

Progress report for
Chemical weed control for export grade potted ornamentals
Period 01/01/02 – 01/01/03
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Objective 1. Complete the analysis of the currently obtained data on chemical weed control for potted orchid and anthuriums and prepare final reports for participating chemical companies.

All herbicide screening experiments on orchids and anthuriums are now completed. The updated progress report for this objective is provided below. Finalized reports will be forwarded to chemical industry representatives prior to the termination of current project period (termination date 09/14/04).

Preemergence herbicides applied to 4 potted anthurium cultivars:

An experiment to determine the response of 4 potted anthurium cultivars to sequential preemergence herbicide applications was conducted at Green Point Nursery (owner Harold Tanouye) located in Mt. View on the Big Island. The four cultivars selected for treatment were: “Lady Ann”, “Sundial”, “Tropic Fire”, and “Nicoya”. The herbicides were applied at two rates, the anticipated labeled use rate (1X) and two times the anticipated labeled use rate (2X). The herbicides evaluated in this experiment were Direx 4L (diuron), Gallery (isoxaben), Spartan (sulfentrazone) and Surflan (oryzalin). Herbicide applications were directed to the base of plants to avoid direct contact with leaves and flowers. The first application applied on 11/11/99 was followed with sequential applications made at 64, 69, 70 and 98 day intervals for a total of 5 sprays. On 11/16/00 (71 days after the last spray application) the experiment was terminated. Each plant was collected for measurements of growth and dry weight accumulation.

There was a significant interaction between the chemical treatments and the cultivar for leaf dry weights. Spartan at 1X and 2X significantly reduced all four cultivars compared to the untreated controls. Leaf weights for the Gallery 1X treatments were not significantly reduced for all cultivars. However, Lady Anne was significantly reduced at the 2X rate. Leaf weights for Direx and Surflan for both 1X and 2X treatments were not significantly different from the untreated control. In fact, for all cultivars except Tropic Fire they had higher weights (Table 1).

Table 1: The response of dry leaf weight of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application.

Treatments	Anthurium Cultivars			
	Leaf Dry Wt (g)			
Treatments	Lady Anne	Nicoya	Sundial	Tropic Fire
Direx 1X	19.8 ab*	17.4abcdef	14.4 efgh	15.5 cdefgh
Direx 2X	18.6 abcd	19.1 ab	12.9 ghi	15.0 defgh
Gallery 1X	18.4 abcd	20.2 a	12.1 hi	15.0 defgh
Gallery 2X	14.3 efgh	16.0 bcdefg	13.9 fgh	15.2 defgh
Spartan 1X	7.2 jk	11.4 hi	10.2 ij	7.0 jk
Spartan 2X	7.3 jk	11.7 hi	7.9 jk	5.7 k
Surflan 1X	18.0 abcd	20.1 a	15.2 defgh	14.2 fgh
Surflan 2X	19.6 ab	18.9 abc	12.8 ghi	13.2 ghi
Untreated	18.7 abcd	17.2 abcdef	13.2 ghi	16.6 abcdefg

Mean in columns and rows followed by the same letter are not significantly different based on a Duncan's multiple range test at the 5% level.

There was no significant interaction between chemical treatment and cultivar when measuring leaf number, shoot weight (aerial portion minus leaves and flowers), root weight and flower number. Since all cultivars responded in a similar way to the treatments, the values in Table 2 represent the mean of 4 cultivars. Gallery 1X is the only treatment with a significantly lower leaf count compared to the rest of the treatments. The highest counts were from Direx and Surflan at 2X (Table 2).

Table 2. The pooled response of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application.

Treatments	Leaf Number (#)	Shoot wt. (g)	Root wt. (g)	Flower Number (#)
Direx 1X	26.7 abc	14.7 ab	11.4 a	4.9 a
Direx 2X	29.9 a	14.8 ab	11.0 a	4.7 ab
Gallery 1X	21.4 d	16.5 a	8.4 b	4.4 ab
Gallery 2X	23.5 cd	14.0 b	6.4 c	4.1 ab
Spartan 1X	24.7 bcd	7.6 c	6.7 c	2.1 c
Spartan 2X	22.7 cd	8.0 c	7.1 c	1.1 c
Surflan 1X	25.8 abcd	15.2 ab	9.5 b	4.5 ab
Surflan 2X	28.9 ab	13.8 b	9.5 b	4.7 ab
Untreated	26.7 abc	13.5 b	11.0 a	3.7 b

Means within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 5% level.

Spartan at both rates consistently caused stunted growth and distorted leaf growth across all cultivars tested and will not be pursued for registration. Direx 4L, Gallery and Surflan did not reduce leaf number, shoot dry weight accumulation or flower number (see Table 2a-d). However, both Gallery and Surflan significantly reduced root weight at the time the experiment was terminated. These data indicate that Direx 4L is clearly the least inhibitory herbicide with regards to anthurium growth. Both Gallery and Surflan caused a reduction in root dry weight and may be excluded from registration. Although these herbicides did not cause growth distortions of aerial portions or reductions in flower numbers, the stunting of root growth is an important consideration for companies considering the addition of these crops to their product labels. Additional studies will have to be conducted to determine if extending the time period between sequential applications can still provide commercially acceptable weed control while reducing the inhibition of root growth.

Tables 2a to 2d contain means of the response (anthurium leaf number, shoot weight, root weight and flower number 72 days after the last herbicide application) of individual cultivars to herbicides sprays. Statistical analysis did not support any mean separation procedures for these data.

Table 2(a): The response of leaf number of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application. Means separation not supported by ANOVA, see Table 2 to determine pooled cultivar response to herbicide treatments.

Treatments	Anthurium Cultivars			
	Leaf number			
Treatments	Lady Anne	Nicoya	Sundial	Tropic Fire
Direx 1X	21.8	22.5	32.5	30.0
Direx 2X	33.5	22.5	36.8	26.8
Gallery 1X	17.3	21.5	22.0	24.8
Gallery 2X	21.5	22.5	27.8	22.3
Spartan 1X	26.8	16.8	33.0	22.3
Spartan 2X	23.5	23.0	27.0	17.3
Surflan 1X	23.5	19.8	38.8	21.3
Surflan 2X	31.3	24.5	35.8	24.3
Untreated	23.3	23.3	34.3	26.0

Table 2(b): The response of shoot weight (aerial portion minus leaves and flowers) of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application. Mean separation not supported by ANOVA, see Table 2 to determine pooled cultivar response to herbicide treatments.

