Fertilizer Placement Effects on Weed Growth and Competition with Container-grown Ornamentals©[a]

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ABSTRACT

The objective of this study was to determine the effect of fertilizer placement on the growth of eclipta (*Eclipta prostrata*) and evaluate its competition effect in container-grown ornamental plants. Results indicated that subdressing at a depth of 7.5 cm resulted in a 50% decrease in eclipta growth in comparison with a topdress fertilizer treatment, but subdressing at 2.5 or 5 cm had no effect on eclipta growth. Growth of *Ligustrum lucidum* and *Buxus microphylla* were similar in pots that were subdressed at 2.5 or 5 cm, but growth decreased when pots were subdressed at a depth of 7.5 cm. Overall, results indicate that subdressing could be an effective weed management strategy but in order to prevent delays in production time, subdressing depth needs to be based on initial liner size.

Keywords: Buxus microphylla, eclipta (*Eclipta prostrata*), *Ligustrum lucidum*, weed control

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[a]Third Place- Charlie Parkerson Graduate Student Research Paper Competition

INTRODUCTION

Weed control is one of the most costly and challenging aspects in nursery production. While weeds can cause growth reductions in field-grown ornamentals, they have an even greater impact on container-grown plants because nutrients and water are more limited compared with field crops. Previous research has shown that a single weed can reduce ornamental growth by 40 to 60% over one season (Berchielli-Robertson et al., 1990). Even if competition were not a concern, container plants must be weed-free in order to be marketable, thus weed thresholds are very low compared with other agricultural systems.

Due to the cost of hand weeding and the challenges associated with preemergence herbicides, more integrated weed management strategies are needed for nursery production. One potential weed management strategy is strategic placement of controlled-release fertilizer (CRF). Currently, most growers fertilize container crops by incorporating (thoroughly mixing fertilizer with potting substrate prior to potting) or topdressing (placing the entire allotment of fertilizer on the media surface after potting). Two alternative or strategic approaches to fertilization include dibbling and subdressing fertilizer (Stewart et al., 2018). Dibbling is accomplished by placing fertilizer just below the rootball of the plant while potting. This method has been shown to be highly effective for weed control. In a study evaluating the effect of fertilizer placement on prostate spurge (*Euphorbia prostrata* L.), topdressing caused an 888% growth increase for compared with spurge growth in dibbled containers (Fain, 2004). While dibbling is effective, it is less commonly used due to a high concentration of fertilizer around the plant roots, which may cause phytotoxicity in some crops (Bir and Zondag, 1986).

Subdressing is another fertilization approach involving filling the pot approximately 50 or 75% with inert (non-fertilized) media, adding the fertilizer in a single layer, and then filling the remainder of the pot with inert media (Stewart et al., 2018). This results in the fertilizer being placed in a single layer, approximately two to three inches below the substrate surface. Crop roots can access the nutrients but germinating weed seedlings cannot. This also offers an advantage over dibbling because subdressing is typically not associated with phytotoxicity issues (Broschat and Moore, 2003).

Preliminary data has shown that subdressing fertilizer at a depth of 2 inches can reduce the growth of spotted spurge (*Euphorbia maculata*) and large crabgrass (*Digitaria sanguinalis*) by over 90% in soilless pine bark substrates (Marble, unpublished data). If subdressing consistently reduced weed growth, it could be used as part of an overall weed management plan in container crops. However, all previous research has focused on subdressing in terms of only weed growth or crop growth, but not both (Broschat and Moore, 2003). In order to utilize subdressing in containers, more research is needed to fully understand the competitive dynamics of weeds and crops under this fertilization method. The objective of this experiment was to first, determine germination and growth of eclipta in pots that been topdressed or subdressed at three different depths. Secondly, our objective was to determine the competitive effects of eclipta on two common ornamental species fertilized via topdressing or subdressing at three different depths.

MATERIALS AND METHODS

All experiments were conducted at the Mid-Florida Research and Education Center in Apopka, FL during the 2019 summer. In all studies, the potting substrate was a pinebark:sand (8:1 v:v) that was amended with 3 kg m^{-3} dolomitic lime prior to use. In all cases, pots were fertilized using 35 g of controlled-release fertilizer [Osmocote® Plus micronutriets 17-5-11 (8-9 mo.), ICL Specialty Fertilizers, Dublin, OH] based on manufacturer recommendations. Regardless of fertilizer placement, all pots were fertilized at the same rate. However, the control was not fertilized. All trials were conducted on a nursery pad in full sun, outdoor conditions and received 1.3 cm of overhead irrigation per day.

