Rogers, E. M. 1983. Diffusion of innovations (3rd Ed.). The Free Press, New York.
Silva-Santos, R. H. and I. M. Cardoso. 1992. Opinion: alternative agriculture in the third world. Amer. J. Alt. Agr. 7:98.
Swisher, M. E. and E. A. Bastidas. 1994. Florida's tomato producers: Are they moving toward sustainability? Fla. Scientist, 57(4):61-70.
Thomas, J. K., H. Ladewig, and W. A. McIntosh. 1990. The adoption of integrated pest management practices among Texas cotton growers. Rural Soc. 55(3):395-410.
York, E.T. 1988. Improving sustainability with agricultural research. Environ. 30(9):18-20, 36-40.

Proc. Fla. State Hort. Soc. 107: 211-215. 1994.

PREEMERGENCE HERBICIDES FOR CALADIUMS

JAMES P. GILREATH AND BRENT K. HARBAUGH
University of Florida
Gulf Coast Research & Education Center
5007 60th St. E.
Bradenton, FL 34203
and
DONALD BATES
Bates and Sons and Daughters
Lake Placid, FL 33852

Additional index words. weed control, tuber, *Caladium* X *hortulanum.*

Abstract. **Five herbicides were evaluated for phytotoxicity to caladiums (*Caladium* X *hortulanum* Birdsey) grown in a greenhouse in 1991. The four most effective herbicides from 1991 plus oryzalin and pronamide were evaluated for crop phytotoxicity and weed control in a field trial on mineral soil during 1992. The most promising three herbicide treatments (metolachlor, flumetralin and a combination of isoxaben and oryzalin) were compared to oryzalin alone for weed control and crop response in a field trial on organic (muck) soil in 1993. Herbicide treatments were applied twice to methyl bromide fumigated and non-fumigated soil. Neither herbicide nor fumigation affected caladium plants. Annual sedge was controlled with metolachlor and flumetralin. Fumigation reduced the number of annual sedge, dayflower and pigweed plants but herbicide had no effect on pigweed or dayflower. Tuber yield was not influenced by herbicide treatment. Fumigation increased number of mammoth and jumbo size tubers but had no effect on smaller sizes or the total number of tubers. Although number of mammoth and jumbo tubers increased, the total crop value was not affected by fumigation. Metolachlor, flumetralin, oryzalin, and a combination of isoxaben and oryzalin appear to be possible options for weed control in caladiums; however, metolachlor and oryzalin are the most likely to be used by growers.**

Weed control is a major expense in caladium tuber production in Florida (Scudder, 1961). Growers rely on herbicides and hand weeding since cultivation often injures the shallow root system of caladium plants (Gilreath and Harbaugh, 1985). Weed control is most critical during the first 3 to 4 months of tuber production before caladium plant canopy closure of the space between rows. During this time herbicides may be applied as many as three times, although twice is more normal. Additional applications of herbicide later in the season may be necessary if caladium plants do not produce enough foliage to shade the middles. Growers have relied on alachlor in the past; however, it is no longer available in Florida (Gilreath et al., 1985). Oryzalin has performed well in research on sandy (Gilreath and Harbaugh, 1985) and organic, muck soils (Gilreath et al. 1985). Some growers have had excellent results with oryzalin while others have not. Part of the problem appears to be related to the weed species being controlled, but application timing also is suspected of being involved. Many growers relied on the contact activity of alachlor on small weeds. Oryzalin does not have contact activity; therefore, if a grower waited until small seedlings were present before applying oryzalin, poor weed control would result.

Use of soil fumigation with methyl bromide for caladiums has increased in recent years and may affect weed spectrum and crop response to herbicides; however, the predicted loss of methyl bromide in a few years could increase the importance of herbicides for weed control in caladiums.

Research was conducted from 1991 through 1993 to identify preemergence herbicides which could be used safely in caladium tuber production and which would provide good control of the weeds commonly observed in caladiums grown on sandy and mucky soils.

