Effect of Fertilizer Placement on Prostrate Spurge Growth in Container Production[1]

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Abstract

Three experiments were conducted to evaluate the effect of fertilizer placement on prostrate spurge growth (*Chamaesyce prostrata*) in container production. In experiment one, Polyon 17N–2.1P–9.2K (17–5–11) was topdressed or dibbled at 45 g (1.6 oz) or 90 g (3.2 oz) per 11.3 liter (#3) container and either 90 g (3.2 oz) or 180 g (6.3 oz) per 26.3 liter (#7) container. In experiments two and three, 180 g (6.3 oz) of Polyon 17N–2.1P–9.2K (17–5–11) was topdressed or dibbled per 26.3 liter (#7) container. In all experiments 20 prostrate spurge seed were applied to the container surface 30 days after potting. In all experiments, weed count and weight were less in dibbled containers compared to topdressed. Across all experiments, weed shoot weights at or beyond 90 days after potting were from 31 to 888% greater in topdressed containers, compared to dibbled containers. Overall, dibbling fertilizer greatly reduced weed growth while producing no visible difference in ornamental plant growth.

Index words: dibble, topdress, controlled-release fertilizer.

Species used in this study: Yaupon holly (*Ilex vomitoria* Ait.); Wax leaf ligustrum (*Ligustrum japonicum* Thunb.).

Significance to the Nursery Industry

Container growers rely heavily on preemergence herbicides and hand labor for weed control. Even with a good preemergence herbicide weed control program, less than 100% control is obtained. Some growers of large container plants rely only on hand-weeding. Data indicate fertilizer placement influences weed control. Dibbling fertilizers (placement of the fertilizer below the liner roots immediately prior to potting) reduced germination of prostrate spurge (*Chamaesyce prostrata*), and reduced subsequent spurge growth compared to topdressing fertilizers. Dibbling fertilizer reduced weed growth, compared to topdressing fertilizer, and resulted in similar crop shoot growth. Understanding how cultural practices, like fertilizer placement, affect weed control will help growers better manage their crops and weed control program. These data provide growers another non-chemical option when developing weed control strategies for container-grown nursery crops.

Introduction

Weed control in container production is achieved primarily through use of preemergence herbicides, along with some hand-weeding. Since most herbicide programs are not 100% effective, growers are continually evaluating new strategies to improve weed control in their nurseries. Among options being evaluated are more frequent herbicide applications, different herbicide combinations, mulches and cultural practices. One cultural factor that has been widely evaluated is dibble fertilization. Dibble fertilization is where fertilizer is placed directly beneath the liner being transplanted. Plant species vary in their response to dibble fertilization (7, 8), but many growers routinely employ this technique. Fertilizer placement in container production may affect weed growth. Fertilizer placement has been shown to affect weed growth in several agronomic cropping systems. Banding of fertilizers below the soil surface in wheat (*Triticum aestivum*) (2) and peanut (*Arachis hypogaea*) (3) reduced weed growth compared to broadcast surface applications.

One possible effect of fertilizer placement is its impact on weed seed germination. Some seed require available nutrients for germination and subsequent growth. Begonia seed require dilute liquid fertilization immediately after germination since small seed size results in low nutrient reserve in the seed, and leaching of nutrients below the top 0.6 cm (0.25 in) of the media in the seed flat may cause 'post-germination stall' (1). Physiological tradeoffs prevent most plants from adapting to environments of high and low nutrient availability, and agricultural weeds generally out-compete other crops in high nutrient environments but compete poorly in low nutrient environments (6).

Pinebark is the primary component used in nursery crop container production. Pinebark substrates are inherently low in anion exchange capacity and available nutrients (5). The role of cation exchange capacity is minimal in soilless substrates as related to plant nutrient uptake and leaching (9). Therefore controlled-release fertilizers (CRF) are typically used to provide a continuous supply of nutrients at optimal levels. Removal of CRF from the site of weed seed germination may limit weed growth in pinebark substrates. Fertilizer placement (topdressed or dibbled) should affect the level of available nutrients on the container surface, thus affecting weed seed germination and subsequent growth.

Little research has addressed the effects of cultural practices on weed growth in container production. The objective of this research was to determine the effect of fertilizer placement on prostrate spurge germination and growth in container crops.

