Mulch type affects degradation and weed control potential in container production©

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SIGNIFICANCE TO THE INDUSTRY

Weed control practices in container production primarily consist of two methods, hand pulling and herbicide applications, but these are not ideal for larger container production. Mulches have been proven to be an effective alternative method of weed control in large containers (Richardson et al., 2008; Bartley et al., 2014). Due to the abundance of fertilizer and water in the nursery environment, degradation rates of available mulch species and types could drastically vary (Altland and Krause, 2014). This research, conducted with the use of litter bags, shows that of five readily available mulch species, pine bark mini-nuggets, Eastern red cedar, and loblolly pine followed by sweetgum and Chinese privet showed the best weed control potential determined by elemental composition, particle size distribution, and degradation rates.

INTRODUCTION

Much like the promise of the United States Postal Service jingle, "Through rain or shine, snow or sleet," weeds consistently deliver a multitude of problems to container nursery growers through spring and summer, fall and winter. Many of these problems are attributed to the ability of weeds to competitively affect the desired ornamental due to the limited amount of space, water, and nutrients within a container (Berchielli-Robertson et al., 1990). Numerous researchers have reported that only one weed in a small container (trade gal. or 1-gal.) could affect the growth of a container grown plant (Berchielli-Robertson et al., 1990; Fretz, 1972; Walker and Williams, 1989) but this is highly variable depending on both the crop and weed species.

The necessity to control weeds in container production has driven two practices in container production, hand pulling and herbicide applications. Hand weeding is increasingly expensive due to increasing labor cost (Gilliam et al., 1990) and further complicated by new immigration laws. 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; Gilliam et al., 1990), such as that required for large container production (7 gallon and greater).

More recent research has shown that tree derived mulches, such as chipped cedar, pine-bark mini-nuggets, and Douglas fir, may reduce the need for hand weeding and herbicide application (Case and Mathers, 2003; Richardson et al., 2008; Bartley et al., 2014). 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). This alternative method of weed control has also been shown to be very effective in large containers where the space in the container could be more easily allocated to a mulch layer instead of growing medium (Richardson et al., 2008; Bartley et al., 2014).

For a mulch to be deemed effective, at least in container production, the mulch must offer an inhospitable site for weed seed germination, and be able to maintain its integrity for an extended period of time. Growing large container plants warrants different growing practices due to the longevity of the plant growing in the container, in some instances, up to 18 months or more (Hunter Trees, LLC, pers. commun.). The problem with most organic

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mulches is they don't provide long-term weed control because of degradation (Altland and Krause, 2014). As the mulch degrades, it becomes an excellent substrate for weed germination due to decreasing particle sizes, barrier depth, and increasing water holding capacity.

Research has been conducted in landscape trials utilizing two different methods to determine mulch degradation rates. Duryea et al. (1999) developed the use of plastic rings to contain mulches on the surface of a plowed, open field and was able to determine decomposition rates by taking an initial dry weight and collecting the mulch within the rings at 1 and 2 years' time. Skroch et al. (1992) established landscape trial plots (4×4 ft) mulched with either pine bark, hardwood bark, cedar chips, longleaf pine needles, or shortleaf pine needles at a depth of 9 cm (3.5 in). Decomposition rates were collected by determining the amount of mulch it took to replenish the plot to the initial depth after 230 and 630 days. However, results from these studies may not be applicable due to the fertilization and irrigation abundance found in nursery and greenhouse production. The nature of this production is highly conducive for organic matter decay (Altland and Krause, 2014).

In order to establish best management practices when using alternative means of weed control, such as mulches, degradation rates of readily available tree species mulches must be recorded in a nursery production environment. These rates will ultimately determine mulch's weed control potential over time. In order to analyze mulch decomposition over time in a nursery production environment, litter bags, which allow for easy recapture of the mulch, were utilized. Litter bags, more commonly implemented in forestry and agronomic research, consist of an inert mesh or screen material resistant to decay such as nylon, woven polypropylene, or fiberglass with mesh spacing recommended based on the objective of the research (Robertson et al., 1999).

MATERIALS AND METHODS

This study is currently being conducted at the Paterson greenhouse complex of Auburn University in Auburn, Alabama. The experiment was initiated on 8 June 2015 when eastern red cedar, loblolly pine, Chinese privet, and sweet gum trees were harvested. Harvested trees measured 10-20 cm (4 to 8 in.) in diameter measured at 30.5 cm (12 in.) from the soil; only the trunk portions of the trees were utilized to provide mulch. Trees were chipped with a Vermeer BC1400XL brush chipper on 12 June 2015. 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. All mulches were sifted through a series of screens to determine particle size distribution (Figure 1) and analyzed for elemental composition. Particles greater than 12 cm (4.75 in.) were discarded. All mulches were subjected to drying at 79°C (175°F) for 10 days to insure consistent moisture levels between mulch species.