Treatments	Anthurium Cultivars			
	Shoot Dry Wt (g)			
Treatments	Lady Anne	Nicoya	Sundial	Tropic Fire
Direx 1X	16.7	14.8	14.6	12.5
Direx 2X	15.7	19.0	11.6	12.8
Gallery 1X	16.7	19.3	16.1	14.0
Gallery 2X	12.4	15.0	14.6	14.0
Spartan 1X	5.5	9.7	8.2	6.8
Spartan 2X	6.6	10.9	7.4	7.1
Surflan 1X	15.5	17.1	15.8	12.6
Surflan 2X	13.5	16.2	13.4	12.2
Untreated	14.2	13.1	12.1	14.5

Table 2(c): The response of root dry weight of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application. Means separation not supported by ANOVA, see Table 2 to determine pooled cultivar response to herbicide treatments.

Treatments	Anthurium Cultivars			
	Root Dry Wt (g)			
Treatments	Lady Anne	Nicoya	Sundial	Tropic Fire
Direx 1X	14.9	12.3	9.4	9.0
Direx 2X	12.4	13.1	8.8	9.6
Gallery 1X	9.4	10.2	6.3	7.9
Gallery 2X	6.8	7.0	5.1	6.6
Spartan 1X	6.8	6.0	6.4	5.4
Spartan 2X	8.7	7.4	5.5	6.5
Surflan 1X	11.3	10.5	5.9	10.5
Surflan 2X	10.8	10.8	5.9	9.5
Untreated	12.7	12.1	8.9	10.3

Table 2(d): The response of flower number of 4 anthurium cultivars to 5 sequential chemical applications of herbicides. Samples taken 71 days after the last herbicide application. Means separation not supported by ANOVA, see Table 2 to determine pooled cultivar response to herbicide treatments.

Treatments	Anthurium Cultivars			
	Flower number			
Treatments	Lady Anne	Nicoya	Sundial	Tropic Fire
Direx 1X	5.3	5.5	3.8	5.0
Direx 2X	5.8	5.3	4.0	4.0
Gallery 1X	4.3	5.3	4.3	4.0
Gallery 2X	4.5	3.8	4.0	4.3
Spartan 1X	.3	3.5	2.3	2.5
Spartan 2X	.3	1.5	.8	2.0
Surflan 1X	4.5	5.0	5.3	3.3
Surflan 2X	5.0	4.8	4.3	4.8
Untreated	3.5	4.8	2.3	4.5

Preemergence herbicides applied to 3 potted orchid cultivars:

An experiment to determine the response of 3 potted orchid cultivars to sequential preemergence herbicide applications was initiated at Newman's Nursery in Pahoia on the Big Island. The three cultivars selected for treatment were: "Sharry Baby", "Silver Chalice" and "Hirota White". The herbicides were applied at two rates, the anticipated labeled use rate (1X) and two times the anticipated labeled use rate (2X). The herbicides evaluated in this experiment were: Direx 4L (diuron), Gallery (isoxaben), Spartan (sulfentrazone) and Surflan (oryzalin). Herbicide applications were directed to the base of plants to avoid direct contact with leaves and flowers. The first herbicide application was applied on 12/02/99 with sequential applications made at 110, 206, 69, 46 and 70 day intervals for a total of 5 sprays. The last herbicide application was made on 01/24/01 and the experiment was terminated on 03/07/01 (42 days after the last spray application) when crop samples were collected for dry weight determinations.

Table 3. The shoot dry weight accumulation of 3 orchid cultivars to 5 sequential applications of preemergence herbicides. Dry weight samples were collected 42 days after the last herbicide application.

Treatments	lb ai/a	Shoot dry wt. (g)		
		Sharry Baby	Silver Chalice	Hirota White
DIREX 1X	1.5	14.48 a	0.43 c	3.33 c
DIREX 2X	3.0	12.05 ab	0.50 c	5.30 c
GALLERY 1X	.75	4.50 c	0.45 c	4.47 c
GALLERY 2X	1.5	4.33 c	0.35 c	5.18 c
SPARTAN 1X	.25	6.83 bc	0.38 c	2.23 c
SPARTAN 2X	.50	5.93 c	0.40 c	3.08 c
SURFLAN 1X	2.0	3.60 c	0.50 c	5.90 c
SURFLAN 2X	4.0	14.80 a	0.55 c	4.30 c
UNTREATED		13.43 a	0.63 c	6.30 bc

Means throughout the table followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 1% level.

The data analysis of shoot dry weight accumulation indicated that the response to the herbicide applications was not the same across the three cultivars used in this experiment. Direx 4L or Surflan did not reduce shoot dry weight of Sharry Baby but Gallery and Spartan did. The shoot reduction by Surflan at the low rate was not related to herbicide application but was caused by other unknown factors possibly disease. Silver Chalice and Hirota White shoot dry weight was not significantly reduced by any herbicide applications.

Table 4. The root dry weight accumulation of 3 orchid cultivars to 5 sequential applications of preemergence herbicides. Dry weight samples were collected 42 days after the last herbicide application.

Treatments	lb ai/a	Root dry wt. (g)		
		Sharry Baby	Silver Chalice	Hirota White
DIREX 1X	1.5	4.85 a	0.30 c	1.03 c
DIREX 2X	3.0	3.88 ab	0.28 c	2.30 bc
GALLERY 1X	.75	1.08 c	0.25 c	1.53 c
GALLERY 2X	1.5	0.70 c	0.20 c	1.65 c
SPARTAN 1X	.25	2.15 bc	0.35 c	1.45 c
SPARTAN 2X	.50	2.20 bc	0.38 c	1.15 c
SURFLAN 1X	2	0.75 c	0.20 c	2.20 bc
SURFLAN 2X	4	4.85 a	0.20 c	1.30 c
UNTREATED		5.40 a	0.35 c	2.23 bc

Means throughout the table followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 1% level.

