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Mulch Depth Effect on Rooting Stem Cuttings and Weed Control During Propagation

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Summary

Hand weeding is the most common method for controlling weeds in nursery crop propagation, but it is time-consuming and costly due to high labor costs. Pre-emergence herbicides are not labeled to be used in non-rooted cuttings, but mulches may be a viable alternative to hand weeding and herbicides. The objective of this study was to determine the effect of mulch type (coarse vermiculite, paper pellets, pine pellets and rice hulls) and mulch depth [1.3 and 2.5 cm (0.5 and 1 in.)] on rooting stem cuttings and weed control in propagation. Hydrangea softwood cuttings (*Hydrangea paniculata* ‘Phantom’) were used for the rooting study while seeds of two weed species [large crabgrass (*Digitaria sanguinalis*) and bittercress (*Cardamine hirsuta)*] were used for the weed control study. Rooting percentage for hydrangea was 100% for all treatments except rice hulls and paper pellets applied at 2.5 cm (1 in.) depth (90% and 95%, respectively). Root dry weight and total root length were similar to the control for all mulches. Root volume was lowest for paper pellets at 2.5 cm (1 in.) depth, but similar to the control for all other treatments. Crabgrass seedling counts were similar for all treatments compared to the non-treated control. Bittercress seedling count was lower than the non-treated control for pine pellets at both mulch depths. Pine pellets and paper pellets suppressed shoot fresh weight of crabgrass and bittercress at both mulch depths. We conclude that pine pellets and paper pellets were found to be effective in controlling weeds in propagation, but further research should focus on rooting safety of other crop species.

INTRODUCTION

Weeds are a major issue in nursery crop production and the problem is more severe in propagation due to the small container volume where weeds compete with the crop for nutrients, light, and water (Altland, 2005). Weeds can also harbor different type of insects and plant pathogens which damage crops (Cranston, 1994; Hobbs et al., 1995). Due to weed infestations, nursery growers can face economic losses of $7000 per acre (Mathers, 2003). Hand weeding is the most common method of weed control in propagation, but hand weeding can suppress growth of cuttings through mechanical disruption (Thetford and Gilliam, 1991). Other challenges of hand weeding are the high cost of labor required (Gilliam et al., 1990). Sanitation and cultural practices along with the use of pre-emergence herbicides can help to reduce weeds in container-grown crops (Altland, 2003). Although pre-emergence herbicides are widely used during crop production, no pre-emergence herbicides are labeled for use in propagation and nursery growers remain reluctant using these products due to the safety issue on rooting (Cook and Neal, 2001; Langmaid, 1987). Also, pre-emergence herbicides cannot be used inside closed structures when crops are present. Since many crops are propagated inside closed structures, this limits the use of herbicides (Altland et al., 2003).

Mulches may be effective alternatives for controlling weeds in propagation. For container-grown crops, mulches are applied to the substrate surface to create a physical barrier which will inhibit weed seed germination and suppress weed growth (Ferguson et al., 2008). In an experiment by Ferguson et al. (2008), southern red cedar and southern magnolia wood chip mulches inhibited the germination of redroot pigweed (*Amaranthus retroflexus*) and large crabgrass (*Digitaria sanguinalis*) in nursery containers. Also, the wood chip mulches did not have an inhibitory effect on the growth of container-grown 'Carolina Beauty' crape myrtle (*Lagerstroemia indica* 'Carolina Beauty'). Nevertheless, some studies show that efficacy of mulches varies with the depth applied in a nursery container. Richardson et al. (2008) reported the reduction in oxalis (*Oxalis corniculata)* and bittercress numbers in large containers (#7) when pine bark mini nuggets were applied to a depth of either 3.8 or 7.62 cm (1.5 or 3 in.). In another study, flexuous bittercress (*Cardamine flexuosa*) and liverwort establishment and growth decreased with increasing rice hull depth (Altland et al., 2016). In an experiment by Altland and Krause (2014), containers with either a 1.3 or 2.5 cm (0.5 or 1.0 in.) depth of rice hulls provided nearly 100% weed control. In a separate study, pine bark mini nuggets at 2.5 cm (1 in.) depth reduced the germination of spotted spurge (*Chamaesyce maculata)* and eclipta (*Eclipta alba*) as compared to 1.3 cm (0.5 in.) mulch depth (Cochran et al., 2009).