Litter bags were made from 2 mm (0.08 in) fiberglass screening (New York Wire, Hanover, Pennsylvania). The 2-mm spacing size was preferred due to reports advising the use of at least 2 mm to allow for the loss of fine particles, macrofauna, and megafauna while maintaining sufficient contact with the substrate or growing medium (Robertson et al., 1999). Litter bags were 30 cm by 20 cm (12×8 in.) with the sides secured with marine-grade nylon thread to withstand constant moisture and the degenerative effects of UV light. With one side left unsecured, litterbags were filled on 23 June 2015 with 1400 mL (6 cups) of the designated mulch species. After the mulch was placed in the bag, the bag was gently shaken for 5 seconds to allow small particles to pass through the screening. The unsecured end was rolled and fastened with a binder clip and then initial weights of all bags were recorded. After the initial weight of the bag was recorded, the mulch bag was placed in a BP167 Lotus Pan (Nursery Supplies Inc., Kissimmee, Florida) filled with substrate that was pine bark and sand (6:1, 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). The lotus pan width allowed the mulch bags to be placed fully prostrate on the media surface without the need for an overabundance of unutilized medium. Drain holes were drilled into the containers to allow for adequate drainage.

Containers, with one mulch filled litter bag per container, were placed on a nursery pad and irrigated with 0.5 in. of water twice daily from impact sprinkler risers.

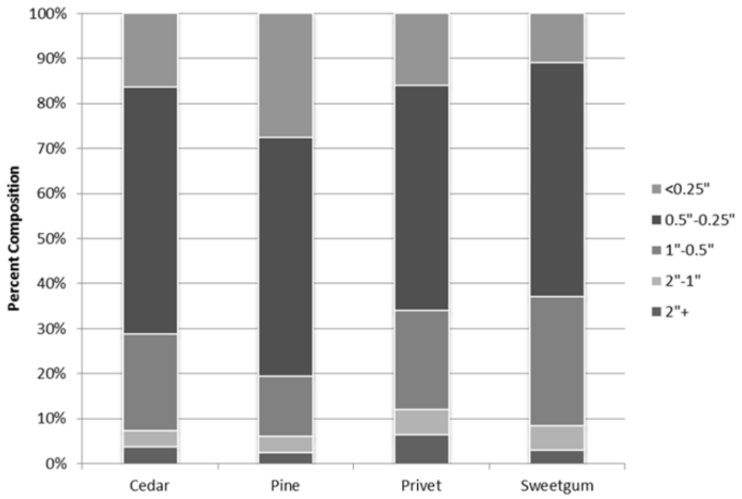

Figure 1. Particle size distribution by mulch species.

The study is a completely randomized design with five mulch treatments (eastern red cedar, pine, pinebark, privet, and sweetgum) with 48 reps per mulch treatment. In monthly intervals, eight reps per mulch treatment were collected, bagged, dried, and weighed. The ultimate objective of the study is to have sufficient data to allow for mulch degradation to be regressed over time. Currently, degradation has been evaluated at only 2 dates (July 27 and Aug 27, 2015) since study initiation. These data were subjected to ANOVA and individual difference between mulch species within each collection date were separated by Tukey's test at a significance level of 0.05.

RESULTS AND DISCUSSION

Initial data was taken on all mulch treatments to determine the elemental composition of each mulch species. The elemental composition of mulch is important because research has shown that those mulches with high carbon-nitrogen (C:N) ratios are favored over those with low ratios (Herms et al., 2001). In general, mulches with ratios greater than 30:1 have ratios high enough to prevent microbe colonization and exhibit nitrogen deficiencies, inhibiting weed growth (Herms et al., 2001). Analysis of each mulch species revealed all mulches had a C:N ratio of 183:1 or greater and trace amounts (typically less than 0.3%) of macro-nutrients (Table 1).

Table 1. Mulch composition analysis.

	Mulch type				
	Cedar[1]	Loblolly pine	Pine bark	Privet	Sweetgum
C:N ratio[2]	183:1	202:1	211:1	211:1	317:1
Nitrogen	0.26[3]	0.24	0.23	0.22	0.14
Phosphorus	0.02	0.02	0.02	0.02	0.02
Potasium	0.16	0.13	0.08	0.20	0.13
Calcium	0.66	0.18	0.18	0.28	0.31

[1]Only the trunk portions of each species were used and analyzed for composition.