The data analysis of root dry weight accumulation was similar to the shoot data analysis. The root weight of Sharry Baby was not significantly affected by either level of Direx 4L application but all other treatments except the high rate of Surflan reduced root dry weight accumulation. Both Silver Chalice and Hirota White root dry weight was not significantly reduced by any herbicide applications, Table 4. These data support the use of both Direx 4L and Surflan on these three orchid cultivars. Gallery and Spartan were too inhibitory to be considered for further testing or pursuit of labeling.

Postemergence herbicides applied to 7 potted orchids of varying size:

An experiment to determine the response of 7 orchid cultivars to sequential postemergence herbicide applications was conducted at Polynesian Orchids and Anthuriums Inc. (owner Leland Anderson) located in Kurtistown on the Big Island. The orchid cultivars selected for treatment in this experiment ranged in size from seedlings in 72-cell trays (“UH 306”, “UH 800” and “Sharry Baby”) to mid-sized flowering plants in 4 inch pots (“Gower Ramsey” and “Hiang Beauty”) to mature production plants grown in 6 inch pots for cut flowers (“Houerman White” and “Barbara Mull x Midas Touch”, both Phalanopsis). The herbicides evaluated in this experiment were Direx 4L, Lontrel (clopyralid) and Aim (carfentrazone). The herbicides were applied at two rates, the anticipated labeled use rate (1X) and two times the anticipated labeled use rate (2X). Spray applications were made directly to crop foliage using a spray to wet application that was calculated to be 100 gallons per acre. The first application was applied on 11/11/99 with sequential applications made at 20, 208, 73 and 69 day intervals for a total of 5 sprays. Visual injury ratings were made during the course of the experiment and on 12/04/00 the experiment was terminated and all orchids except Phalanopsis were collected for dry weight accumulation.

The first spray injury rating indicated that Aim was too phytotoxic to be useful on orchids and no additional applications of this herbicide were made. The dry weight accumulation of the orchid cultivars responded in a similar to the sequential spray applications. The analysis of the combined dry weight of 5 orchid cultivars indicated that all treatments significantly reduced growth of both roots and shoots, see Table 5.

Table 5. The response of the combined dry weight accumulation of 5 orchid cultivars to 5 sequential herbicide spray applications made directly to crop foliage. Cultivar response to treatments was not significantly different, thus weight of 5 cultivars were combined.

Treatments	lb or g ai/a	Combined dry wt. of 5 cultivars (g)	
		Shoot Dry Wt.	Root Dry Wt.
DIREX 4L	.5 lb	12.35 b	2.81 b
DIREX 4L	1.0 lb	12.18 b	3.19 b
LONTREL 3EC	.28 lb	11.69 b	2.59 b
LONTREL 3EC	.56 lb	13.17 b	2.63 b
AIM	3.7 g	15.52 ab	3.15 b
AIM	7.4 g	12.94 b	3.56 ab
UNTREATED	-	22.92 a	4.76 a

Means within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 1% level.

The analysis of the data collected in this experiment indicates that all herbicide applications reduced dry weight accumulation by nearly 35-45%. These results indicate that foliar exposure to herbicides like Direx 4L are more detrimental than applications directed to the base of plants that minimizing foliar contact (see **Tables 3&4**). However, the actual data varied widely and conclusions must be made with caution. The data in **Table 5(a)** contains the whole plant dry weight for the individual cultivars. The means in this table cannot be declared significantly different because of a high level of variation not attributable to herbicide treatments. However, the data can be useful in determining where additional research may be required. A tentative conclusion appears to be that UH 306, UH 308 and Hiang Beauty are much more sensitive to Direx 4L and Lontrel than Sharry Baby and Gower Ramsey.

Table 5(a). The response of 5 orchid cultivars to 5 sequential herbicide spray applications made directly to crop foliage. Cultivar response to treatments was not significantly different. Data for all Aim treatments represents the response to a single application followed by 12 months of recovery. The data analysis from this experiment was affected by the high level of variation in plant dry weight that could not be attributed to herbicide treatments.

Treatments	LB or g ai/a	Whole plant dry wt. of 5 cultivars (g)				
		UH 306	UH 800	Sharry Baby	Gower Ramsey	Hiang Beauty
DIREX 4L	.5 LB	17.8	17.1	26.0	2.2	12.7
DIREX 4L	1.0 LB	11.6	15.6	35.8	7.0	6.9
LONTREL 3EC	.28 LB	15.4	9.6	22.4	5.3	18.7
LONTREL 3EC	.56 LB	12.3	13.5	22.6	2.0	30.2
AIM ^z	3.7 g	20.2	22.8	25.1	1.5	24.1
AIM	7.4 g	16.2	18.5	25.0	7.3	20.9
UNTREATED	-	32.0	36.6	25.0	4.2	40.9

^z Data reported for Aim represent the result of a single application followed by 12 months of recovery. The interaction between orchid cultivars and herbicide treatments was not significant, therefore statistical comparison of means in this table are not appropriate.

Postemergence herbicides applied to 4 potted orchids:

An experiment to determine the response of 4 orchid cultivars to sequential postemergence herbicide applications was conducted at Newman's Nursery in Pahoehoe on the Big Island. The orchid cultivars selected for treatment in this experiment were potted up in 4 inch pots used to finish the crop for sale. The cultivars used were: "Emma White" (Dendrobium), Wildcat "Blood Ruby", "Volcano Queen" (both Oncidiums) and "SuFun Beauty" (Vanda). The herbicides evaluated in this experiment were Direx 4L and Lontrel. The herbicides were applied at two rates, the anticipated labeled use rate (1X), 2 times anticipated the use rate (2X) and four times the anticipated labeled use rate (4X). Spray applications were made directly to crop foliage using a spray to wet application that was calculated to be 100 gallons per acre. The first application was applied on 11/11/99 with sequential applications made at 20, 208, 73 and 69 day intervals for a total of 5 sprays. Visual injury ratings were made during the course of the experiment and on 12/04/00 the experiment was terminated and all plants were collected for dry weight accumulation.

The data in **Table 6** indicates that herbicide sprays did not significantly reduce dry weights and that all cultivars responded in a similar way. Data for shoot and root weights of individual cultivars is provided in **Table 6a and Table 6b**, respectively. The orchid cultivars at NN responded in a similar way to herbicide applications and neither shoot nor root dry weight accumulation was adversely affected. The only orchid cultivar to show abnormal growth to Lontrel was "Emma White", expressed as J-shaped flower spikes and deformed flowers. The other three cultivars did not show any noticeable injury in response to any of the spray applications.