Mulches may be an effective weed control method in crop propagation, but these products have not been thoroughly evaluated for cutting propagation. The objective of this research is to determine the effect of different mulches and application depth on rooting of stem cuttings and weed control in propagation.

MATERIALS AND METHODS

Two separate experiments (rooting stem cuttings and weed control) were conducted at the Tennessee State University, Otis L. Floyd Nursery Research Center in McMinnville, TN.

Rooting Stem Cuttings

Softwood cuttings (2-3 nodes) of hydrangea (*Hydrangea paniculata* 'Phantom') were collected from container-grown stock plants. Containers (6.6 cm diameter; SVD250, T.O. Plastics, Clearwater, MN) were filled with a 100% pine bark substrate amended with controlled-release fertilizer and micronutrient fertilizer. After saturation, mulches (coarse vermiculite, rice hulls, paper pellets, and pine pellets) were applied to containers at two depths [1.3 and 2.5 cm (0.5 and 1 in.)] and saturated. Cuttings were stuck (single cutting per container; 25 cuttings per treatment) on 19 May 2020. All cuttings received a 3-sec basal quick dip in rooting hormone (Dip'N Grow, Clackamas, OR) before sticking. Containers were completely randomized and placed under shade (50%) and intermittent mist (10 s every 8 min from 6:00 to 21:00). After 12 weeks, data were collected on rooting percentage, root dry weight, and digital image root analysis (total root length and root volume) using WinRhizo software (Reagent Instrument Canada Inc., Quebec City). Data were analyzed with linear models using the GLIMMIX procedure of SAS (Version 9.3; SAS Institute, Inc., Cary, NC, USA) and differences between treatment means were determined using the Shaffer-Simulated method ($P < 0.05$).

Weed Control

The weed control efficacy of four mulches applied at two depths (as described above) were evaluated on two weed species [large crabgrass (*Digitaria sanguinalis*) and bittercress (*Cardamine hirsuta*)]. Containers (6.6 cm diameter) were filled with substrate, placed under mist until saturation, then mulches were applied.

Twenty (bittercress) or 30 (crabgrass) seeds were sown per container (8 replications per treatment) on 28 February 2020. Containers were completely randomized (within species) and maintained in a shade house under intermittent mist (as described above). Weed seedling count was recorded at 2, 4, and 6 weeks after sowing (WAS). At 6 WAS, shoot fresh weight was collected. All data were analyzed as described above.

RESULTS

Rooting Stem Cuttings

Rooting percentage for hydrangea was 100% for all treatments except for rice hulls (90%) and paper pellets (95%) applied at 2.5 cm (1 in.) (Table 1). Root dry weight and total root length were similar to the non-treated control for all mulches. Root volume was lowest for paper pellets at 2.5 cm (1 in.) depth, but root volume for all the other treatments was similar to the non-treated control (Figs. 1 and 2).

Table 1. Rooting percentage, root dry weight, total root length and root volume of hydrangea cuttings treated with mulches at two depths.

Treatment	Mulch Depth (cm)	Rooting (%)	Root dry weight (g)	Total root length (cm)	Root volume (cm^3)
Non-treated control	NA	100 a[z]	0.16 a	771.3 ab	1.88 a
Vermiculite	1.3	100 a	0.17 a	847.6 a	2.06 a
Rice hulls		100 a	0.12 a	615.7 ab	1.41 ab
Pine pellets		100 a	0.16 a	762.5 ab	1.77 ab
Paper pellets		100 a	0.17 a	780.9 ab	1.66 ab
Vermiculite	2.5	100 a	0.18 a	872.6 a	2.11 a
Rice hulls		90 a	0.14 a	608.8 ab	1.43 ab
Pine pellets		100 a	0.17 a	793.2 ab	1.79 ab
Paper pellets		95 a	0.11 a	504.3 b	1.07 b

[z]Means followed by different letters within columns indicate significant difference at $P < 0.05$ using the Shaffer-Simulated method for multiple comparisons.

