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GROWTH OF FIVE SPECIES OF CONTAINERIZED ORNAMENTALS AS INFLUENCED BY SIX COMMERCIAL FERTILIZER SOURCES[1]

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Abstract. **Nitrogen equivalent to 2,800 kg/ha/yr (2,500 lbs/a/yr) was applied in two equal portions 4 months apart to 5 species of containerized ornamentals and was derived from the following commercial fertilizer sources: A, Organic Turfmaster[R] 16-4-8 (16-1.7-6.6); B, Osmocote[R] 18-6-12 (18-2.6-10.0); C, Pro-Gro[R] 31-6-5 (31-2.6-4.2); D, Sta-Green[R] 19-5-10 (10-2.2-8.3); E, Sure Gro[R] 14-14-12 (14-6.1-10.0); and F, Tri-Nite[R] 16-1-0 (16-.4-0). Treatments by source were: A alone; B alone; B (90% of Total N); plus F (10% of Total N); C alone; C (90% of total N) plus F (10% of total N); D alone; and E alone. Source F was used only as a micronutrient source supplement for the other materials which did not guarantee trace elements in the analysis. Plants used were:** Anthurium tikalense **Lundell,** Brassaia actinophylla **Endl.,** Chrysalidocarpus lutescens **H. Wendl.,** Ixora coccinea **L., and** Podocarpus macrophylla **D. Don. Plants were ranked for quality, changes in growth were determined, root growth was evaluated, and media soluble salts content and pH were measured. In general, treatments B, B+F, and E resulted in consistently good growth and quality, while other treatments resulted in inconsistent to poor results. Soluble salts and pH were low in all treatments.**

Fertilizer must be applied frequently and regularly during the commercial production of ornamental plants to promote rapid growth and good quality. The use of a slow-release fertilizer reduces the number of fertilizer applications required for a given crop and reduces waste due to leaching. Osmocote[R], one of the first slow-release fertilizers available, has been used by many growers for a number of years. Its slow-release properties are based on a resin coating. Other slow-release fertilizer manufacturers using a sulfur-coating, urea formaldehyde, or isobutylidene diurea (IBDU) to impart slow-release properties to their products and some have included micronutrients in them. Osmocote does not claim to contain any micronutrients, and these are commonly deficient in most Florida nursery soil mixes. Growers are faced with either utilizing a soil mix to which micronutrients have been added or adding them with the first application of fertilizer.

Six commercial slow-release fertilizers used in south Florida were evaluated on 5 commonly grown species of ornamental plants to determine whether differences in plant growth would occur if each were applied at the same rate of nitrogens, and whether the addition of micronutrients to fertilizers not containing them would influence growth.

Materials and Methods

Liners of *Anthurium tikalense, Brassaia actinophylla* (schefflera), *Chrysalidocarpus lutescens* (areca palm), *Ixora coccinea* cv. Super King, and *Podocarpus macrophylla* were planted in gallon plastic pots (15.2 cm diam. (6 inches)) in a soil mix containing 20% sand, 50% coarse cypress sawdust, and 30% Florida peat by volume and amended with 5.9 kg/m^3 (10 lbs/yd^3) dolomitic limestone. Well water was supplied to each plant using an emitter in each container. Plants were grown on raised benches under a woven polypropylene fabric supplying 47% shade. The following fertilizer materials were used in the experiment: Organic Turfmaster[R2] (O.T.) 16-4-8 (16-1.7-6.6) slow release fertilizer with micronutrients (1.2 Mg .8 Mn, 1.4 Fe, Osmocote[R3] (Os) 18-6-12 (18-2.6-10); Pro-Gro[R4] (P.G.) 31-2.6-4.2) slow release without micronutrients; Sta-Green[R5] (S.G.) 19-5-10 (19-2.2-8.3) containing 9% water insoluble organic nitrogen and micronutrients (.05 Mn, 1.01 Fe, .05 Cu, .02 B, .042n, trace Mo, 2.25 S), Sure-Gro[R6] (S.Gro) 14-14-12 (14-6.1-10) sulfur coated slow release fertilizer with micronutrients; 1.33 Mg, 0.7 Mn, 1.58 Fe, 0.3 Cu, .03 B, .07 Zn, trace Mo) and Tri-Nite (T.N.)[7] 16-1-0 (16-0.4-0) high organic 50% ureaformaldehyde based fertilizer with micronutrients (1.8 Mg, 1.5 Mn, 3.5 Fe, .2 Cu, .12n, 5.0 S). T.N. was only used as a micronutrient source supplement in combination with those fertilizers not containing micro-nutrients and was used at a rate such that it supplied 10% of the total nitrogen applied at each application. On an annual basis, nitrogen equivalent to 2,800 kg/ha (2,500 lbs/a) was applied in 2 equal portions 4 months apart in the following treatments: O.T.; Os.; Os. plus T.N.; P.G., P.G. plus T.N.; Sta G., and S.Gro. Seven replicates of each treatment were arranged in a randomized complete block design.