Materials and Methods

Three experiments were conducted during the course of this study. The first was a greenhouse screening trial at the Gulf Coast Research and Education Center (GCREC) to tentatively identify those preemergence herbicides which were not injurious to caladium plants. The second was a field experiment on sandy soil at the GCREC to assess weed control and crop effects in a situation which would favor crop injury, specifically low cation exchange capacity sandy soil. The third experiment was conducted on a commercial caladium farm near Lake Placid, FL to assess weed control and effects on crop production in both fumigated and nonfumigated soil under typical commercial conditions. Although several rates of most herbicides were included in each experiment, each herbicide and rate combination was treated as a separate

Florida Agricultural Experiment Station Journal Series No. N-00976. The authors wish to thank Bates, Sons & Daughters and Happiness Frams, Inc. for supporting this research. Results reported herein are provided solely for informational purposes. Mention of a specific product does not constitute an endorsement or recommendation by the authors or the University of Florida.

Table 1. Phytotoxicity of herbicide treatment, vigor of 'Frieda Hemple' caladiums and tuber growth in organic soil (muck) in pots in a greenhouse. Experiment 1.

Treatment	Rate (kg/ha)	Phyto[z] (%)	Vigor (%) 55 days	Vigor (%) 112 days	Tuber wt. (g)
Nontreated	0.0	2.0 b[y]	68abc	64abc	33abc
Alachlor	2.2	3.5 b	56abc	53bc	25bc
Alachlor	4.5	4.5 b	67abc	67ab	36abc
Alachlor	6.7	7.0 b	63abc	65abc	27abc
Isoxaben	0.8	4.5 b	56abc	56bc	27abc
Isoxaben	1.7	2.0 b	66abc	67ab	34abc
Isoxaben	2.5	10.5 b	69ab	68ab	34abc
Metolachlor	2.2	4.5 b	75a	70ab	36abc
Metolachlor	4.5	11.5 b	68abc	73ab	40ab
Metolachlor	6.7	11.5 b	79a	80a	40ab
Flumetralin	2.2	8.2 b	73a	73ab	42a
Flumetralin	4.5	15.6 b	75a	80a	38abc
Flumetralin	6.7	14.5 b	66abc	72ab	43a
Oxadiazon	2.2	32.5 a	63abc	73ab	33abc
Oxadiazon	4.5	38.5 a	48bc	54bc	29abc
Oxadiazon	6.7	43.0 a	46c	46c	21c

[z]Foliar phytotoxicity, percentage of leaves with visible injury.
[y]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test.

treatment. Therefore, analyses of data were based on treatments and did not consider rate effects.

Experiment 1

'Frieda Hemple' caladium tuber chips (2.5 cm square) were placed in 10 cm diameter, round pots filled with Florida muck on 3 July 1991. Four grams of an 18N-2.6P-10K slow release fertilizer was added to each pot on 10 July 1991. Pots were sprayed with herbicide treatments (Table 1) the same day with a CO2 powered backpack sprayer equipped with a 2-nozzle boom delivering 468 liters/ha of spray. Pots then were placed in a greenhouse where they were manually watered overhead. After the initial overhead irrigation, a capillary mat irrigation system was used.

The experimental design was completely random with 10 single pot replications. The caladiums were grown for 112 days, then the tubers were harvested and weighed. Foliar phytotoxicity was evaluated once (55 days after application) and plant vigor was evaluated twice (55 and 112 days after application) on a percentage scale.

Experiment 2

Sixty 'Frieda Hemple' caladium tuber chips (2.5 cm square) were planted in 2 rows per bed in 15 cm tall, raised beds of EauGallie fine sand on 18 May 1992. Row spacing was 22 cm with 10 cm between tubers in the row. Beds were spaced 1.5 m apart on center. Fertilizer was banded down the bed center at a rate of 337 kg N/ha from a slow release 18N-2.6P-10K fertilizer.

Treatments (Table 2) were assigned to 3.7-m long, single bed plots arranged in a randomized complete block design and replicated 4 times. Herbicides were applied 3 times during the season. The first application was the day after planting and was preemergence to the crop and weeds. The second and third applications were over the top of the crop on 13 July and 18 Sep. 1992. Sethoxydim (Poast) was applied to all plots over the top of the crop on 13 July and 19 Aug. to reduce grass

Table 2. Effect of herbicide treatment on vigor of caladium plants grown in mineral soil after each of three herbicide applications. Experiment 2.

