Nonchemical Alternatives for Weed Control in Containers

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Studies were conducted to evaluate recycled waste paper mulch for nonchemical weed control in container production of *Rhododendron* 'Fashion' and *Rhododendron* 'Girard's Rose'. Pelletized and a crumbled formulation of recycled paper were evaluated at 2 depths: 1.3 and 2.5 cm (0.5 and 1 inch). A fabric disk and a fabric disk treated with Spin Out™ were also evaluated. Pelletized paper at a depth of 2.5 cm (1 inch) provided weed control equal to Rout herbicide. Plant growth was similar among all treatments, except with Fashion azalea which was smaller when grown in pelletized paper mulch compared to the crumbled paper system. Container medium solution pH and soluble salts were within the recommended range for acceptable plant growth. Fabric disks allowed weed growth around the container circumference and in the area where the disk fits around the plant. The crumbled paper mulch had minimal weed control. Pelletized paper applied at 2.5 cm (1 inch) provided the most effective nonchemical weed control.

INTRODUCTION

Typically granular herbicides are broadcast with a cyclone spreader over the top of container-grown plants. This method of application results in significant nontarget herbicide loss (herbicide falling between pots rather than in the pots). When using round pots placed on 30-cm (12-inch) centers, nontarget herbicide loss of 80% to 86% per application can occur (Gilliam et al., 1990; Porter and Parish, 1993). Most container nurseries make 3 to 5 annual applications of granular herbicide (Gilliam et al., 1990). In many nurseries as much as 13 to 18 mm (0.5 to 0.7 inches) of water is applied daily during the growing season, causing irrigation runoff (Fare et al., 1992). Runoff water may contain herbicides, thereby threatening nearby water bodies.

Two recently developed products with potential to reduce herbicide use in container nursery crop production are made from recycled waste paper. These products are pelletized recycled paper or crumbled recycled paper (Tascon, Inc. Houston, TX). Waste paper is ground with a hammer mill equipped with a series of three screens [the smallest about 6 mm (0.25 in.)], then compressed using pelletizing equipment to form pellets about 5 mm × 25 mm (0.19 to 1 inch). To develop the crumble product, pellets are put through a granulator with variable pressure plates. Both recycled paper products are noncomposted and have a C : N ratio of about 500 : 1 (Edwards, 1997).

Paper in various forms has been evaluated for a number of uses. Pellet and Heleba (1995) evaluated chopped newspaper for weed control for nursery row crops. They reported newspaper mulch at 6.9 kg m^{-2} (4.2 lb yd^{-2}) at 15 cm (6 inches) depth, suppressed weed germination for two seasons without a negative effect on three plant species, while a fourth species had suppressed growth. One problem encountered in the use of chopped paper was the dispersion of paper during windy conditions. Rolling the paper with a lawn roller reduced blowing of small pieces of paper; however, the nuisance created from the blowing of paper was unacceptable.

While recycled waste paper has demonstrated potential for a number of uses in the landscape (Smith et al., 1997), development of these recycled waste products into a manageable form may allow for use in container-grown crops. The objectives of this study were to evaluate recycled waste paper products as nonchemical weed control alternatives for container production and to determine their effect on plant growth.

MATERIALS AND METHODS

Uniform liners of *Rhododendron* 'Fashion' (Fashion azalea) and *Rhododendron* 'Girard's Rose' (Girard's azalea) were potted in trade gallons on 9 Aug. 1995. The medium was a pine bark and peat (3 : 1, v/v) with 9 kg m^{-3} (15 lb yd^{-3}) Nutricote (18N-6P-8K), 3.6 kg m^{-3} (6 lb yd^{-3}) lime, and 0.9 kg m^{-3} (1.5 lb yd^{-3}) Micromax. Plants were grown in full sun and received overhead irrigation as needed.

Two paper products, recycled paper crumble and recycled paper pellets obtained from Tascon, Inc., Houston, Texas, were surface applied at 1.3 and 2.5 cm (0.5 or 1 inch). Phosphorus was applied to the recycled waste paper products in the pots as triple superphosphate, at either 0 or 7.5 mg $liter^{-1}$ (ppm), based on the dry weight of the paper products. Phosphorus was added since previous work had demonstrated sensitivity of some bedding plants to aluminum in the recycled paper (Smith et al., 1997). Other treatments included fabric disks (Texel Corp., Quebec, Canada), and a fabric disk with Spin Out™ (a copper hydroxide root growth regulator) (Griffin, Corp., Valdosta, Georgia), 3.5 kg ai ha^{-1} (3 lb ai A^{-1}) of Rout 3G™ (Scott's Co., Marysville, OH), and a nontreated control. With all mulch treatments 30 prostrate spurge seeds (*Chamaesyce maculata* (L.) Small), were placed either under the mulch or on top of the mulch. Azaleas were repotted into 3-gal containers on 7 May 1996 using the same medium, remulched with the recycled waste paper treatments, and the treatment of Rout 3G was reapplied. The experimental design was a randomized block with eight single plant replications per treatment for each of the two plant species.