The data from NN and PO&A indicate that orchid cultivars can vary widely in their response to herbicide applications. Potential users need to be careful **NOT** to assume that herbicide applications that appear safe on one cultivar predict safe use on all. It is clear that additional experiments need to be conducted simultaneously with the same cultivars, at similar stages of development and potting media, at different locations to accurately establish the impact of sequential herbicide spray applications on orchid growth and yield attributes.

Table 6. The response of the combined dry weight accumulation of 3 orchid cultivars to 5 sequential herbicide spray applications made directly to crop foliage. Cultivar response to treatments was not significantly different, thus the weight of 3 cultivars were combined.

Treatments	lb. ai/a	Combined wt. of 3 cultivars	
		Shoot Dry Wt. (g)	Root Dry Wt. (g)
DIREX 4L	.5	12.34	6.39
DIREX 4L	1.0	11.56	6.03
DIREX 4L	2.0	12.04	5.72
LONTREL 3EC	.28	11.29	5.68
LONTREL 3EC	.56	11.22	5.13
LONTREL 3EC	1.2	11.09	5.07
UNTREATED		11.74	5.51

Means for shoot and root dry wt were not significantly different in response to chemical treatments

Table 6(a). Shoot dry weight accumulation of 4 orchid cultivars to 5 sequential herbicide spray applications made directly to crop foliage.

Treatments	lb. ai/a	Shoot Dry Wt. (g)			
		Volcano Queen	Emma White	Blood Ruby	SuFun Beauty
DIREX 4L	.5	12.0	17.4	14.0	6.0
DIREX 4L	1.0	11.1	14.4	15.0	5.7
DIREX 4L	2.0	11.4	18.0	13.0	5.9
LONTREL 3EC	.28	9.1	21.7	8.8	5.5
LONTREL 3EC	.56	11.2	18.0	9.8	5.9
LONTREL 3EC	1.2	11.2	17.0	10.2	6.0
UNTREATED		11.4	18.6	11.1	5.8

The interaction between orchid cultivars and herbicide treatments was not significant, therefore statistical comparison of means in this table are not appropriate.

Table 6(b). Root dry weight accumulation of 4 orchid cultivars to 5 sequential herbicide spray applications made directly to crop foliage. Cultivar response to treatments was not significantly different; thus all cultivars responded to the herbicide treatments in a similar way.

Treatments	lb. ai/a	Root Dry Wt. (g)			
		Volcano Queen	Emma White	Blood Ruby	SuFun Beauty
DIREX 4L	.5	3.6	7.9	8.5	5.5
DIREX 4L	1.0	4.7	5.6	8.5	5.2
DIREX 4L	2.0	5.1	5.6	7.2	5.0
LONTREL 3EC	.28	3.4	8.8	5.3	5.3
LONTREL 3EC	.56	3.4	6.0	5.4	5.8
LONTREL 3EC	1.2	3.7	5.5	5.2	6.0
UNTREATED		4.0	7.6	4.6	5.8

The interaction between orchid cultivars and herbicide treatments was not significant, therefore statistical comparison of means in this table are not appropriate.

The analysis of the dry weight accumulation data sharply contrasts the response of the orchid cultivars studied in the previous experiments. The orchid cultivars at Newman's all responded in a similar way to spray applications and neither shoot nor root dry weight accumulation was adversely affected. The only orchid cultivar to show abnormal growth to Lontrel applications was "Emma White", expressed as J-shaped flower spikes and deformed flowers. The other three cultivars did not show any noticeable injury in response to any of the spray applications.

These data indicate that orchid cultivars can vary widely in their response to herbicide spray applications. Potential users need to be careful not to assume that safe use on one cultivar means safe use on all.

Postemergence herbicides on 4 anthurium cultivars.

An experiment to determine the response of 4 potted anthurium cultivars to sequential postemergence herbicide applications was conducted at Green Point Nursery. The four cultivars selected for treatment were "Lady Ann", "Sundial", "Tropic Fire", and "Nicoya". The herbicides were applied at two rates; the anticipated labeled use rate (1X) and four times the anticipated labeled use rate (4X). The herbicides evaluated in this experiment were Direx 4L (diuron) and Lontrel (clopyralid). Herbicide applications were applied directly to crop foliage using a 100 gallon per acre rate of application. The first application was applied on 05/05/00 with sequential applications made at 52, 72, 70 and 70 day intervals for a total of 5 sprays. Visual injury ratings were made through out the course of the experiment. The experiment was terminated on 03/21/01, 59 days after the last spray application, when all treated plants were collected for measurements of growth and dry weight accumulation.

Table 7. The leaf dry weight response of 4 anthurium cultivars to 2 postemergence herbicides applied as 5 sequential spray applications. The initial cultivars of Sundial developed a root rot during the first half of the experiment and are designated as "sick". New Sundial cultivars ("healthy") were added to experiment on 06/26/00 and received only 4 sequential spray applications.

Treatments	lb ai/a	Leaf dry wt (g)				
		Lady Ann	Tropic Fire	Nicoya	Sundial (sick)	Sundial (healthy)
DIREX 4L	.5	17.33 abc	18.10 abc	30.98 a	0.80 c	7.68 abc
DIREX 4L	2.0	11.30 abc	2.60 bc	31.35 a	0.33 c	2.08 bc
LONTREL 3EC	.3	22.40 abc	22.93 abc	25.80 ab	4.83 bc	9.18 abc
LONTREL 3EC	1.2	26.20 ab	18.60 abc	30.50 a	8.95 abc	10.23 abc
UNTREATED		21.98 abc	19.73 abc	29.95 a	9.05 abc	2.48 bc

Means in both columns and rows followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 1% level.