Treatment	Rate (kg/ha)	Vigor (%) 1 Appl.	Vigor (%) 2 Appl.	Vigor (%) 3 Appl.
Nontreated	0.0	71a[z]	24d	39c
Alachlor	2.2	72a	78abc	50bc
Alachlor	4.5	70ab	85a	64ab
Isoxaben	0.8	66ab	82ab	52abc
Isoxaben	1.7	71a	66abc	49bc
Metolachlor	2.2	72a	68abc	52abc
Metolachlor	4.5	74a	80abc	52abc
Flumetralin	2.2	74a	78abc	61ab
Flumetralin	4.5	75a	84a	64ab
Oryzalin	2.2	69ab	79abc	70a
Oryzalin	4.5	54bc	61bc	56abc
Pronamide	4.0	41c	60c	58abc

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test.

weed competition with other weed species and with the caladiums. All applications were made with a CO2 powered backpack sprayer equipped with a 2 nozzle boom and delivering 468 liters/ha of spray preparation.

Caladium plant vigor (%) and control (%) of *Digitaria ciliaris* (Retz.) Koel. and *Amaranthus viridis* L. were evaluated 60 days after each herbicide application. Control of *Eclipta alba* (L.) Hassk. was evaluated 60 days after the second and third applications of herbicide. Caladium tubers were dug and harvested 20 Jan. 1993 and were placed in a greenhouse to dry. Tubers were size graded and weighed on 3 Feb. 1993.

Experiment 3

Chips (3 cm or smaller dia.) of 'Pink Beauty' caladium tubers were planted 5 cm apart in rows spaced 36 cm apart on 5 May 1993 at a caladium farm in Lake Placid, FL. The soil in the experimental area was a typical muck found in the majority of the caladium production area. One side of the field was fumigated with methyl bromide, while the other side was not fumigated.

Herbicide treatments (Table 6) were assigned to 12.3-m long by 4 row wide plots arranged in a randomized complete block design with 4 replications within each fumigation area. Each plot contained 984 caladium chips at planting, assuming no skips in planting. Herbicides were applied twice during the season with the first application immediately after planting. The second application was on 11 June 1993 and was sprayed over the top of the crop after weeding, sidedressing, and cultivating, but prior to canopy closure. All applications were made with a CO_2 backpack sprayer equipped with a 3 nozzle boom and delivering 221 liters/ha of spray preparation.

Phytotoxicity of herbicides to caladiums was evaluated visually 14 days after each application using a pretransformed rating scale (Little and Hills, 1978) and results are presented on a percentage basis. Caladium plant vigor was evaluated using a similar pretransformed scale at the time of the second application of herbicide treatments and 45 days later. Weeds were removed manually from each plot 30 days after each of 2 herbicide applications and the number of plants of *Cyperus compressus* L., *Amaranthus spinosus* L. and *Commelina communis* L. were counted.

Caladium tubers were harvested during the winter, graded by size, and counted. Tuber value was determined based on current market prices for that season. Data were analyzed by herbicide treatment with each herbicide and rate combination being considered a distinct treatment.

Results and Discussion

Experiment 1

Oxadiazon (Ronstar) was phytotoxic to caladiums in the greenhouse screening trial, regardless of application rate (Table 1). Little difference in plant vigor existed among treatments. Plants growing in muck soil treated with the low and high rates of metolachlor (Pennant) and the low and medium rates of flumetralin (Prime Plus) were more vigorous than plants in soil which received the medium and high rates of oxadiazon when evaluated 55 days after herbicide application. At the end of the growing period (112 days), plants were more vigorous where they were treated with 6.7 kg of metolachlor or 4.5 kg of flumetralin per ha than plants treated with 4.5 or 6.7 kg of oxadiazon, 2.2 kg of alachlor (Lasso) or 0.8 kg of isoxaben (Gallery). There were few differences in tuber weights at the end of the experiment. Tubers were heavier in pots treated with flumetralin (2.2 and 6.7 kg/ha) than in those which received 2.2 kg of alachlor or 6.7 kg of oxadiazon per ha.

Experiment 2

Few differences in caladium plant vigor were observed during this experiment. Vigor generally was not affected by the first application of herbicides with the exception of 4.5 kg of oryzalin (Surflan) per ha and pronamide (Kerb) which reduced vigor compared to most of the other herbicide treatments (Table 2). Vigor of plants in the nontreated control plots was not reduced until weed competition was heavy after the second application of herbicides. At this time plants treated with 4.5 kg of either alachlor or flumetralin were more vigorous than those treated with pronamide or 4.5 kg of oryzalin, but no other differences existed. Plant vigor appeared to decline after 3 applications of herbicides and only plots treated with 4.5 kg of alachlor, 2.2 kg of oryzalin or flumetralin had plants which were more vigorous than the nontreated control plots. Plants receiving 2.2 kg of oryzalin were more vigorous than those in soil sprayed with the low rate of alachlor or the high rate of isoxaben; no other differences existed among treatments.