Data collected were spurge number per pot 30 and 75 days after treatment (DAT), and spurge fresh weight 75 DAT for 'Fashion' pots only. In 1996 after repotting, spurge number was determined 30 and 60 DAT and spurge fresh weights were determined in pots of both azaleas 60 DAT. Growth indices (height + 2 perpendicular widths/3) were determined for both species 240 and 550 DAT. Medium solution electrical conductivity (soluble salts) and pH of 'Fashion' containers were measured 7, 30, 90, 210, and 240 DAT using the Virginia Tech Extraction Method (VTEM) (Wright, 1987).

Statistical analyses were performed using the general linear models (glm) procedure (SAS Institute, Inc., 1989), with LSD as a mean separation procedure. All statistical analyses are reported at $P < 0.05$. In presenting the data in Table 1, only those affects, i.e., main, 2-order and 3-order interactions, that were significant were included in the model statement.

RESULTS AND DISCUSSION

Weed Data. Recycled waste paper pellets applied to a depth of 2.5 cm (1 inch) suppressed spurge germination, regardless of whether spurge seed were sown on top of the mulch or under the mulch (Table 1). In contrast, recycled crumble provided poor spurge control at both depths and when spurge was sown on top of the mulch,

Table 1. Mulch control of prostrate spurge in container grown plants.

			Before repotting			After repotting[Z]		
			Spurge #/pot	Spurge #pot	Spurge fresh wt(g)	Spurge #/pot	Spurge #/pot	Spurge fresh wt (g)
Treatment[Y]	Depth (mm)	P-level[X] (mg liter^{-1})	30 DAT[W]	75 DAT	75 DAT	30 DAT	60 DAT	60 DAT
Pellet/su[V]	12.5	0	1.0	3.3	2.6	0.25	2.3	3.1
Pellets/su	12.5	7.5	0.8	0.8	12.9	0.37	1.4	10.6
Pellet/su	25	0	0.0	0.0	0.0	0.0	0.0	0.0
Pellet/su	25	7.5	0.0	0.7	1.3	0.0	0.25	0.03
Crumble/su	12.5	0	10.1	18.8	22.7	1.9	4.0	5.6
Crumble/su	12.5	7.5	4.7	9.8	51.7	5.5	5.5	23.0
Crumble/su	25	0	2.5	8.5	9.2	1.4-	2.0	3.5
Crumble/su	25	7.5	2.6	6.8	36.8	2.5	3.6	56.2
Pellet/st[U]	25	0	0.0	0.3	0.0	---[T]	---	---
Pellet/st	25	7.5	0.0	0.2	0.0	---	---	---
Crumble/st	25	0	9.2	21.6	12.7	---	---	---
Crumble/st	25	7.5	8.0	17.3	46.2	---	---	---
mulch		***	***	****	***	***	**	
depth		***	**	**	NS	**	NS	
seed placement		***	***	NS	---	---	---	
phosphorus		*	**	***	*	NS	**	
mulch × depth		**	NS	NS	NS	NS	NS	
mulch × seed[S]		***	***	NS	---	---	---	
mulch × P		NS	*	***	*	NS	*	

Fabric disk/su	0.3	9.5	3.5	---	---	---	
Fabric disk/st	5.8	8.3	25.3	---	---	---	
Fabric disk+spin out/su	0.8	1.3	7.1	---	---	---	
Fabric disk+spin out/st	2.6	4.6	11.3	---	---	---	
fabric disk	NS	**	NS	---	---	---	
seed placement	**	NS	**	---	---	---	
fabric disk*seed	**	NS	**	---	---	---	
Rout[R]		0.0	3.5	0.0	0.25	1.6	9.5
Control[Q]		12.0	20.5	26.8	5.3	8.1	59.1
LSD[P]		3.1	6.0	11.4	2.2	2.8	27.4

[Z]Plants were repotted 7 May 1996 and retreated.

[Y]Only significant affects were included in the statistical model statement.

[X]P source was triple superphosphate; mg liter^{-1} (ppm) based on pounds of recycled paper per pot.

[W]DAT = days after treatment.

[V]su = seed applied under the mulch.

[U]st = seed applied on top of the mulch.

[T]Treatment not included.

[S]Mulch × seed interaction based on 25 mm depth only.

[R]Rout 3G herbicide applied at 3.5 kg ha^{-1} (3 lb ai A^{-1}).

[Q]Non-mulched control.

[P]Overall experimental LSD; 5% level.

there was increased spurge growth compared to when the seed were sown under the crumble mulch (significant mulch × seed) at both 30 and 75 DAT. There was a mulch × phosphorus (P) interaction at 75 DAT with spurge number where pellets with and without P had 0.6 and 1.2 spurge per container respectively, while the crumbled formulation with and without P had 11.3 and 16.3 spurge, respectively.