The analysis for leaf dry weight indicates that anthurium cultivars responded differently to the herbicide treatments. Nicoya was clearly the most vigorous of all the cultivars and leaf dry weight was not adversely affected by any treatments. Leaf dry weight for Lady Ann and Tropic Fire were not significantly reduced by any treatment. Direx 4L at the 4X level appears (based on numerically lower leaf dry weight values) to have adversely affected growth. "Tropic Fire" consistently responded with a 10-20 % leaf tissue injury to Direx 4L at the 4X rate two weeks after spray application. Once injured leaves were dropped, no subsequent injury appeared. "Sundial" was less affected than "Nicoya" and "Lady Ann". Lontrel caused little to no injury to anthurium foliage at any rate and all cultivars responded in a similar way.

Table 8. The shoot dry weight (aerial portion of plants minus leaves and flower) response of 4 anthurium cultivars to 2 postemergence herbicides applied as 5 sequential spray applications. The initial cultivars of Sundial developed a root rot during the first half of the experiment and are designated as “sick”. New Sundial cultivars (“healthy”) were added to experiment on 06/26/00 and received only 4 sequential spray applications.

Treatments	lb ai/a	Shoot dry wt (g)				
		Lady Ann	Tropic Fire	Nicoya	Sundial (sick)	Sundial (healthy)
1 DIREX 4L	.5	10.98 e	12.40 e	26.58 bc	0.43 f	5.88 ef
2 DIREX 4L	2.0	7.93 ef	2.33 f	26.6 bc	0.40 f	1.10 f
3 LONTREL 3EC	.28	13.38 de	25.28 bc	30.48 ab	2.80 f	2.58 f
4 LONTREL 3EC	1.2	12.73 e	21.10 c	35.40 a	2.88 f	2.80 f
5 UNTREATED		12.70 de	19.95 cd	34.10 a	2.25 f	1.55 f

Means in both columns and rows followed by the same letter are not significantly different according to Duncan’s Multiple Range Test at the 1% level.

The shoot dry weight data consists of stems and petioles up to the leaf and flower attachment points. These data are similar to the leaf dry weight data with respect to characterization of anthurium growth in response to spray applications. Shoot growth of Lady Ann and Sundial were not significantly reduced by herbicide treatments. The 1 and 4X level of Direx 4L significantly reduced shoot growth of Nicoya and Tropic Fire. The variation in anthurium response based on cultivar may require the labeling of specific cultivars that are safe for use and excluding all others that have not been evaluated under Hawaiian conditions.

Table 9. The root dry weight response of 4 anthurium cultivars to 2 postemergence herbicides applied as 5 sequential spray applications. The initial cultivars of Sundial developed a root rot during the first half of the experiment and are designated as “sick”. New Sundial cultivars (“healthy”) were added to experiment on 06/26/00 and received 4 sequential spray applications.

Treatments	lb ai/a	Root dry wt (g)				
		Lady Ann	Tropic Fire	Nicoya	Sundial (sick)	Sundial (healthy)
1 DIREX 4L	.5	14.25 bcd	10.18 cde	21.00 ab	0.60 g	7.28 efg
2 DIREX 4L	2.0	9.13 def	3.95 efg	16.18 abc	0.70 g	2.88 fg
3 LONTREL 3EC	.3	16.30 abc	18.83 ab	22.33 a	3.63 efg	3.63 efg
4 LONTREL 3EC	1.2	17.25 ab	15.83 abc	22.15 a	4.75 efg	4.53 efg
5 UNTREATED		17.28 ab	19.15 ab	22.43 a	2.30 fg	4.18 efg

Means in both columns and rows followed by the same letter are not significantly different according to Duncan’s Multiple Range Test at the 1% level.

The root dry weight data clearly characterizes the differences in cultivar response to the herbicide treatments. With these data, Nicoya remains the most vigorous of all cultivars with a numerical reduction in root growth at the 4X level of Direx 4L that is not significantly different than the untreated plants. Root growth with Sundial was not significantly reduced by any herbicide treatments. Both Lady Ann and Tropic Fire both showed reduced root growth with Direx 4L at the 4X level of application.

The conclusion for anthurium cultivar response to foliar sprays of Direx 4L and Lontrel is a clear one. Both Nicoya and Sundial appear to be the most resistant to both Direx 4L and Lontrel and the 4X level of Direx 4L adversely effects both Lady Ann and Tropic Fire. These data may be able to support registration of the 1X level of both Direx 4L and Lontrel but labeling may be restricted to only those cultivars that are supported by

experimental data. The only way to know for sure how companies will view these developments is to submit these results and request a decision with regards to adding cultivars that can be safely treated with rates used in these experiments.

Postemergence herbicides on 10 orchid cultivars in the seedling stage:

An experiment to determine the response of 10 orchid cultivars in the seedling stage to sequential postemergence herbicide applications was conducted at the Waianae location of Hawaii Rainbow Orchids (owner Creighton Mow). The orchids selected for this experiment included 9 Dendrobiums and 1 Vanda. At the beginning of the experiment, seedling age from culture flasks ranged from 57 to 117 days. The dendrobium orchids used in this experiment were: “D. Bangsaen Beauty Udomsri”, (#2716), “D. Vipa Mary MR x D. Udom Flare X D. Kanokporn” (#2701), “D. Burana Jade”, “D. Jacky mutation” (WRM 303), “D. Sakura Pink”, “D. Bertha Chung X Imelda Romualdez `Blue” (224), “D. Thoung `Pink”, “D. Kannayao Red” (392), “D. Woor Leng X D. Pathum Thani”. The only vanda selected for this experiment was Vanda “D.K. Hybrid”. Direx 4L was the only herbicide used in this experiment and was applied at the anticipated labeled use rate (1X) and four times the anticipated labeled use rate (4X). Spray applications were made directly to plant foliage using a 100 gallon per acre application rate. The first application was made on 04/27/00 with sequential applications made at 50, 21, 70, and 66 day intervals for a total of 5 sprays. Visual injury ratings were made during the course of the experiment and on 12/20/00 the experiment was terminated and all plants were collected for dry weight accumulation.

Whole plant dry weight accumulation of the 10 cultivars in this experiment responded in a similar way to herbicide applications. Since cultivar response was not significantly different, orchid response to the treatments can be analyzed by pooling the mean dry weight accumulation of all cultivars. In **Table 10**, the pooled response of all cultivars indicates that no herbicide treatment reduce orchid dry weight accumulation in comparison to untreated plants.