The ht and width of each plant were measured on the initial application date, Feb. 21, on the second application date, June 21, and on Sept. 21, when the experiment was terminated. In June and September the plants in each replication of treatments were ranked for quality visually on the basis of color, size and appearance as explained in Table 1. Increases in plant size were determined and compared at each evaluation time using a growth index (G.I.), calculated by dividing the sum of the height and width of each plant by 2.

At the conclusion of the experiment containers were removed from the root balls of the plants and the root systems graded for both quantity and quality as explained in Table 2. In cases where too few of the roots were visible for an accurate quality score, the roots were exposed by removing some soil.

When the roots were evaluated, soil samples were taken from the lower half of the root ball to avoid removing any fertilizer which may have been near the top of the ball. A saturation paste extract (1) was obtained from each sample and the pH and conductivity of each determined.

Shoot and root fresh wt of all areca palms and podocarpus plants were taken for each treatment and compared. Analysis of variance was used to determine significant differences, with Duncan's New Multiple Range Test used to separate means at the p=0.05 level to determine significant differences between rankings (2).

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[1]Florida Agricultural Experiment Station Journal Series No. 871. The use of a trademark name does not constitute a guarantee nor warranty of the product by the University of Florida and does not imply its approval to the exclusion of other products that may also be suitable.

[2]Kerr McGee Chemical Corp., Jacksonville, FL
[3]Sierra Chemical Corp., Newark, C.A.
[4]O.M. Scott, Marysville, OH
[5]Sta-Green Plant Food Co., Sylacauga, AL
[6]Nurserymans Sure-Gro Corp., West Palm Beach, FL
[7]Florida East Coast Fertilizer Co., Homestead, FL

Table 1. Quality ranking[z] of 5 species of containerized ornamentals as influenced by six commercial fertilizer sources 4 months after the first application and 3 months after the second.

Fertilizer Source	Anthurium	Brassaia	Chrysalidocarpus	Ixora	Podocarpus
Organic Turfmaster	3.4 b[y]	3.7 c	4.5 b	4.1 bc	4.0 bc
Osmocote	5.9 a	6.7 b	7.1 a	6.9 a	5.9 a
Osmocote + Tri-Nite	6.3 a	7.8 a	6.5 ab	6.0 a	6.0 a
Pro-Gro	6.0 a	4.7 c	5.0 b	4.0 bc	5.1 b
Pro-Gro + Tri-Nite	6.0 a	4.0 c	4.1 bc	3.6 bc	5.2 b
Sta-Green	1.3 c	1.1 d	2.1 c	2.6 bc	1.3 d
Sure-Gro	5.1 a	6.0 b	4.8 b	7.1 a	6.3 a
50% of Turfmaster	2.0 bc	1.8 d	1.5 c	1.7 c	2.1 c
(three months after second application)					
Organic Turfmaster	5.1 ab	5.1 a	6.7 a	5.7 a	5.9 a
Osmocote	6.9 a	6.6 a	5.1 abc	7.1 a	6.4 a
Osmocote + Tri-Nite	6.7 a	7.4 a	6.6 ab	6.1 a	6.0 a
Pro-Gro[x]	3.4 bc	3.6 b	5.6 ab	3.1 b	3.4 b
Pro-Gro + Tri-Nite[x]	2.9 c	3.3 b	3.7 bcd	3.6 b	3.9 b
Sta-Green	2.4 cd	1.7 c	2.0 cd	1.9 c	2.1 c
Sure-Gro	7.0 a	6.9 a	4.7 abcd	7.0 a	7.0 a
50 % of Turfmaster	1.6 d	1.4 c	1.6 d	1.4 c	1.4 c

[z]Each replication of treatments ranked from best (8) to worst (1) quality on a combined color-size-appearance basis.
[y]Means within columns followed by the same letter are not significantly different at the p=0.05 level according to the Kruskal-Wallis Test and Ryans Procedure.
[x]Not reapplied a second time.