Spurge fresh weight was less with 2.5 cm (1 inch) compared to 1.3 cm (0.5 inches) (11.8 vs. 22.5 g). Also, there was a mulch × P interaction at 75 DAT with spurge fresh weight. When no P was added, spurge fresh weights were 0.9 and 14.8 g for the pelleted and crumbled formulations, respectively; however, with supplementary P, fresh weights were respectively 4.7 and 44.9 g. This greater spurge growth in the crumbled paper formulation with supplementary P is possibly due to improved fertility status. The crumbled paper formulation with supplementary P had fewer spurge numbers than without P, yet the fresh weights were about three times greater with P.

Better weed control from use of recycled pellets probably results from two factors. First, the pellets are three times the density of the crumbled product, thus creating a greater barrier for weed seed germination under the mulch. Secondly, the recycled waste paper pellets absorb approximately three times their weight in water within a few days after application. As water is absorbed the pellets swell, forming an interlocked mat of bonded pellets with a relatively smooth surface.

Results from the fabric disk showed limited spurge control was obtained with any treatment. There was a seed placement affect at 30 DAT with spurge number and at 75 DAT with fresh weight where seed placement under the fabric resulted in less growth than seed placed on top of the fabric (Table 1). Spurge also emerged around the container circumference and in the slit where the fabric disk fits around the plant. This observation concurs with those previously reported by Appleton and Derr (1990). There was a fabric disk × seed placement interaction at 30 DAT with spurge number and spurge fresh weight at 75 DAT with the greatest amount of spurge occurring when seed were placed on top of non-Spin Out™-treated fabric. Rout provided excellent spurge control.

Recycled pellets continued to provide excellent spurge control after the plants were repotted in May 1996 (Table 1). With 'Girard's Rose' at 60 DAT, recycled pellets provided greater spurge control (spurge number) than crumbled paper (1.0 vs. 3.8), and the 2.5 cm (1 inch) depth provided greater control than the 1.3 cm (0.5 inches) depth (1.5 vs. 3.3); data for 'Fashion' followed a similar trend.

Growth Indices. Both cultivars of azaleas grown with recycled waste paper mulch were generally similar in size to nontreated control plants and Rout-treated plants at 240 DAT (data not shown). No treatment produced a negative affect on plant growth when comparing effects of recycled paper treatments on 'Girard's Rose'. At 550 DAT all recycled paper treatment ehfl ã‰s!/'re similar with 'Girard's Rose' to plants grown with Rout and nontreated control plants.

'Fashion' showed a significant mulch × depth interaction with growth indices at 240 DAT. Plants grown in the crumbled paper mulch at a depth of 1.3 and 2.5 cm (0.5 and 1 inch) were similar with growth indices of 22.4 vs. 23.6, respectively. Plants grown with a pelleted mulch of 2.5 cm (1 inch) were smaller than those grown at 1.3 cm (0.5 inch) (19.5 vs. 24.3 growth index). We observed that the pelleted mulch appeared to retain greater water than the crumbled paper mulch. Since all treatments were watered similarly with overhead irrigation, the growth suppression with recycled pellets may be related to excessive moisture.

At 550 DAT, 'Fashion' growth indices were affected by mulch, depth, and P (data not presented). Plants in the pelleted mulch had smaller growth indices compared to crumbled material (53.9 vs. 56.2 growth index). Plants in the 1.3 cm (0.5 inch) depth were larger than those grown in the 2.5 cm (1 inch) (56.3 vs. 53.7 growth index), as were plants without supplementary P (56.3 vs. 53.7 growth index).

Salts and pH. The pH of the waste pellets is 6.8 and crumble is 7.0. Medium solution pH gradually became more acidic with all treatments over the course of the study; ranging from 5.6 to 6.6 at 7 DAT to 4.9 to 6.0 at 240 DAT (data not shown). These levels are within acceptable ranges for container-grown nursery crops (Wright, 1987).

Soluble salts (7 and 30 DAT) were affected by additional P and mulch (mulch × P interaction). At 7 DAT plants with pelleted mulch and supplementary P had medium solution soluble salt levels of about 2.0 dS m^{-1}, whereas pelleted mulch without supplementary P, and crumbled paper mulch with and without supplementary P, had soluble salts of 0.87, 0.88, and 0.46 dS m^{-1}, respectively. A similar trend occurred at 30 DAT; however, medium solution salt levels had dropped; ranging from 0.43 to 0.26 dS m^{-1}.

Our research shows that recycled waste paper in the pelletted form provides superior weed control compared to the crumbled form. The 2.5 cm (1 inch) depth is necessary to provide adequate weed control. Repotting and reapplying the mulch to the 3-gal, container-grown azaleas had no negative effect on azalea growth at any time during the study. While plant quality was not rated, plant appearance for all plants was reflected in good foliar color.

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