Table 10. The whole plant dry weight accumulation of 10 orchid cultivars in the seedling stage to 5 sequential applications of Direx 4L. Cultivars responded in a similar way to herbicide treatments, thus the mean of 10 cultivars is used to describe effects of herbicide sprays applications.

Treatments	lb ai/a	Mean of whole plant dry wt. of 10 cultivars(g)
1 DIREX 4L	.5	4.25 a
2 DIREX 4L	2.0	2.98 b
3 Untreated	-	3.75 ab

Means in columns followed by the same letter are not significantly different according to Duncan’s Multiple Range Test at the 1% level.

The data in **Table 11** is provided to illustrate the individual cultivar response to Direx 4L spray applications. Note that for most cultivars (except #4), the 4X level of Direx 4L appears to be suppressing dry weight accumulation. The suppression in growth was not significantly less than untreated plants but was significantly different than plants treated with the 1X level of Direx 4L.

Table 11. The whole plant dry weight response of 10 orchid cultivars to direct foliar application of Direx 4L spray applications.

Treatments	lb ai/a	Whole Plant dry wt. of 10 cultivars (g) ^x									
		# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10
DIREX 4L 1X	.5	1.50	3.90	4.83	3.43	3.73	5.00	5.63	4.47	4.63	5.33
DIREX 4L 4X	2.0	1.57	3.17	3.63	2.17	3.10	3.07	2.97	1.60	3.07	5.46
Untreated	-	2.27	4.00	4.57	1.30	3.83	3.67	5.30	2.20	4.33	6.10

The interaction between orchid cultivars and herbicide treatments was not significant, therefore statistical comparison of means in this table are not appropriate.

^x The list below provides the cultivar coding for the means reported in **Table 11**.

Cultivar Code	Cultivar Name
1	D. Bangsaen Beauty Udomsri, #2716
2	D. Vipa Mary MR x D. Udom Flare X D. Kanokporn, #2701
3	D. Burana Jade
4	D. Jacky mutation, WRM 303
5	D. Sakura Pink
6	D. Bertha Chung X Imelda Romualdez `Blue, 224
7	D. Thoung `Pink
8	D. Kannayao Red, 392
9	D. Woor Leng X D. Patham Thani
10	Vanda D.K. Hybrid

These data indicate a high level of safety when using Direx 4L on these cultivars even in the seedling stage. These results will be useful in requesting herbicide labeling for these cultivars across a wide range of growth stages.

Hot cinder using preemergence herbicides on 3 orchid cultivars.

The Hot Cinder experiment on 3 orchid cultivars was terminated on 05/05/01. The updated progress report is provided below. Funding to initiate experiments using Hot Ciders on anthuriums and orchids was not provided and no additional work in this area was initiated.

In this experiment, a cement mixer was used to treat growth media with preemergence herbicides prior to their use in pots. Cubed coconut fiber was the media component impregnated with various herbicides and is commercially marketed as coir. Cubed coir was treated at two rates with Direx 4L, Surflan and Gallery as a mixture and Ronstar WP (a wettable powder). Treated coir was used in two ways, as a top dressing after orchids were planted and as a growth medium component in a 50% mixture with volcanic cinder. Herbicides used to treat coir were also applied as directed sprays to the surface of potted orchids with a growth media composed of a 50% mixture of coir and cinder. This treatment design allowed for the comparison of orchid growth in response to a herbicide dose introduced 3 different ways, i.e. treated coir as a surface topdress, treated coir as a potting component in the growth medium and as a conventional directed spray application to the surface of the growth medium. Ronstar G (a granular formulation) was also included in the treatment set. All chemical treatments were applied at two rates, 1 and 4 four times the anticipated labeled use rate (1X and 4X, respectively). Seedling orchids were removed from common trays and planted into 4 inch pots and grown in a commercial production environment on 05/04/00. Both spray and granular herbicide applications were applied only once, immediately after planting. The experiment was located at Newman's Nursery and each pot included 3 orchid cultivars, "Ocelot", "D. Roi ET – D. Doctor Peacock" (325) and "D. Burana Green".

The only problem in this experiment was the lack of regular fertilization to maintain commercially acceptable vigor of the orchids. The experiment was terminated on May 05, 2001 and orchid cultivars were sampled for whole plant dry weight accumulation. Weed control ratings and weed counts were also taken to determine the efficacy of the three methods of introducing herbicides into pots.

The orchid response to the herbicide treatments was similar for all cultivars. The data for orchid dry weight accumulation in response to herbicide treatments in **Table 12** includes the pooled data for the three orchid cultivars used in this experiment, data for the response of individual cultivars are contained in **Table 12a**. The data indicate that none of the herbicide treatments significantly reduced orchid dry weight accumulation. The numerically lowest dry weight levels were recorded when herbicide treated coir (at the 4X level) was used as part of the growth media.

Moss was introduced on seedlings removed from infested common trays. The best control of moss was recorded in Ronstar WP treatments. Moss control with Ronstar G was not significantly different than untreated pots. Even though the amount of active ingredient in Ronstar G and WP treatments were the same, the granular formulation was unable to control moss. These results show how important the formulation and placement of Ronstar are to be effective on certain weeds, like moss. Moss was almost nonexistent in treatments containing Ronstar WP treated coir as part of the growing media.

The two other weeds present in this experiment were Artillery Fern and Bitter Cress. These weeds were not as consistently distributed across all treatment like moss. The lack of even distribution explains why untreated pots had little to no counts for these species while pots treated with Direx 4L had high levels of bitter cress. Conclusions, based on weed counts, suggest that Direx 4L applied as a single preemergence application lacked good control of Bitter Cress after 12 months. Artillery Fern was present in treatments containing the Gallery/Surflan mixture.

The method of herbicide application appears to have little impact on the response of orchid growth and weed control in pots. However, orchid growth does not support continued study of treated coir (at the 4X level) as a media component. It makes more sense to compare conventional spray applications to a fortified top dress of coir or volcanic cinders. Also, granular formulations appear to be less effective for control of moss than spray applications on coarse media used to grow orchids.

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Table 12. The response of 3 orchid cultivars (Ocelot, D. Roi ET – D. Doctor Poyck #325 and D. Burana Green) and weeds to herbicides introduced to pots in three ways: herbicide treated coir as a top dress (TD) above a growth media mixture of 50% coir and 50% volcanic cinder, herbicide treated coir as a component in 50% mixture of coir and volcanic cinder and as a conventional directed spray application. Ronstar was the only herbicide applied as a granular formulation to the top of the 50% mixture of coir and volcanic cinder.