Figure 1. Hydrangea root and shoot growth after two months when treated with four mulches at 0.5- and 1-inch depth. Left to right: Control, vermiculite (0.5inch), rice hulls (0.5inch), pine pellets (0.5inch), paper pellets (0.5inch), vermiculite (1inch), rice hulls (1inch), pine pellets (1inch), and paper pellets (1inch).

Figure 2. Hydrangea cuttings under mist after treated with four mulches (Vermiculite, Rice hulls, Pine pellets and Paper pellets) at 0.5- and 1-in. depth.

Table 2. Seedling count of two weed species at 2, 4 and 6 weeks after sowing onto mulches at two depths.

		Crabgrass			Bittercress		
		Weed seedling count					
Treatment	Mulch depth (cm)	2 WAS	4WAS	6WAS	2WAS	4WAS	6WAS
Non-treated control	NA	11.3 b	16.8 ab	17.6 abc	16.5 a	19.3 a	18 a
Vermiculite		17 a	19.4 a	19.6 ab	18.3 a	18.8 a	17.8 a
Rice hulls		4.6 cd	15.5 abc	15.5 abc	9.9 b	17.9 a	16.8 a
Pine pellets	1.3	3.9 cd	14.9 abc	15.5 abc	2 cd	10.9 b	0.8 b
Paper pellets		7.9 bcd	14.8 abc	14.9 bc	3.6 c	17.1 a	19 a
Vermiculite		17.6 a	19.8 a	20.6 a	19.1 a	18.5 a	18.8 a
Rice Hulls	2.5	9.4 bc	15.9 ab	14.6 bc	11.4 b	17.4 a	17.1 a
Pine pellets		3.1 d	10.1 c	12.8 c	0.3 d	10.5 b	0 b
Paper pellets		4.1 cd	13.5 bc	13.9c	4.6 c	16.4 a	17.6 a

[z]Means followed by different letters within columns indicate significant difference at $P < 0.05$ using the Shaffer-Simulated method for multiple comparisons.

Weed Control

At 6 WAS, crabgrass seedling counts were similar for all treatments compared to the non-treated control (Table 2). Although crabgrass seed germination was not affected by the mulches, shoot fresh weight was suppressed at least 35% for all treatments except vermiculite at 2.5 cm (1 in.) depth, compared to the non-treated control (Table 3).

Bittercress seedling count (6 WAS) was lower for pine pellets at both mulch depths while all remaining treatments were similar to the non-treated control (Table 2). Shoot fresh weight of bittercress was 98% lower for paper pellets and pine pellets at both mulch depths compared to the non-treated control. For all other treatments, shoot fresh weight was similar to the non-treated control (Table 3).

Table 3. Shoot fresh weight of two weed species growing in containers treated with mulches at two depths.

Treatment	Mulch depth (cm)	Crabgrass	Bittercress
		Shoot Fresh Weight	(g)
Non-treated control	NA	4.39 a	0.97 ab
Vermiculite		3.12 ab	0.95 ab
Rice hulls	1.3	2.89 b	0.97 ab
Pine pellets		0.17 c	0.02 c
Paper pellets		0.02 c	0 c
Vermiculite		2.34 b	1.15 a
Rice Hulls	2.5	2.65 b	0.27 bc
Pine pellets		0.03 c	0 c
Paper pellets		0 c	0 c

[z]Means followed by different letters within columns indicate significant difference at $P < 0.05$ using the Shaffer-Simulated method for multiple comparisons.

DISCUSSION

The mulches used in this study did not affect root growth of hydrangea cuttings except paper pellets at 2.5 cm (1 in.) depth. In another study, 'Fashion' azalea (*Rhododendron indicum* x 'Fashion') had smaller growth indices when grown with paper pellets as a mulch (Smith et al., 1998). The chemical composition of the paper pellets is unknown but may have caused negative effects on root growth. The mulches used in our study were not very effective in lowering the germination of weed seeds, but several mulches were very effective in suppressing weed growth. Even though the seeds germinated, mulches prevented weed seedling from growing; hence, they did not compete with the crops. Pine pellets and paper pellets suppressed the growth of bittercress and crabgrass at both mulch depths, whereas vermiculite was only effective at suppressing crabgrass at 2.5 cm (1 in.) depth. In a study by Smith et al. (1998), recycled wastepaper pellets applied to a depth of 2.5 cm (1 in.) suppressed prostrate spurge (*Chamaesyce maculata)* germination.