[2]Carbon: nitrogen ratio

[3]Figures expressed for macronutrients are a percentage of the composition.

On 27 July 2015, eight replications from each mulch species were collected, bagged with paper bags, and dried for 5 days at 79°C (175°F). Each tagged mulch bag was weighed in the paper bag to insure no further loss of mulch particles occurred. Weights collected were subtracted from the initial weight taken on 23 June 2015 to yield the total weight lost due to degradation. Means comparisons between the five mulch treatments revealed significant differences in degradation rates after just 34 days of exposure in a nursery environment. Pine bark retained its integrity greater than any other mulch with a mean loss of just 3.8 g or 1.6% of the initial weight. Loblolly pine and cedar mulches each had a mean loss 8.5 g or 4.2% and 3.8%, respectively. The greater percentage loss of loblolly pine than cedar is attributed to the lower bulk density when compared to cedar. Sweetgum degraded more than pine bark, loblolly pine, and cedar but less than privet with a mean loss of 18.8 g or 7.2% of the initial weight. Privet, having the greatest initial bulk density, also degraded the most in the first month losing 31.7 g on average or 10% (Table 2). At this time, fungal growth (mycelium) was visually seen only in litter bags containing sweetgum mulch.

Table 2. Degradation of mulches over two months[1,2].

Mulch	Bulk density	Weight lost[3] (g)		Percent lost[4] (%)	Weight lost (g)		Percent lost (%)
Eastern red cedar	224.7[5]	8.5	C[6]	3.8	10.5	c	4.4
Loblolly pine	212.6	8.5	c	4.2	9.6	c	4.4
Pine bark mini-nuggets	229.8	3.8	d	1.6	5.9	c	2.3
Privet	324.5	31.7	a	10.0	43.7	a	13.5
Sweetgum	259.8	18.8	b	7.2	27.3	b	10.6

[1]1 month degradation rates were taken on July 27, 2015, 34 days after treatment.

[2]2 month degradation rates were taken on August 27, 2015, 64 days after treatment.

[3]Average weight lost = Initial weight - weight at the time of collection.

[4]Percent lost = (weight - initial weight / initial weight) x 100

[5]Bulk density measured in g 1400 cm^{-3}

[6]Means followed by the same letter are not significantly different according to the Tukey test (p=0.05).

n=8

On 27 Aug 2015, eight additional per mulch treatment reps were collected and analyzed in the same manner as the month previous. After 64 days, means comparison between mulch species revealed significant difference, expanding upon the results recorded in July. Pine bark, with a mean loss of 5.9 g or 2.3%, showed the least amount of degradation but was not significantly different than loblolly pine or cedar. Loblolly pine and cedar lost 9.6 and 10.5 g, respectively. Both loblolly pine and cedar lost 4.4% of their initial weight after 64 days in a nursery environment. Sweetgum, after two months, weighed 27.3 g lighter on average with an average percent loss of 10.6%. This loss is 3.4% greater that the percentage lost after just 34 days. Privet continued to show the greatest degree of degradation losing an average 43.7 g or 13.5% of its initial weight (Table 2). At this time, fungal growth (mycelium and reproductive structures) were seen in litter bags container sweetgum and privet mulches.

Due to the initial data presented, pine bark mini-nuggets have shown great potential to control weeds effectively due to its larger particle size distribution, minimal degradation rates over 64 days, and very high C:N ratio compared to the other mulches evaluated in this test. Other research results indicate that the ability of pine bark to withstand degradation may also be attributed to high lignin and low carbohydrate levels (Duryea et al., 1999). Loblolly pine and Eastern red cedar have shown good weed control potential due to good C:N ratios and degradation rates that are statistically equivalent to pine bark mini-nuggets after roughly two months. Loblolly pine and cedar’s ability to resist decay may be attributed to phenolic chemicals or hydroxylated aromatic compounds which may negatively influence decomposing organisms (Swift et al., 1979). These compounds were found in very high concentrations in a mulch blend containing both pine and cedar in a study conducted by Duryea et al. in 1999. Because of the high degree of decomposition recorded in both sweetgum and privet mulches, these data suggest that these mulches may provide weaker weed control efficacy than that of the three aforementioned. As this study progresses, it is our hope with this research to be able to study and plot degradation rates of these readily available mulches in order to better equip the container plant industry to effectively utilize mulch as an alternative method of weed control where current practices fall short.

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