Materials and Methods

Experiment 1 was conducted at the Auburn University Ornamental Horticulture Research Center, Mobile, AL. Uni-

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form 10 cm (4 in) liners of yaupon holly (*Ilex vomitoria*) and wax leaf ligustrum (*Ligustrum japonicum*) were potted on June 29, 2000, in either 11.3 liter (#3) or 26.3 liter (#7) containers with a 3:1 (v:v by vol) pinebark:peat substrate amended per m^3 (yd^3) with 3.6 kg (6 lb) dolomitic limestone, 1.2 kg (2 lb) gypsum and 0.9 kg (1.5 lb) Micromax (The Scotts Co., Marysville, OH) micronutrients. Polyon 17N–2.1P–9.2K (Polyon 17–5–11, Purcell Technologies Inc., Sylacauga, AL) was topdressed or dibbled at 45 g (1.6 oz) or 90 g (3.2 oz) per 11.3 liter (#3) container and either 90 g (3.2 oz) or 180 g (6.3 oz) per 26.3 liter (#7) container. The lower rate or higher rate of fertilizer were equivalent to approximately 0.7 kg/m^3 (1.18 lb/yd^3) or 1.4 kg/m^3 (2.36 lb/yd^3) of substrate, respectively, for both container sizes. Topdressed fertilizers were distributed uniformly over the container surface, while dibbled fertilizers were placed immediately beneath the root ball of the liners, approximately 8 cm (3.1 in) below the container surface. Prostrate spurge (*Chamaesyce prostrata*) were seeded (20 seeds per container) on July 28, 2000. Data collected included weed count and weed shoot fresh weight (SFW) at 90 days after potting (DAP). Treatment arrangement was a 2 × 2 factorial, with 2 fertilizer rates and 2 fertilizer placements. Each species and container size was considered a separate test and placed under overhead irrigation, accordingly. The experiment was arranged in a completely randomized design with eight single plant replications per treatment. Data were analyzed using analysis of variance, and means were separated by Duncan's multiple range test ($\alpha = 0.05$).

Experiment 2 was conducted at the Truck Crops Branch Experiment Station in Crystal Springs, MS. Uniform 3.8 liter (#1) liners of wax leaf ligustrum were potted on May 24, 2002, in 26.3 liter (#7) containers using an 8:1 (v:v by vol) pinebark:sand medium amended per m^3 (yd^3) with 3.0 kg (5 lb) of dolomitic limestone and 0.9 kg (1.5 lb) of Micromax (The Scotts Co.) micronutrients. Polyon (Purcell Technologies Inc.) 17N–2.1P–9.2K (17–5–11) was applied at 180 g (6.3 oz) per container either topdressed or dibbled. Plants were placed in full sun under overhead irrigation. At 30 DAP containers were either seeded with 20 prostrate spurge or not seeded. Data collected were initial plant growth indices [(height + width + width) ÷ 3], percent weed coverage (PWC) and weed count at 60, 90, and 120 DAP. Weed shoot dry weight (SDW) and ligustrum growth indices were collected at 120 DAT. Treatment arrangement was a 2 × 2 factorial, with 2 fertilizer placements and seeded or not seeded with prostrate spurge. The experiment was arranged in a completely randomized design with eight single plant replications per treatment. Data were analyzed with analysis of variance, and means were separated with Duncan's multiple range test ($\alpha = 0.05$).

Experiment 3 was conducted at the Auburn University Ornamental Horticulture Research Center, Mobile, AL. Uniform 3.8 liter (#1) liners of wax leaf ligustrum were potted on May 23, 2002, in 26.3 liter (#7) containers with a 3:1 (v:v by vol) pinebark:peat substrate amended per m^3 (yd^3) with 3.6 kg (6 lb) dolomitic limestone, 1.2 kg (2 lb) gypsum and 0.9 kg (1.5 lb) Micromax (The Scotts Co.) micronutrients. Polyon (Purcell Technologies Inc.) 17N–2.1P–9.2K (17–5–11) was applied at 180 g (6.3 oz) per container either topdressed or dibbled. Plants were placed in full sun under overhead irrigation. At 21 DAP containers were either seeded with 20 prostrate spurge or not seeded. Data collected included initial plant growth indices [(height + width + width) ÷ 3], weed count at 60, 90, and 120 DAP and PWC at 90 DAP. Final ligustrum growth indices and prostrate spurge SDW were collected at 120 DAP. Treatment arrangement was the same as experiment 2. The experimental design was a completely randomized design with eight single plant replications per treatment. Data were analyzed using analysis of variance, and means were separated by Duncan's multiple range test ($\alpha = 0.05$).