Parboiled rice hulls have been shown to provide effective control of flexuous bittercress or creeping woodsorrel when applied 1.25 to 2.5 cm (0.5 and 1 in.) deep over the container substrate surface during crop production (Altland et al., 2016). In the present study, rice hulls did not provide adequate weed control, yet rice hulls are successfully used as mulch for controlling weeds in production. The hydrophobic nature of rice hulls creates dry environment, which inhibit the weed seed germination. But due to frequent irrigation in propagation rice hulls are moist enough creating a favorable condition for weed seed to germinate.

We concluded that among all the mulches used in the study, pine pellets and paper pellets were most effective in controlling weeds in propagation. Although paper pellets resulted in a slight reduction in root growth for hydrangea, this may be more acceptable compared to the risk of injury due to herbicide use and high cost of labor associated with hand weeding.

Literature Cited

Altland, J. (2005). Weed Control in Nursery Field Production. Extension Horticulture Faculty, North Willamette Research and Extension Center, Oregon State University. EM 8899-E.

Altland, J. and Krause, C. (2014). Parboiled rice hull mulch in containers reduces liverwort and flexuous bittercress growth. J. Environ. Hort. *32*:59-63.

Altland, J., Regan, R., and Newby, A. (2003). Liverwort control in propagation: Challenges and opportunities. Comb. Proc. Intl. Plant Prop. Soc. *53*:383-386.

Altland, J.E. (2003). Weed control in container crops: A guide to effective weed management through preventive measures. Oregon St. Univ. Coop. Ext. Publ. EM 8823.

Altland, J.E., Boldt, J.K., and Krause, C. (2016). Rice hull mulch affects germination of bittercress and creeping woodsorrel in container plant culture. Amer. J. Plant Sci. *7*:2359-2375.

Cochran, D.R., Gilliam, C.H., Eakes, D.J., Wehtje, G.R., Knight, P.R., and Olive, J. (2009). Mulch depth affects weed germination. J. Environ. Hort. *27*:85-90.

Cook, J.C. and Neal, J.C. (2001). Effects of herbicides and application timing on rooting of azalea and Japanese holly cuttings. Proc. SNA. Res. Conf. *46*:422-424.

Cranston, R. (1994). Weed control: An introductory manual. British Columbia Ministry of Agr. Fisheries and Food, Abbottsford.

Ferguson, J., Rathinasabapathi, B., and Warren, C. (2008). Southern redcedar and southern magnolia wood chip mulches for weed suppression in containerized woody ornamentals. HortTech.*18*:266-270.

Gilliam, C.H., Foster, W.J., Adrain, J.L., and Shumack, R.L. (1990). A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. *8*:133-135.

Hobbs, H.A., Johnson, R.R., Story, R.N., and Black, L.L. (1995). Weed hosts and thrips transmission of tomato spotted wilt virus in Louisiana. Tospoviruses and Thrips of Floral and Vegetable Crops. Acta Hortic. *431*:291-297.

Langmaid, M. (1987). Herbicides used in propagation at Wight Nurseries. Proc. Intern. Plant Prop. Soc. *37*:539-540.

Mathers, H.M. (2003). Novel methods of weed control in containers. HortTech. *13*:28-34.

Richardson, B.M., Gilliam, C.H., Wehtje, G.R., and Fain, G.B. (2008). Pine bark mini nuggets provide effective bittercress and oxalis control. J. Environ. Hort. *26*:144-148.

Smith, D.R., Gilliam, C.H., Edwards, J.J., Olive, J.W., Eakes, D.J., and Williams, J.D. (1998). Recycled wastepaper as a non-chemical alternative for weed control in container production. J. Environ. Hort. *16*: 69-75.

Thetford, M. and Gilliam, C.H. (1991). Herbicide use in propagation: Effects on rooting and root growth of stem cuttings. J. Environ. Hort. *9*:21-23.