Eclipta germination and growth. The objective of this experiment was to determine if eclipta germination or growth is affected by fertilizer placement. Containers were filled with the aforementioned potting substrate and fertilized via topdressing, subdressing, or contained no fertilizer. Pots that were topdressed were filled with pine bark substrate, and 35 g of fertilizer was added to the container surface. For pots that were subdressed, the bottom portion of the container was filled either 2.5, 5, or 7.5 cm from the top with pine bark substrate, fertilizer was added, and then the remaining portion of the pot was filled with substrate. This resulted in subdressed containers with fertilizer being placed at depths of 2.5, 5, or 7.5 cm from the substrate surface. Another set of containers were included that only contained the pine bark substrate and no fertilizer was added to serve as a non-fertilized control. After filling, all containers were placed on a full sun container pad and 25 eclipta seeds were surface sown. After four weeks, weed counts were taken to determine differences in germination between the different fertility placements. A second study was installed at the same time following the same procedures except that after four weeks, pots were thinned (hand weeded) so that only one eclipta plant was in each container. The eclipta plant in each pot was allowed to grow for 12 weeks to determine the effects of fertilizer placement on eclipta growth. Data collected included eclipta growth index (average of plant height and two perpendicular width measurements), final shoot, and root dry weight determination at trial conclusion, which was 12 weeks after potting (WAP). Substrate pH and EC was also assessed on a bi-weekly basis throughout the trial. Both experiments were completely randomized designs with four single pot replications per treatment. All data were subjected to analysis of variance in JMP software (SAS Institute, Cary, NC) and means separation was performed using Tukey's Honest Significance Differences test at $P = 0.05$. For sake of brevity, only eclipta germination and growth index data is presented and discussed.

Eclipta competition with ornamentals. The objective of this experiment was to assess the competitive effects of eclipta on two ornamental species fertilized via topdressing or subdressing at depths of 2.5, 5, or 7.5 cm. Pots were filled and fertilized as described above except the non-fertilized control was not included. Uniform liners of ligustrum (*Ligustrum lucidum*) and Japanese boxwood (*Buxus microphylla*) grown in 5-cm plug trays were transplanted into separate sets of containers after filling. A separate set of containers were fertilized as described above but were left fallow and contained no ornamental plant. At 3 days after potting, eclipta seedlings that had been germinated in a separate set of pots were transplanted into half of the pots containing ligustrum and half the pots containing boxwood. Eclipta seedlings contained two true leaves, were approximately 1-cm in diameter, and had emerged two weeks prior to transplanting. In ornamental pots containing eclipta, the eclipta was placed 2.5 cm from the ornamental rootball. In fallow containers, eclipta was transplanted into the center of the container. This resulted in boxwood and ligustrum being fertilized via topdressing or subdressing at three different depths (2.5, 5, or 7.5 cm) and either containing one eclipta plant to assess competition or being hand-weeded on a bi-weekly basis and having no weed competition. Eclipta growth was also monitored both when grown in fallow containers and when it was grown in containers with ornamentals to determine if ornamentals had any negative influence on eclipta growth. Data collected included growth index measurements on ornamentals at 8 and 12 WAP, root and shoot dry weight determination for ornamentals and eclipta at 12 WAP, eclipta seed production at 12 WAP, and foliar nutrient concentrations at 12 WAP. To determine the significance of trends in ornamental or eclipta growth based on fertilizer depth, orthogonal contrast analysis was also performed and were considered significant at $P = 0.05$. Multiple comparison procedures were performed as described above to make individual comparisons of crop growth based on fertilizer depth. For sake of brevity, only shoot and root dry weight data are discussed for ornamentals and eclipta.

RESULTS AND DISCUSSION

Eclipta germination and growth. Eclipta germination was similar in all treatments regardless of fertilizer placement, ranging from 56 to 66% (Table 1). However, subdressing at a depth of 7.5 cm resulted in a greater than 50% growth decrease in comparison with topdressed pots. Eclipta did not grow past the cotyledon stage in non-fertilized pots. These data indicate that subdressing could be an effective management method for eclipta, but depths of 7.5 cm would be needed. The greater fertilizer placement at 7.5 cm is required because Eclipta can grow deep roots soon after germination - even in the absence of fertilizer (Fig. 1). In these studies, results suggest eclipta roots reached the fertilized layer in contrast to other trials with spurge or crabgrass, which were unable to do so (Stewart et al., 2018).

Ornamental growth. Averaged over all fertilizer treatments, eclipta reduced shoot growth of boxwood by 5% and ligustrum by 16% over a 12-week period (Table 2). Boxwood growth was minimal in all treatments, likely because this is a slower growing species, thus competitive effects were not as evident in this short-term study. In contrast, ligustrum shoot data showed that growth tended to decrease in a linear manner as fertilizer depth increased. When comparing individual treatments, ligustrum growth was similar in pots that were topdressed and subdressed at 2.5 or 5 cm, both with and without eclipta competition. Both crop species had similar root growth regardless of eclipta competition. While boxwood roots grew similarly regardless of fertilizer placement, ligustrum root growth tended to decrease as fertilizer depth increased.