Table 2. Change in growth index[z] of 5 species of containerized ornamentals as influenced by six commercial fertilizer sources 4 months after the first application and total change in growth index measured 3 months after the second application

Fertilizer Source	Anthurium	Brassaia	Chrysalidocarpus	Ixora	Podocarpus
	Growth index change 4 months after first application				
Organic Turfmaster	11.4 b[y]	10.0 c	6.5 a	4.9 a	4.7 abc
Osmocote	16.8 a	15.1 ab	6.5 a	5.8 a	6.7 a
Osmocote + Tri-Nite	16.2 a	16.8 a	7.6 a	5.9 a	7.1 a
Pro-Gro	14.3 ab	12.1 bc	7.8 a	3.8 ab	4.2 abc
Pro-Gro + Tri-Nite	14.6 ab	10.6 c	5.8 a	3.2 ab	5.3 ab
Sta-Green	3.2 c	2.2 d	4.5 a	—0.5 b	2.1 bc
Sure-Gro	15.5 ab	15.0 ab	7.8 a	6.8 a	7.2 a
50% of Turfmaster	6.1 c	3.3 d	7.8 a	5.8 a	1.1 c
	Total (7 Month) growth index change				
Organic Turfmaster	40.3 a	29.1 b	14.7 bc	25.2 b	16.3 a
Osmocote	44.9 a	36.6 a	14.3 bc	17.1 c	16.0 a
Osmocote + Tri-Nite	45.2 a	36.2 a	23.5 a	17.6 c	18.3 a
Pro-Gro[x]	32.4 b	18.7 c	15.9 b	8.0 d	7.2 b
Pro-Gro + Tri-Nite[x]	30.9 b	19.0 c	12.1 bc	7.4 d	7.4 b
Sta-Green	24.8 c	6.5 d	7.6 c	0.1 e	4.8 b
Sure-Gro	41.2 a	37.9 a	13.5 bc	32.0 a	20.1 a
50% of Turfmaster	23.0 c	6.4 d	7.9 c	5.4 de	2.2 b

[z]Growth index = (Ht + Width) ÷ 2.
[y]Means within columns followed by the same letter are not significantly different at the p = 0.05 level according to Duncan's New Multiple Range Test.
[x]Not applied a second time.

Results and Discussion

First evaluation. With the exception of schefflera, Os, Os + T.N., and S. Gro treatments resulted in plants of similarly high quality (Table 1). Schefflera alone appeared to benefit from the addition of T.N. to Os. P.G. treatments resulted in high quality anthurium plants but only fair quality in the others. With the exception of anthurium, O.T. treatments were comparable to P.G. treatments. Sta G. treatments resulted in plants of inferior quality for all species, being comparable to the 50% rate of O.T., except with podocarpus where Sta G. ranked lowest.

Plant growth as measured by the change in G.I. after 4 months followed a similar pattern, with no significant difference between Os, Os + T.N. and S. Gro treatments for any species, Table 2. These treatments resulted in consistently greater growth of all 5 species than did any other. The Sta G. and 50% O.T. treatments were comparable, and resulted in less growth than other fertilizers in most instances.

Second evaluation. Unfortunate circumstances left an insufficient amount of Pro-Gro to allow for a second application and we were unable to obtain any locally. However, treatment data from the second evaluation period were included for completeness and because some of the treatments revealed interesting differences.

Plant quality ranking again revealed uniformly high quality with no differences between plants treated with Os., Os. + T.N., S. Gro, or O.T. (Table 1). Of interest is the generally better ratings of the P.G. and P.G. + T.N. treatments than the Sta-G. or 50% O.T. treatments, even though P.G. was applied only once.

Total growth as measured by the 7 month G.I. value re-

Table 3. Quantity[z] and quality[y] of roots of 5 species of containerized ornamentals as influenced by six commercial fertilizer sources.