Trt #	App. Mode	Mean Dry wt. of 3 cultivars (g)	% Cover with Moss ^w	BICR ^v counts (#)
Surflan/Gallery 1X	TD	2.72 a	99.5 a	0.4 e
Surflan/Gallery 4X	TD	2.41 ab	90.5 abc	0.1 e
Surflan./Gallery 1X	MIX	2.37 abc	94.5 a	2.2 e
Surflan /Gallery 4X	MIX	1.74 bc	78.5 cd	0.3 e
Surflan/Gallery 1X	SPRAY ^z	2.10 abc	79.5 bcd	2.8 e
Surflan/Gallery 4X	SPRAY	1.56 bc	54.0 e	3.6 e
Direx 4L 1X	TD	1.98 abc	100.0 a	17.6 a
Direx 4L 4X	TD	1.65 bc	99.5 a	12.2 b
Direx 4L 1X	MIX	2.06 abc	100.0 a	8.3 c
Direx 4L 4X	MIX	1.49 c	91.5 ab	15.8 a
Direx 4L 1X	SPRAY	2.34 abc	91.0 abc	3.6 de
Direx 4L 4X	SPRAY	2.02 abc	95.0 a	7.1 cd
RONSTAR 50 WP 1X	TD	2.18 abc	6.6 g	0.3 e
RONSTAR 50 WP 4X	TD	2.18 abc	33.5 f	0.9 e
RONSTAR 50 WP 1X	MIX	1.55 bc	1.4 g	0.0 e
RONSTAR 50 WP 4X	MIX	1.69 bc	0.5 g	0.0 e
RONSTAR 50 WP 1X	SPRAY	2.05 abc	32.5 f	0.0 e
RONSTAR 50 WP 4X	SPRAY	2.42 ab	.4 g	0.0 e
RONSTAR 2%G 1X	GRANULAR	2.07 abc	89.5 abc	0.0 e
RONSTAR 2%G 4X	GRANULAR	2.09 abc	68.0 d	0.0 e
UNTREATED-TD ^y	-	2.23 abc	100.0 a	0.0 e
UNTREATED-MIX ^x	-	2.14 abc	95.0 a	0.5 e

^z SPRAY indicates that herbicides were applied to the top of growth media in a directed spray application.

^y TD indicates that herbicide treated coir potting component was applied as a topdress to orchids rooted in a growth media mix of 50 volcanic cinder and 50% untreated coir.

^x MIX indicates that herbicide treated coir was applied as a growth media component within a 50% mixture with volcanic cinders.

^w Moss: unidentified species

^v BICR: Bitter Cress, *Cardamine hirsuta* L.

^u AFERN, Artillery Fern, *Nephrolepis* spp.

Table 10(a). The response of 3 orchid cultivars (Ocelot, D. Roi ET – D. Doctor Poyck (325) and D. Burana Green) and weeds to herbicides introduced to pots in three ways: herbicide treated coir as a top dress (TD) above a growth media mixture of 50% coir and 50% volcanic cinder, herbicide treated coir as a growth media component in 50% mixture of coir and volcanic cinder and as a conventional directed spray application. Ronstar was the only herbicide applied as a granular formulation to the top of the 50% mixture of coir and volcanic cinder. The interaction between orchid cultivars and herbicide treatments was not significant, therefore statistical comparison of means in this table are not appropriate.

Herbicide treatment	Application method	Mean whole plant dry wt. (g)		
		D. Burana Green	Ocelot	D.Roi Et x D. Dr. Poyck (325)
Surflan/Gallery 1X	TD	4.3	2.1	1.7
Surflan/Gallery 4X	TD	3.9	1.0	2.3
Surflan./Gallery 1X	MIX	3.3	1.9	2.0
Surflan /Gallery 4X	MIX	3.2	0.9	1.1
Surflan/Gallery 1X	SPRAY ^z	3.0	1.1	2.2
Surflan/Gallery 4X	SPRAY	2.5	0.6	1.6
Direx 4L 1X	TD	2.6	1.4	2.0
Direx 4L 4X	TD	2.3	1.4	1.2
Direx 4L 1X	MIX	3.2	1.6	1.4
Direx 4L 4X	MIX	2.6	1.1	0.8
Direx 4L 1X	SPRAY	3.4	2.4	1.3
Direx 4L 4X	SPRAY	3.5	1.1	1.4
RONSTAR 50 WP 1X	TD	2.7	1.9	2.0
RONSTAR 50 WP 4X	TD	3.5	1.3	1.7
RONSTAR 50 WP 1X	MIX	2.6	1.2	1.0
RONSTAR 50 WP 4X	MIX	3.2	1.1	0.8
RONSTAR 50 WP 1X	SPRAY	2.8	1.6	1.7
RONSTAR 50 WP 4X	SPRAY	3.6	2.1	1.6
RONSTAR 2%G 1X	GRANULAR	3.8	1.1	1.3
RONSTAR 2%G 4X	GRANULAR	2.8	1.8	1.7
UNTREATED-TD ^y	-	3.0	1.5	2.1
UNTREATED-MIX ^x	-	2.8	1.8	1.8

^z SPRAY indicates that herbicides were applied to the top of growth media in a directed spray application.

^y TD indicates that herbicide treated coir potting component was applied as a topdress to orchids rooted in a growth media mix of 50 volcanic cinder and 50% untreated coir.

^x MIX indicates that herbicide treated coir was present as a growth media component with 50% of volcanic cinders.

Objective 2. Continue the currently running experiment on Raphus palms and prepare finalized report for forwarding to chemical company representatives.

An experiment was initiated on 07/02/01 at the Hilo location of Kohala Nursery to determine the response of Raphus palm stock plants (in 2 gallon pots) and weeds to directed sprays of preemergence herbicides. The herbicides evaluated in this experiment were Direx 4L (1.5 and 6.0 lb ai/a) a tank mix of Gallery (.75 and 3.0 lb ai/a) and Surflan (2.0 and 8.0 lb ai/a) and Barricade (.5 and d 2.0 lb ai/a). The initial spray application was made on 07/02/01 followed by sequential applications 88, 70, 69 AND 69 days later. The palm experiment was terminated 69 days after the last spray application, when the total number of fully expanded leaves were counted and removed from all stems to obtain a dry weight accumulation as a measure of growth in response to the sequential application of herbicides.