Digitaria ciliaris (crabgrass) was the most populous weed in this experiment, almost establishing a monoculture in the nontreated plots in the first 2 months. The initial application of preemergence herbicides controlled *D. ciliaris* fairly well until the first evaluation; however, its dominance in plots where control was less than about 90% reduced the population of other weed species and threatened to reduce the value of the experiment (Table 3). Therefore, sethoxydim was applied to all plots the day of the second application of preemergence herbicides and again 1 month later. Good control of *D. ciliaris* was obtained with all preemergence herbicide treatments when augmented with sethoxydim.

Amaranthus viridis (pigweed) did not compete well with *D. ciliaris* as evidenced by the higher level of *A. viridis* control in the nontreated plots than in plots treated with 2.2 kg of alachlor which provided good control of *D. ciliaris* (Table 4). Early control (after 1 application) of *A. viridis* was better with isoxaben, oryzalin, pronamide, and 4.5 kg of flumetralin than with alachlor or metolachlor. Few differences existed after the second or third application of herbicides. Nontreated plots still had low populations of *A. viridis*, presumably due to shading effects of the *D. ciliaris* plants and their residue after killing them with sethoxydim. Pronamide provided less control of *A. viridis* than 2.2 kg of flumetralin after 2 applications and 2.2 kg of alachlor, both rates of isoxaben and flumetralin, and 4.5 kg of metolachlor after 3 applications.

Eclipta alba appeared in the plots after the second application of herbicide treatments (Table 4). Initially, *D. ciliaris* appeared to reduce the population of *E. alba*, but once *D. ciliaris* was controlled by sethoxydim, more plants appeared in the nontreated control plots. After 2 applications, alachlor, metolachlor, and pronamide provided less control than 1.7 kg isoxaben and 2.2 kg of flumetralin. Control levels remained similar after the third application. Alachlor (2.2 kg/ha), 2.2 kg of metolachlor and pronamide provided significantly less control of *E. alba* than isoxaben.

Table 3. *Digitaria ciliaris* (southern crabgrass) control in caladium with preemergence herbicides after each of 3 herbicide applications to mineral soil. Experiment 2.

Treatment	Rate (kg/ha)	Control (%) 1 Appl.	2 Appl.[z]	3 Appl.
Nontreated	0.0	12 b[y]	32b	0b
Alachlor	2.2	91 a	100a	96a
Alachlor	4.5	99 a	99a	98a
Isoxaben	0.8	76 a	92a	94a
Isoxaben	1.7	75 a	75a	98a
Metolachlor	2.2	88 a	92a	91 a
Metolachlor	4.5	90 a	99a	85a
Flumetralin	2.2	94 a	99a	85a
Flumetralin	4.5	97 a	100a	91 a
Oryzalin	2.2	96 a	100a	98a
Oryzalin	4.5	100 a	100a	97a
Pronamide	4.5	99 a	100a	94a

[z]Sethoxydim was applied twice to all plots 1 and 2 months before the second evaluation to reduce grass weed competition with other weed species and with caladiums.

[y]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test.

Table 4. Control of *Amaranthus viridis* (slender amaranth) and Eclipta alba (eclipta) in caladium after each of 3 applications of preemergence herbicides to mineral soil. Experiment 2.

Treatment	Rate (kg/ha)	Control (%) A. viridis 1 Appl.	A. viridis 2 Appl.	A. viridis 3 Appl.	E. alba 2 Appl.	E. alba 3 Appl.
Nontreated	0.0	64bc[z]	98a	95ab	89a	46c
Alachlor	2.2	25d	91ab	96a	44de	49c
Alachlor	4.5	46cd	98ab	91ab	43de	71abc
Isoxaben	0.8	91a	96ab	96a	80abc	93a
Isoxaben	1.7	93a	95ab	99a	86a	86a
Metolachlor	2.2	48cd	89ab	92ab	49cde	51c
Metolachlor	4.5	62bc	91ab	97a	52bcde	61abc
Flumetralin	2.2	85ab	99a	100a	86a	74abc
Flumetralin	4.5	95a	97ab	100a	83ab	71abc
Oryzalin	2.2	97a	96ab	92ab	74abcd	85ab
Oryzalin	4.5	99a	88ab	94ab	76abc	72abc
Pronamide	4.5	93a	86b	86b	41e	52bc

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test.