Fertilizer Source	Anthurium		Brassaia		Chrysalidocarpus		Ixora		Podocarpus	
	Quant.	Qual.	Quant.	Qual.	Quant.	Qual.	Quant.	Qual.	Quant.	Qual.
Organic Turfmaster	8.9 ab[x]	10.0 a	8.0 b	10.0 a	4.7 abc	8.4 ab	8.3 ab	9.6 ab	3.9 abc	10.0 a
Osmocote	10.0 a	10.0 a	9.1 ab	10.0 a	4.1 bc	7.9 ab	6.9 bcd	9.6 ab	5.3 a	10.0 a
Osmocote + Tri-Nite	10.0 a	10.0 a	8.7 ab	10.0 a	5.3 ab	9.6 ab	7.9 abc	10.0 a	4.9 ab	10.0 a
Pro-Gro[w]	7.6 bc	10.0 a	4.7 cd	6.1 cd	6.4 a	10.0 a	6.4 cde	10.0 a	3.3 c	9.0 a
Pro-Gro + Tri-Nite[w]	7.3 c	10.0 a	5.0 c	7.3 bc	5.0 abc	10.0 a	6.1 de	9.6 ab	3.6 bc	10.0 a
Sta-Green	5.3 d	10.0 a	3.3 d	5.4 d	3.6 bc	9.3 ab	5.3 e	9.6 ab	3.6 bc	9.6 a
Sure Gro	10.0 a	10.0 a	9.6 a	9.3 a	3.3 c	7.6 b	9.1 a	10.0 a	5.0 ab	10.0 a
50% of Turfmaster	5.0 d	10.0 a	3.6 cd	8.1 ab	4.1 bc	10.0 a	5.0 e	8.7 b	2.4 c	10.0 a

[z]Quantity scoring: 10 = numerous intertwined roots at periphery of root ball, little or no soil without roots; 7 = less root activity than 10 but still abundant on sides and bottom, some bare soil at edge of ball; 5 = few roots on sides of ball, more on bottom with less roots than 7; 3 = very few roots at sides or bottom of ball; 1 = no roots at surface of ball.
[y]Quality scoring: 10 = healthy white feeder roots with no browning or burning; 7 = generally all healthy and active roots, but a few brown or burned roots present; 5 = up to 25% of roots browned or burned, but some white feeder root activity present; 3 = few healthy, active roots, from 25-50% browned or burned roots; 1 = roots mostly dead or inactive.
[x]Means within columns followed by the same letter are not significantly different at the p=0.05 level according to Duncan's New Multiple Range Test.
[w]Not applied a second time.

vealed several differences not shown by the previous comparisons, Table 2. O.T., Os, Os + T.M., and S. Gro resulted in the best growth of anthurium and of podocarpus. Os, Os + T.N., and S. Gro resulted in the best growth of schefflera, while Os + T.N. was the best on areca palm and S. Gro was best on Ixora. T.M. was almost as good on ixora as S. Gro. Sta G. and the 50% O.T. rate consistently resulted in the least growth, bettered in several instances by the P.G. or P.G. + T.N. treatments, despite the fact that they were applied only once.

Root quantity and quality evaluations yielded data which closely paralleled shoot data (Table 3). Good shoot growth was accompanied by abundant, healthy root growth.

Measurements of the conductivity (soluble salts content) of soil extracts from the treatments yielded low values, although there were significant differences between treatments (Table 4). The fresh, unleached soil-mix contained the greatest amount of soluble salts, possibly due to salts in the peat or sawdust source. Excluding the fresh media, conductivity readings were all similar in the Os., Os. + T.N., and S. Gro treatments. Conductivity readings were significantly lower and did not differ from each other for O.T., P.G., P.G. + T.N., Sta G., and the 50% T.M. treatments. Considering that the P.G. and P.G. + T.N. treatments were applied only once, the similarity in readings between these treatments and those of the T.M. and Sta G. treatments indicates that the release of P.G. is a lengthy process.

The soil pH was quite low in the starting material and was not changed by P.G., P.G. + T.N., Sta G., or the 50% T.M. treatments. It was reduced slightly by Os. and Os. + T.N., and somewhat more by S. Gro. From these data it would appear that T.N. has no effect on pH, but that Os will depress it slightly. The lowered reading for S. Gro may have resulted from oxidation of the sulfur coating to sulfuric acid. In cases where the initial pH is quite low (as was the case in this experiment) any further reduction should be avoided. However, certain media components and most irrigation waters in south Florida are alkaline, and a slight reduction in pH by the fertilizer would be beneficial under such circumstances. In general, a change of less than 1 pH unit would not be expected to affect materially plant growth.