The data in Table 13 represents palm growth (leaf dry weight accumulation) and weed control response at 69 days after the last of 5 sequential herbicide applications. Digital images were recorded of the root ball of all plants treated in this experiment. The analysis of the fully expanded leaf dry weights and the average weight of a single leaf did not indicate a significant difference between any of the treatments. However, digital images recorded on the termination date help to interpret the data obtained. The low rate of Direx allowed for growth of palm roots that was similar to growth observed in untreated pots. At the high rate of Direx and in all other chemical treatments, surface roots were reduced to varying degrees. Barricade application caused the greatest amount of surface root reduction followed by the Gallery/Surflan mixture. There were no apparent distortions to leaf shape but smaller leaves were found in treatments with the highest levels of surface root reduction.

Direx, at both rates proved good to excellent control of artillery fern and Niruri. The low rate of the Gallery/Surflan mixture provided unacceptable control of Artillery Fern with control improving at the higher rate. Niruri was controlled at commercially acceptable levels at both rates of this mixture. Barricade provided acceptable control of Artillery Fern at both rates but Niruri control was clearly reduced at the low rate of Barricade at the end of the experiment.

Direx, at the low rate is clearly the safest herbicide evaluated in this experiment to control weeds that are growing as well as certain weeds germinating from seeds.

Table 13. The response of Raphus palm leaf dry weight accumulation when experiment was terminated on 07/02/02. Weed control rating were made at termination at 07/02/02 using a scale of 0 to 10, where 0 means no weed control, 10 mean perfect weed control with no weeds present and 7.0 is the lowest level of control regarded as commercially acceptable.

Treatments	lb ai/a	Total Leaf wt. (grams) 07/02/02	Wt/leaf (grams) 07/02/02	Visual rating 07/02/03	
				AFERN ^y	NIRU ^x
DIREX	1.5	65.7	4.3	9.0 a	8.3 a
DIREX	6.0	56.9	3.5	9.3 a	9.5 a
GALLERY + SURFLAN	.75 + 2.0	50.4	3.2	5.0 b	7.3 a
GALLERY + SURFLAN	3.0 + 8.0	37.5	2.4	9.0 a	8.0 a
BARRICADE 65WG	0.5	44.8	3.2	8.8 a	7.8 a
BARRICADE 65 WG	2.0	48.2	3.6	10.0 a	9.0 a
UNTREATED		61.2	3.6	1.8 c	1.3 b

Means within a column followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 1% level.

^y NIRU, Niruri, *Phyllanthus debilis*

^x AFER, Artillery fern, *Nephrolepis spp*

Objective 3. Initiate replicated experiments to characterize the response of fishtail palm (*Caryota mitis*) and weeds to hot cinder top dress containing Ronstar and a Ronstar/Direx 4L mixture. Chemical binders will also be evaluated for their ability to extend the time that herbicides are effective.

No progress due to insufficient funding.

Plan of Work for 2003

CHEMICAL WEED CONTROL FOR EXPORT GRADE POTTED ORCHIDS, ANTHURIUMS AND POTTED PALMS.

Submitted by Dr. Joe DeFrank (June 2003), UH-Manoa.

Objective 1. Compose detailed reports on currently terminated experiments and forward them to representative of chemical companies that have products used in these experiments.

Procedures of Objective 1.

Work will continue on the description of work completed on pre and postemergence herbicides on orchids and anthuriums. Finalized reports will be forwarded to representatives of companies that produced and/or distribute the herbicides reported on in this annual report. Preparation and submission of finalized publications will also be completed.

Objective 2. Prepare web-based content describing the research conducted during this project. Content will include downloadable progress reports and narrated slide shows.

Procedures of Objective 2.

Annual progress reports and narrated PowerPoint presentations describing the research conducted during the course of the project will be adapted for web based delivery. Text as well as color images will provide a comprehensive description of the research conducted and the results obtained. Publication of these research results will allow chemical company representative to better evaluate their risks when deciding to add Hawaiian orchid and anthurium cultivars to herbicide labels.

Time line.

Month of project	Objectives addressed	Narrative
1-9	1	Prepare reports and forward to chemical companies.
11-12	2	Prepare content for distribution over the Internet with hosting on CTAHR server.

Budget:

None requested at this time, current funding levels are sufficient to carryout proposed objectives.

Publications

Progress reports on the Internet:

Progress report for chemical weed control in orchids. Presentation made to the Dendrobium Orchid Growers Association (on Oahu) on Jan. 09, 2003

http://www2.hawaii.edu/~defrenk/research_reports_and_update/ORCHID_WEEDS_2003.pdf

Progress report for chemical weed control for export grade potted ornamentals - period 01/01/02 – 12/31/02

http://www2.hawaii.edu/~defrenk/research_reports_and_update/DeFranks%20PROGRESS%20REPORT%2002.pdf

Progress report for chemical weed control for export grade potted ornamentals -period 01/01/01– 12/31/01

http://www2.hawaii.edu/~defrenk/research_reports_and_update/DeFranks%20PROGRESS%20REPORT%2001.pdf

Narrated Power Point Presentations on the Internet.

To view these narrated presentations requires the downloading and installation of the RealOne video player.

The Player is free and easy to install. To get the Real One Player:

http://www.real.com/R/RC.020305realhome_1.fbar.txt..R/forms_real.com/real/realone/realone.html?dc=317316315&type=dl&src=020305realhome_1

USDA Floriculture 2002 Progress Report -Weed Control on potted ornamentals for export. (47 min.).

http://uhtv.hawaii.edu:7070/ramgen/ctahr/tpss/defrank/USDA_Floriculture_2002_Progress_Report_-_Weed_Control/trainer.smi

USDA Progress report 2003 for chemical weed control in potted orchids (1hr. 07 min.) updated 01/10/03.

http://uhtv.hawaii.edu:7070/ramgen/ctahr/tpss/defrank/orchids_weeds_resh_2003/trainer.smi