Overall, this trial indicates that subdressing could be an effective management tool for eclipta if depths of at least 7.5 cm were used. Previous research has also shown that depths of 2.5 cm are effective for spotted spurge, crabgrass, bittercress (*Cardamine flexuosa*) and liverwort (Stewart et al., 2017). However, for eclipta, a depth of 7.5 was needed to reduce growth. This depth could slow the production time of ornamentals in smaller 3.8 L containers as was observed for ligustrum and boxwood in this trial.

For both species, liners had root balls of 2.5 cm wide by 2.5 cm deep. Liners had no contact with fertilizer, at least initially, when fertilizer was subdressed at 7.5 cm. When rootballs were in contact with fertilizer (topdressing or subdressing at depths of 2.5 or 5 cm), no differences in shoot growth was observed in comparison with the industry standard of topdressing. This indicates that subdressing depth should be based on initial liner size. While eclipta or other species may not be well controlled at shallower subdressing depths, many other weed species would be as outlined in previous research reviews (Stewart et al., 2017). Future research is planned in order to develop recommendations for subdressing depth based on liner size. This would allow growers to subdress fertilizer at proper depths that do not decrease crop growth. Evaluating other predominate weed species would also provide information to growers on which weed species could be controlled with subdressing, and the critical depth that is needed for a particular weed species. When combined, this information could be used by growers to implement subdressing to help reduce hand weeding costs and possibly eliminate one or more herbicide applications throughout the year to provide additional cost savings.

Literature Cited

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Figure 1. Eclipta rooting in a pot subdressed at a 7.5 cm depth. Note the thin white roots growing into contact with fertilizer layer. Darker tan roots are *Ligustrum lucidum*.

Table 1. Eclipta germination and growth in response to fertilizer placement.

Placement[a]	Germination (counts/pot^{-1})[b]	Growth index (cm)[c]
Topdress	15.3 a[d]	27.1 a
Subdress 2.5 cm	16.6 a	25.8 a
Subdress 5.0 cm	14.0 a	20.1 ab
Subdress 7.5 cm	16.1 a	13.0 b
No fertilizer	15.6 a	0.0 c*

[a]Placement refers to the location of 35 g of 17-5-11 (8 to 9 month) controlled release fertilizer in the container.

[b]Eclipta counts at 4 weeks after surface sowing 25 seeds per container.

[c]Average of plant height and two perpendicular width measurements.

[d]Means followed by the same letter within a column are not significantly different according to Tukey's HSD (P = 0.05).

*Indicates a mean growth index of less than 1 cm.

Table 2. Competitive effects of *Eclipta prostrata* on container-grown *Ligustrum lucidum* and *Buxus microphylla* as influenced by fertilizer placement.

Depth (cm)[c]	Boxwood					
	Shoot wt.[a]			Root wt.[b]		
	weeded	w/eclipta	decrease (%)[d]	weeded	w/eclipta	decrease (%)
0.0	21.8 ab[e]	20.3 ab	7	17.6 a	17.7 a	-1
2.5	23.0 a	22.5 a	2	17.8 a	18.1 a	-2
5.0	22.5 ab	20.1 ab	11	17.7 a	17.3 a	2
7.5	19.7 b	19.8 b	-1	17.2 a	17.3 a	-1
Mean	21.7 A[f]	20.7 B	5	17.6 A	17.6 A	0
Linear	NS[g]	NS		NS	NS	
Quadratic	**	NS		NS	NS	
	Ligustrum					
0.0	43.4 a	33.6 a	23	22.6 a	22.8 a	-1
2.5	38.2 a	32.6 a	15	21.9 ab	21.2 ab	3
5.0	34.1 ab	28.0 ab	18	19.7 bc	19.9 b	-1
7.5	26.1 b	24.5 b	6	19.3 c	20.1 b	-4
Mean	35.4 A	29.7 B	16	20.9 A	21.0 A	-1
Linear	***	***		***	**	
Quadratic	NS	NS		NS	NS	

[a]Shoot dry weight grown either weed free ("weeded") or in competition with one eclipta plant ("w/eclipta) over 12 weeks.

[b]Shoot dry weight grown either weed free ("weeded") or in competition with one eclipta plant ("w/eclipta) over 12 weeks.

[c]Depth of 35 g of Osmocote 17-5-11 (8 to 9 month) controlled release fertilizer. Depth of 0 cm is a topdress

application.

[d]Percent decrease in growth resulting from eclipta competition over 12 weeks. Negative values indicate a percent increase in growth.

[e]Means within a colum and variable (shoot or root dry wt.) followed by the same lowercase letter are not significantly different based on Tukey's HSD at $P = 0.05$.

[f]Means within a row and variable (shoot or root dry wt.) followed by the same uppercase letter are not significantly different based on t-tests $P = 0.05$.

[g]*, **, and *** represent significant linear or quadratic responses at $P = 0.05$, 0.01, and 0.001, respectively based on orthogonal contrasts. NS = not significant.