Shoot and root fresh weights were affected differently by the treatments on areca palm and podocarpus (Table 5). Areca responded best to Os. and Os. + T.N., with O.T. resulting in the second best growth of both shoots and roots. Other treatments did not differ significantly from the results obtained with the 50% O.T. application rate, although P.G. and P.G. + T.N. shoot and root weights were both more than double those of the 50% O.T. rate. This again points to the long residual activity of P.G. S. Gro was the best fertilizer on podocarpus, with O.T., Os and Os = T.N. treatments resulting in similar growth all substantially above that obtained with Sta G. and the 50% O.T. treatments.

Table 4. Conductivity and pH of a saturated past extract from soil treated twice with 6 commercial fertilizer sources over a seven month period as measured after 7 months.

	Conductivity mhos x 10^{-5}	pH
1. Organic Turfmaster	.12 c[zy]	4.2 b
2. Osmocote	.27 b	4.2 b
3. Osmocote + Tri-Nite	.22 b	4.2 b
4. Pro-Gro[x]	.11 c	4.5 a
5. Pro-Gro + Tri-Nite[x]	.11 c	4.5 a
6. Sta-Green	.12 c	4.5 a
7. Sure-Grow	.23 b	3.8 c
8. 50% dose of #1	.11 c	4.6 a
9. Fresh, unleached soil mix	.48 a	4.6 a

[z]Means from 14 replicates.
[y]Means within columns followed by the same letter are not significantly different at the p=0.05 level according to Duncan's New Multiple Range Test.
[x]Not applied a second time.

Table 5. Shoot and root fresh wt of *Chrysalidocarpus lutescens* and *Podocarpus macrophylla* as influenced by 6 commercial fertilizer sources.

Fertilizer Source	Chrysalidocarpus		Podocarpus	
	Shoot wt. (gm)	Root wt. (gm)	Shoot wt. (gm)	Root wt. (gm)
Organic Turfmaster	24.0 bc[z]	11.5 abc	20.7 b	7.5 abc
Osmocote	33.8 ab	12.8 ab	20.8 b	6.7 bcd
Osmocote + Tri-Nite	36.4 a	14.9 a	21.9 b	8.6 ab
Pro Gro[y]	18.2 cd	12.5 abc	9.7 c	5.0 cde
Pro Gro + Tri-Nite	15.5 cd	9.9 abcd	11.0 c	6.2 bcde
Sta Green	8.5 d	5.1 cd	5.5 c	3.7 de
Sure-Gro	13.3 cd	5.8 bcd	32.3 a	10.6 a
50 % of Turfmaster rate	6.4 d	4.7 d	4.3 c	3.1 e

[z]Means within columns followed by the same letter are not significantly different at the p=0.05 level according to Duncan's New Multiple Range Test.
[y]Not applied a second time.

Although conductivity readings were similar between the S. Gro and O.S. and Os + T.N. treatments, the shoot and root growth of areca palm was much less with S. Gro. It would appear that the low pH could have been a contributing and, perhaps major, factor in the response inasmuch as low pH has been associated with poor growth of areca palms (3). Ixora, by contrast, grew best at the lowest pH (S. Gro).

The only clear difference in any factor evaluated which may have been caused specifically by the addition of micronutrients occurred in the quality ranking of schefflera between Os and Os + T.N. (Table 1). However, this difference was not observed between P.G. and P.G. + T.N. These results indicate that there was probably enough micronutrient "contamination" of the various chemicals used in the manufacture of these fertilizers to supply most plant needs in a small container over a time span such as was used in this experiment so that the addition of supplemental micronutrients was not important. However, plants requiring longer growing periods will likely require the addition of some kind of micronutrient component for proper growth.