Results and Discussion

Experiment 1. There were no interactions between fertilizer rate and placement. Fertilizer rate had no effect on spurge number at 90 DAP for either plant species or container size (Tables 1 and 2). Weed numbers were greater at 90 DAP with the topdressed treatment with both plant species and container sizes, with the exception of the #3 ligustrum. Increases in numbers of weeds per pot due to fertilizer placement ranged from 27 to 116%. At 90 DAP spurge SFW was greater in topdressed containers compared to dibbled, regardless of species or container size. Among topdressed containers SFW was 68 to 888% greater than dibbled containers. There was a 54% increase in SFW at 90 DAP for the 90 g (3.2 oz) fertilizer rate with the yaupon holly in #3 containers (Table 1). Similarly there was a 31% increase in SFW at 90 DAP for the 180 g (6.3 oz) fertilizer rate with the ligustrum in #7 containers (Table 2).

Experiment 2. There were no interactions between fertilizer placement and prostrate spurge seeding (data not shown).

Table 1. Effect of fertilizer placement and rate on prostrate spurge control in #3 containers (Expt. 1).

	Yaupon holly		Wax leaf ligustrum	
	Spurge count 90 DAP[y]	Spurge weight[z] 90 DAP	Spurge count 90 DAP	Spurge weight 90 DAP
Fertilizer placement				
Topdressed	11.2a[x]	84.0a	10.9a	100.5a
Dibbled	8.8b	8.5b	9.6a	59.8b
Fertilizer rate				
50 grams	10.4a	36.4b	11.3a	72.4a
90 grams	9.6a	56.0a	9.3a	88.7a

[z]Spurge fresh weight in grams.

[y]Days after potting.

[x]Means (within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range test ($\alpha = 0.05$).

Table 2. Effect of fertilizer placement and rate on prostrate spurge control in #7 containers (Expt. 1).

	Yaupon holly		Wax leaf ligustrum	
	Spurge count 90 DAP[y]	Spurge weight[z] 90 DAP	Spurge count 90 DAP	Spurge weight 90 DAP
Fertilizer placement				
Topdressed	11.2a[x]	163.7a	14.5a	193.6a
Dibbled	6.3b	16.6b	6.7b	50.7b
Fertilizer rate				
90 grams	11.9a	85.8a	11.2a	105.7b
180 grams	10.9a	95.3a	10.0a	138.7a

[z]Spurge fresh weight in grams.

[y]Days after potting.

[x]Means (within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range test ($\alpha = 0.05$).

By 90 DAP there were no differences in prostrate spurge count or PWC, whether over-seeded or not (Table 3). This was most likely due to the high weed pressure in and around the study site. At 120 DAP ligustrum in seeded containers were statistically larger than those in non-seeded containers; however, this difference was not noticeable and would not be considered a marketable difference. By 90 DAP prostrate spurge count and PWC were 230 to 423% greater, respectively, for topdressed containers compared to dibbled containers. At 120 DAP, SDW was 313% greater for topdressed containers compared to dibbled containers. There was no difference in final plant growth index between fertilizer placement methods.

Experiment 3. There were no interactions between fertilizer placement and prostrate spurge seeding. By 90 DAP there was no difference in PWC, regardless of whether containers

Table 3. Effect of fertilizer placement and over-seeding on spurge control in #7 containers (Expt. 2).

	Ligustrum	Prostrate spurge							Ligustrum
	Growth index 0 DAP[w]	Count 60 DAP	% Coverage[z] 60 DAP	Count 90 DAP	% Coverage 90 DAP	Count 120 DAP	% Coverage 120 DAP	Weight[y] 120 DAP	Growth index[x] 120 DAP
Fertilizer placement									
Topdressed	56.0a[v]	0.9a	2.8a	6.8a	28.1a	17.1a	58.1a	18.6a	111.3a
Dibbled	54.9a	0.4a	1.9a	1.3b	8.5b	0.6b	8.6b	4.5b	110.8a
Seed source									
Seeded	55.6a	0.9a	3.4a	4.1a	21.4a	9.6a	35.9a	11.9a	115.1a
Non-seeded	55.3a	0.4a	1.3b	3.9a	15.3a	8.2a	30.8a	11.2a	107.1b

[z]Percent of container surface covered with weeds.

[y]Spurge dry weight in grams.

[x]Ligustrum growth index = (height + width + width) ÷ 3.

[w]Days after potting.

[v]Means (within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range test ($\alpha = 0.05$).