Table 5. Effect of 3 applications of each herbicide treatment on yield of 'Frieda Hemple' caladium tubers grown in mineral soil. Experiment 2.

Treatment	Rate (kg/ha)	Number of tubers/plot[z]				Tuber dry wt. (g) per plot
		Jumbo	#1	#2	#3	
Nontreated	0.0	0a[y]	7b	25a	14ab	420c
Alachlor	2.2	2a	30a	25a	10b	1049ab
Alachlor	4.5	2a	33a	22a	11b	1122ab
Isoxaben	0.8	2a	32a	20a	13ab	1146ab
Isoxaben	1.7	1a	26a	22a	15ab	928abc
Metolachlor	2.2	2a	25a	25a	10b	1010ab
Metolachlor	4.5	1a	30a	24a	18a	1128ab
Flumetralin	2.2	2a	30a	20a	14ab	1193ab
Flumetralin	4.5	3a	34a	20a	10b	1299a
Oryzalin	2.2	3a	29a	21a	14ab	1258a
Oryzalin	4.5	7a	24a	22a	8b	682bc
Pronamide	4.5	2a	23a	19a	10b	898abc

[z]Out of 60 tuber chips planted in each plot.
[y]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

Herbicide treatment had little effect on caladium tuber production (Table 5). Production of jumbo and number 2 size tubers was not affected by treatment. All herbicide treatments increased the production of number 1 tubers compared to the nontreated control, but there was no difference among herbicide treatments in this regard. Fewer number 3 size tubers were produced in soil treated with alachlor, 2.2 kg metolachlor, 4.5 kg flumetralin, 4.5 kg oryzalin or pronamide than where 4.5 kg metolachlor was applied. Weed competition greatly reduced dry weight of tubers produced in the nontreated control. This low weight was probably due to the decreased production of the larger number 1 size tubers. Among the herbicide treatments, 4.5 kg of flumetralin and 2.2 kg of oryzalin produced more dry weight of tubers than 4.5 kg of oryzalin.

Experiment 3

No phytotoxicity was observed nor were there any differences in plant vigor (data not presented). Caladium plant growth was vigorous during this experiment and canopy closure occurred early in the summer, thereby reducing the time period available for weed plant establishment. *Cyperus compressus* and *Amaranthus spinosus* were present from the beginning, but *Commelina communis* did not appear in plots until after the second application of herbicides.

Fewer *C. compressus* plants occurred in plots treated with metolachlor than isoxaben + oryzalin (Snapshot DF) or oryzalin alone after 1 application (Table 6). After a second application of herbicides, only the low rate of the combination of isoxaben + oryzalin had more plants than the two metolachlor treatments. Fewer *C. compressus* plants had to be hand weeded after the first application of herbicides where the soil was fumigated, but after a second application this advantage was lost. Herbicide treatment had no effect on the number of *A. spinosus* or *C. communis* plants which were weeded from the plots; however, fewer *A. spinosus* plants were present in fumigated soil after 1 application of herbicide and fewer *C. communis* plants appeared in fumigated soil after the second herbicide application.

Caladium tuber production was not affected by herbicide treatment (Table 7). Soil fumigated with methyl bromide produced more mammoth and jumbo size tubers but did not affect yield of other sizes or total production (data not presented). Results of economic analysis using the current wholesale price of the various tuber sizes were similar to those for yield; total value of tubers produced was not affected by herbicide treatment (data not presented).

The location of this experiment was a field which had been in production for some time and the grower had used standard production practices, including soil fumigation in some years previous to this study. These results could vary by location, market conditions, previous weed and cropping history, and cultural program in use by the grower. High infestations of nematodes or difficultly controlled weeds could increase the importance of fumigation. Each grower must assess his/her situation and act accordingly.