The efficiency of nutrient uptake from various slow release fertilizers for ornamental plants varies between plant species. Through natural selection plants have developed fairly specific physical requirements for optimal growth such as soil type, soil pH, soluble salts, and nutrient availability. Thus for plants adapted to acid conditions such as ixora and podocarpus, acid fertilizers were superior to others in this test. Other plants, such as areca palms, which require more nearly neutral soil conditions, did not respond as well to the more acid fertilizers. Two nitrogen sources, Osmocote and Sure-Gro showed the most consistent results in providing adequate nutrient levels to container-grown ornamental plants, although in some cases specific plant species may have responded better to another fertilizer tested.

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EFFECTS OF OXADIAZON PREEMERGENCE HERBICIDE ON WEED CONTROL AND GROWTH OF SIXTEEN SPECIES OF CONTAINERIZED ORNAMENTAL PLANTS[1]

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Abstract. **Oxadiazon (Ronstar(R))[2] 2G (2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl) —Δ^2 —1,3,4 oxadiazoline-t-one) was applied at rates of 0, 2.24, 4.48, and 8.96 kg a.i./ha (0,1,4, and 8 lbs a.i./acre), 4 times at 6 week intervals to 16 species of ornamentals growing in 15.2 cm diam. plastic containers during the spring and summer of 1977. Plants were:** Araucaria heterophylla **Franco (Norfolk Island pine),** Asparagus densiflorus **Jessop (Sprengeri Fern);** Brassaia actinophylla **Endl. (schefflera);** Chrysalidocarpus lutescens **H. Wendl. (areca palm);** Citrus **(seedling 'Temple' orange)[3];** Codiaeum variegatum **Blume (croton);** Eriobotrya japonica **Lindl. (loquat);** Eugenia uniflora **L. (Surinam Cherry);** Ficus benjamina **L. (Benjamin Fig);** Gardenia jasminoides **Ellis (gardenia);** Ixora coccinea **L. (red ixora);** Ligustrum japonicum **Thunb. (ligustrum 'recurvifolia');** Livistona chinensis **R. Br. ex Mart. (Chinese Fan Palm);** Murraya paniculata **Jack (orange jasmine);** Podocarpus macrophylla **D. Don (podocarpus);** Severina buxifolia **Ten. (Chinese Box Orange). With the exceptions of** Gardenia, Livistona, **and** Podocarpus, **none of the plants were affected by any treatment. The growth index (G.I.; (ht + width) ÷ 2) of** Gardenia **treated with 8.96 kg rate was greater (P = .05) than those of the other rates, while the G.I.'s of** Livistona **at the 2.24 and 4.48 kg rates were greater than the 0 or 8.96 kg rates, which were similar to each other. All G.I.'s of** Podocarpus **were similar and larger than that of the 0 rate. Weeds harvested from treatments averaged 2.8 g/pot for the 0 rate; 0.8 g/pot at 2.4 kg; 0.6 g/pot at 4.5 kg; and 0.1 g/pot at 9.0 kg. Weed genera controlled were identified and their frequency of occurrence in the treatment replicates were tabulated; control of** Pilea **was 100% at all rates above 0.**

Weed control is essential in the efficient, profitable prodution of both container grown and field grown ornamental plants. Weeds effectively compete for fertilizer, light and water needed by the ornamental, and some weeds secrete inhibitory (alleolopathic) substances which further retard the growth of the ornamental (2, 7, 9, 13). Container grown plants are particularly vulnerable to competition because their root systems are very restricted.

Hand weeding is very expensive, with costs being estimated as much as \$8,800/ha/year (\$3,560/acre/year) (5). Considerable work on the use preemergence-type herbicides on ornamental plants has been done in various states including Florida, and results indicate that certain materials can be used effectively and safely on certain species at great cost savings (5, 10, 11). However, the use of any pesticide (herbicides are classified as pesticides) for other than a use specified on the label is a violation of the law, and no preemergence-type herbicides have been labeled for use on container grown ornamental plants as of late 1977.

Research is being done with preemergence herbicides to establish phytotoxicity and efficacy data which are necessary to labeling procedures. Oxadiazon is one of several preemergence herbicides which has been investigated by other researchers (5, 10, 11, 13, 14) as having potential for use on containerized ornamentals. This paper describes work done

[1]Florida Agricultural Experiment Station Journal Series No. 870.
[2]Mention of a trademark name should not be contrued an endorsement of one proprietary product by the University of Florida over another one possessing equivalent characteristics.
[3]'Temple' is a reputed tangor (tangerine x orange). Ed.