysis of variance using SAS which reflected the factorial treatment arrangement.

In conjunction to the weed control study, snowball viburnum (*Viburnum macrocephalum*) and wax leaf ligustrum (*Ligustrum japonicum*) up sized from a 1-gal. containers to 7-gal containers on 31 May 2014 to determine if the mulch species or depth caused phytoxicity injury to either species. These 1-gal container plants were transplanted in 7-gal containers filled with the same substrate used in the weed control study, leaving 10.2 cm (4 in.) from the top of the containers. Treatments consisted of the aforementioned mulches, two mulch depths [5.1 and 10.2 cm (2 and 4 in.)], two levels of dimethenamid-p (Tower) (no herbicide and herbicide), for each of the two ornamental species for a total of 22 treatments (including control and herbicide with no mulch). Each treatment was replicated 5 times for a total of 110 pots per ornamental species. The study was arranged in a complete random design within each ornamental species and arranged in a factorial arrangement. Tower was applied as previously described as a directed spray to the media surface on 2 June 2014. The containers were then mulched with the designated treatments on the same day.

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 an observed dead plant. Ratings were taken at 30, 60, 90 DAT and will be recorded again at 120 DAT with plant growth indices (height × width × perpendicular width) also taken at 120 DAT.

RESULTS AND DISCUSSION

In the weed control portion of this study at 30-d after seeding, mulch depth was shown to have the most influence on both weed counts and weed fresh weights. Data for the first round of this study was taken 30 June 2014. Mulch type only had a significant effect on weed counts of long-stalked phyllanthus and no other significance (Table 1). Mulch depth and Tower herbicide treatments revealed significance across both spotted spurge and phyllanthus on weed count and weed fresh weight. All treatments other than the non-treated control exhibited complete eclipta control and, therefore, it was excluded from Table 1.

After the data were collected from round 1 of the experiment, all containers received a burn down treatment of Gramoxone (paraquat) to kill and non-target or remaining weeds. The containers were then reseeded with 10 seeds per partition of each container with seeds scattered on top of the mulch on 18 July 2014. Thirty one days after seeding, the weeds were counted and fresh weights were taken. Round 2 of the experiment showed that the preemergent herbicide, Tower, had seemingly lost all activity and showed no significant reduction in weed count or fresh weight in comparison to the control treatment (Table 2). Mulch species was revealed to have significance differences on spotted spurge weed counts. Pine-bark mini-nuggets, sweetgum, and privet mulches had control percentages of 94, 93, and 91%, respectively, when compared to the control treatments. On the other hand, cedar and ground whole loblolly pine had 83 and 74% control, respectively, when compared to the control treatments. Depth of the mulch treatments, across all species, showed significance in both weed count and fresh weight with the exception of eclipta, with which no significance was observed in fresh weight. Treatments with 2.5 cm (1 in.) of mulch reduced the weed fresh weight of spotted spurge by 80.3% when compared to the treatments of no mulch with no herbicide and the treatments of no mulch with herbicide. Treatments with 5.1 cm (2 in.) of mulch reduced the foliage fresh weight of spotted spurge by 99.7% and treatments with 10.2 cm (4 in.) of mulch were observed showing complete control of spotted spurge.

Table 1. Round 1: Analysis of variance for weed control as determined from seedling counts and fresh weight.

Source of variation	Spotted spurge		Phyllanthus	
	Count	Weight	Count	Weight
	Probability			
1. Mulch species	0.0015	NS	0.01	NS
2. Depth	<0.0001	0.0002	<0.01	<0.01
3. Tower	NS	NS	<0.01	<0.01
4. Mulch*Depth	NS	NS	0.03	NS
5. Mulch*Tower	NS	NS	NS	NS
6. Depth*Tower	0.03	NS	<0.01	<0.01

Data was collected for Round 1 on 20 June 2014, 30 days after seeding on 30 May.

Table 2. Round 2: Analysis of variance for weed control as determined from seedling counts and fresh weight.

Source of variation	Spotted spurge		Phyllanthus		Eclipta	
	Count	Weight	Count	Weight	Count	Weight
	Probability					
1. Mulch species	0.0015	NS	NS	NS	NS	NS
2. Depth	<0.0001	0.0002	<0.0001	<0.0001	0.01	NS
3. Tower	NS	NS	NS	NS	NS	NS
4. Mulch*Depth	NS	NS	NS	NS	NS	NS
5. Mulch*Tower	NS	NS	NS	NS	NS	NS
6. Depth*Tower	0.03	NS	NS	NS	NS	NS

Data was collected for Round 2 on 18 Aug. 2014, 31 days after seeding on 18 July.

The phytotoxicity test on snowball viburnum and was leaf ligustrum have shown no observed injury 30 and 60 days after treatment (DAT). Pending 90 and 120 DAT injury data and 120 DAT growth indices, we expect the current trend to continue and reveal that all treatments to both species of ornamentals cause no injury.

Data for the last of the three rounds of the weed control experiment will be taken on 1 Oct. 2014. It is expected that this data will follow the trend already taking place and that is that herbicide will no longer have any effect on weed counts or fresh weight and that mulch depth will have the main effect. As the mulches begin to degrade further, we do expect to see some difference in the mulch species based upon chemical differences between species.

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