Loss of alachlor has been a major concern for caladium growers. Oryzalin performed well in previous research but does not have the contact activity that alachlor has on very small weeds. Also, the spectrum of weeds controlled with oryzalin is somewhat different from that provided by alachlor. Thus, growers have felt that oryzalin does not completely meet their needs or fill the niche left by alachlor. Results of

Table 6. Effect of herbicide treatments on number of *Cyperus compressus* (annual sedge), *Amaranthus spinosus* (spiny amaranth), and *Commelina communis* (Asiatic dayflower) plants removed from caladiums 30 days after each of 2 herbicide applications to muck soil. Experiment 3.

Herbicide	Rate (kg/ha)	No. of weeds removed per plot				
		C. compressus		*A. spinosus*		*C. com.*
		1 Appl.	2 Appl.	1 Appl.	2 Appl.	2 Appl.
Metolachlor	2.2	1c[z]	0.1b	4a	0a	0a
Metolachlor	4.5	0c	0.0b	2a	0a	0a
Flumetralin	2.2	5bc	0.2ab	1a	0a	1a
Flumetralin	4.5	2bc	0.2ab	2a	0a	1a
Isoxaben +	0.4	13a	0.9a	4a	0a	1a
Oryzalin	1.3					
Isoxaben +	0.9	10ab	0.4ab	4a	0a	1a
Oryzalin	2.7					
Oryzalin	2.2	14a	0.6ab	9a	0a	1a
Oryzalin	4.5	14a	0.5ab	4a	0a	1a

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's new multiple range test.

Table 7. Effect of herbicide treatments on 'Pink Beauty' caladium tuber production per hectare, Lake Placid, FL, 1993.

Herbicide	Rate (kg/ha)	No. of tubers/size grade				Seed (liter)	Total number[z]
		Mammoth	Jumbo	One	Two		
Metolachlor	2.2	1038	13378	74382	78995	7727	168369
Metolachlor	4.5	808	14277	62274	70923	6286	148188
Flumetralin	2.2	1268	14529	68039	73228	6113	157415
Flumetralin	4.5	1441	15281	66887	71498	6343	154531
Isoxaben +	0.4	1095	13492	77841	73806	6286	172407
Oryzalin	1.3						
Isoxaben +	0.9	1846	16837	65734	62850	4900	147034
Oryzalin	2.7						
Oryzalin	2.2	1211	14475	71498	83609	6459	170677
Oryzalin	4.5	2078	13956	68039	72077	6632	156261
Significance[y]		ns	ns	ns	ns	ns	ns

[z]Total number of tubers in size grades Mammoth through Two, not including seed size tubers.
[y]Analysis of variance indicated no significant difference among treatments at the 5% level of probability.

these studies indicate that several available herbicides provide effective weed control in caladiums without crop injury or loss of tuber production. Metolachlor is in the same chemical family with alachlor and has a similar spectrum of weed control. It provided excellent control of *C. compressus* (annual sedge) which is a common, difficultly controlled weed in caladiums. Flumetralin is a relatively new compound, the availability and development of which is unsure at this time. Isoxaben + oryzalin might have some utility in certain situations; however, the current price will limit its use in caladium production. Methyl bromide fumigation should be based on the economics of this practice and the potential returns. This decision probably should be made on an individual field and cultivar basis rather than in consideration of the entire farm.

Literature Cited

Gilreath, J. P. and B. K. Harbaugh. 1985. Chemical weed control in caladiums. HortScience 20:1056-1058.

Gilreath, J. P., B. K. Harbaugh and C. S. Lott. 1985. Chemical weed control in caladiums grown in organic soil. Proc. Fla. State Hort. Soc. 98: 107-110.

Little, T. M. and F. J. Hills. 1978. Agricultural experimentation: design and analysis. 350 pp. J. Wiley & Sons, N.Y., N.Y.

Scudder, W. T. 1961. Controlling annual weeds in caladiums on Florida peat soils. Proc. So. Weed Sci. Soc. 14:164-174.

Proc. Fla. State Hort. Soc. 107: 215-217. 1994.