Table 4. Effect of fertilizer placement and over-seeding on spurge control in #7 containers (Expt. 3).

	Ligustrum	Prostrate spurge					Ligustrum
	Growth index 0 DAP[w]	Count 60 DAP	Count 90 DAP	% Coverage[z] 90 DAP	Count 120 DAP	Weight[y] 120 DAP	Growth index[x] 120 DAP
Fertilizer placement							
Topdressed	56.0a[v]	2.9a	3.6a	42.3a	7.1a	21.9a	95.6a
Dibbled	54.9a	2.1a	3.7a	20.0b	5.4b	9.9b	90.1b
Seed source							
Seeded	55.6a	4.0a	5.1a	37.2a	7.6a	25.1a	93.7a
Non-seeded	55.3a	0.9b	2.3b	25.1a	4.9a	6.8b	92.1a

[z]Percent of container surface covered with weeds.

[y]Spurge dry weight in grams.

[x]Ligustrum growth index = (height + width + width) ÷ 3

[w]Days after potting.

[v]Means (within a column and for each factor) with different letters are significantly different, according to Duncan's Multiple Range test ($\alpha = 0.05$).

were over-seeded or not (Table 4). At 120 DAP weed count and SDW were 31 and 121% greater in topdressed containers compared to dibbled containers. At 120 DAP seeded containers had a SDW 269% greater than non-seeded containers. By 90 DAP PWC was 111% greater among containers which were topdressed compared to dibbled containers. Analysis of the data indicated ligustrum in topdressed containers were larger than those in dibbled containers; however, these differences were not considered economically important.

Dibbling fertilizer minimizes the amount of nitrogen, phosphorus and potassium available at or near the container surface where weed seed germinate. Small seeded weeds like prostrate spurge with limited nutrient reserves would have difficulty obtaining needed nutrients in dibbled containers. It is likely that nutrient deficiencies of spurge seedlings resulted in the differences in prostrate spurge weight in the containers where dibbled fertilizer was used. It is also of importance to note that the high weed pressure in a study of this nature may contribute to increased weed seed germination. This is supported by work done by Hepburn et al. (4) where it was demonstrated that greater seed numbers result in greater weed pressure and increased weed seed germination.

In conclusion, data herein suggest that dibbling fertilizer results in reduced prostrate spurge growth when compared to topdressed fertilizer applications. Results were similar in tests conducted at two locations. Dibbling fertilizers is a cultural practice that can be incorporated into most nursery production systems to reduce weed pressure, resulting in less hand-weeding, less competition to the nursery crop and possibly fewer herbicide applications.

Literature Cited

1. Ball, V. 1991. Ball RedBook, 15th ed. Geo J. Ball Publishing, West Chicago, IL. pg. 395.

2. Chochran, B.L., L.A. Morrow, and R.D. Schirman. 1990. The effect of N placement on grass weeds and winter wheat responses in three tillage systems. Soil Tillage Res. 18:347–355.

3. Everaarts, A.P. 1992. Response of weeds to the method of fertilizer application on low-fertility acid soils in Suriname. Weed Res. 32:391–397.

4. Hepburn, V.F., C.H. Gilliam, A.C. Folmar, G.J. Keever, and D.J. Eakes. 1994. Influence of herbicide rate and weed pressure on prostrate spurge. Proc. Southern Nursery Res. Conf. 39:40–41.

5. Landis, T.D., R.W. Tinus, S.E. McDonald, and J.P. Barnett. 1990. Containers and Growing Media, Vol. Two, The Container Tree Nursery Manual. Agric. Handbk. 674. Department of Agriculture, Forest Service, Washington, DC.

6. Liebman, M., C.L. Mohler, and C.P. Staver. 2001. Ecological Management of Agricultural Weeds. Cambridge University Press, NY.

7. Meadows, W.A. and D.L. Fuller. 1983. Relative effectiveness of dibble applied vs. incorporated Osmocote for container grown woody ornamentals. Proc. Southern Nursery Res. Conf. 28:63–66.

8. Meadows, W.A. and D.L. Fuller. 1984. Plant quality and leachate effluent as affected by rate and placement of Osmocote and SREF on container grown woody ornamentals. Proc. Southern Nursery Res. Conf. 29:75–79.

9. Yeager, T.H., C.H. Gilliam, T.E. Bilderback, D.C. Fare, A.X. Niemiera, and K.M. Tilt. 1997. Best Management Practices Guide for Producing Container-Grown Plants. Southern Nursery Assoc., Marietta, GA.