COPPER HYDROXIDE-TREATED POTS IMPROVE THE ROOT SYSTEM OF BOUGAINVILLEA CUTTINGS

JAMES H. ALDRICH AND JEFFREY G. NORCINI
North Florida Research and Education Center
IFAS, University of Florida
Monticello, FL 32344

Additional index words. Spin Out™, propagation

Abstract. **The responses of root systems of 'Barbara Karst' bougainvillea [*Bougainvillea* x *buttiana* (*Bougainvillea glabra* Choicy x *Bougainvillea peruviana* Humb. & Bonpl.) 'Barbara Karst'] cuttings to 100 g $Cu(OH)_2$/liter in latex paint applied to the interior surface of square 66, 120, or 280-ml plastic pots were determined. Cuttings (10 cm long; 3-5 nodes; 2 leaves) were scored on opposite sides and dipped in KIBA at 6000 mg·liter^{-1} for 3 sec on 16 Apr. 1993. Cuttings were placed in treated or untreated pots that contained a medium of 1 Canadian sphagnum peat: 1 coarse perlite (v/v). The pots were completely randomized in a 3X2 factorial design. The cuttings were rooted under intermittent mist 9 sec·5 min^{-1} for 12 hr·day^{-1} in a greenhouse (20% shade). Cuttings rooted in $Cu(OH)_2$-treated containers had no root circling and a more compact, well-branched root system compared to cuttings rooted in untreated containers. However, root fresh weight was reduced by the $Cu(OH)_2$ treatment. Container size affected the number of primary roots as well as root fresh and dry weight.**

Bougainvillea are primarily propagated by stem cuttings. The cuttings root well but the root systems are usually composed of long brittle non-fibrous roots which circle the interior of the propagation container. When transplanted some of the roots are often broken.

The results of recent studies have demonstrated the usefulness of chemical root pruning with copper hydroxide (Arnold, 1992; Arnold et al., 1993; Svenson and Broschat, 1992). A relatively new product, Spin Out™, is a water-based latex paint containing copper hydroxide that is applied to the interior of containers. Root pruning occurs at the interface of the root tip and the copper-treated interior surface of the container. Root circling, matting, and kinking are eliminated or reduced in many species (Appleton and Salzman, 1993; Arnold, 1992; Arnold et al., 1993; Arnold and Struve, 1993; Beeson and Newton, 1992; Case and Arnold, 1992). When these negative root growth habits are controlled, rooting increases within the media. This results in a more evenly distributed root system which provides the opportunity for increased water and nutrient uptake (Arnold and Struve, 1993).

The objective of this study was to determine the effect of application of copper hydroxide to three different-sized containers on root system development of bougainvillea cuttings.

Florida Agricultural Experiment Station Journal Series No. N-01009

The authors gratefully acknowledge Griffin Corporation for their donation of SpinOut™ and Ms. Lucy Rogers and Mr. Judd Butler for their technical assistance.

Materials and Methods

Softwood stems cuttings were removed from 'Barbara Karst' bougainvillea [*Bougainvillea* x *buttiana* (*Bougainvillea glabra* Choicy x *Bougainvillea peruviana* Humb. & Bonpl.) 'Barbara Karst'] on 16 Apr. 1993 and submerged in a mixture of insecticidal soap (Safer, Wellsley, Mass.) (19.5 ml·liter^{-1}) and dimethyl[(1,2-phenylene)-bis(iminocarbonothioyl)]bis(carbamate) (thiophanate-methyl; Domain FL; OM Scott, Marysville, Ohio) (1.3 ml·liter^{-1}). Cuttings (10 cm long; 3-5 nodes; 2 leaves) were scored on two sides and dipped in KIBA at 6000 mg·liter^{-1} for 3 sec. The cuttings were placed in one of three containers treated on the interior with $Cu(OH)_2$/liter (in latex paint; Spin Out™, Griffin Corp., Valdosta, GA) and filled with a medium of 1 Canadian sphagnum peat: 1 coarse perlite (v/v). Container sizes were 66 ml (4.5 cm square top, 4 cm bottom, and 3.7 cm deep), 120 ml (5 cm square top, 4.3 cm bottom, and 6 cm deep), and 280 ml (7 cm square top, 6 cm bottom and 7 cm deep). The containers, with and without $Cu(OH)_2$, were completely randomized in a factorial experiment with 15 replications per treatment per container size. The cuttings were rooted under intermittent mist 9 sec·5min^{-1} for 12 hr·day^{-1} in a greenhouse (20% shade). The number of primary roots, root fresh and dry weights, and degree of rooting were recorded 15 June. The degree of rooting was rated on a scale of 1=no callusing, 2=only callusing, 3, 4, and 5=light, medium, and heavy rooting, respectively.