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FLORIDA'S ORNAMENTAL NURSERIES: ARE THEY MOVING TOWARD SUSTAINABILITY?

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Abstract. **The results of a survey of 113 ornamental plant producers are reported. The relationship between farm size, cost of technology, and the management intensity of technology and the adoption behavior of nursery growers is examined. The authors hypothesize that larger farms will be more likely to adopt higher cost and more management intensive technologies than will smaller production units. The authors conclude that these factors do explain some of the adoption behavior. However, there are exceptions to the overall pattern which are not explained by the hypothesis.**

The adoption of sustainable agricultural practices by nursery growers is as elusive as defining the term "sustainable." The term is the current banner cry of a broad, and often conflicting, spectrum of organizations and groups (Edwards, 1993; Palm and Sandell, 1989; Papendick and Parr, 1992; Silva-Santos and Cardoso, 1992; York, 1991). In this paper, the term "sustainable" means maintaining and increasing the biological and economic productivity of Florida's commercial nurseries. To accomplish this, producers must use inputs as efficiently as possible, maintain stable production, reduce any adverse environmental impacts and guarantee social compatibility (Lightfoot and Noble, 1993).

Rogers (1983) describes five characteristics that are necessary for adoption of an innovation. These are: (1) the belief that the innovation will provide an economic or social benefit over their traditional practice, (2) compatibility with past experience, (3) the innovation is not too complex or difficult to understand, (4) the possibility of trying or experimenting with the innovation on a limited basis, and (5) results of the innovation are clearly visible. This diffusion of innovation theory does not address all the factors that influence the adoption of new technologies. There are other factors such as economic, physical, and environmental, that are part of the decision-making process (Nowak, 1987; Thomas et al., 1990).

Fernandez-Cornejo et al. (1992) demonstrate that economic factors play a big role in the adoption of innovations. They mention that there is a possible "critical lower limit" for the size of an operation which would prevent adoption of certain innovations. They predict a direct linear correlation between the increase in the cost of a technology and an increase in the "critical lower limit" where a farm could afford to adopt a technology.

They also predict that off-farm employment takes time away from the labor available to work on the operation. The more time dedicated to this employment directly decreases the amount of time available to work in the nursery. This is a major factor preventing adoption of labor/management intensive practices like integrated pest management (IPM).

Swisher and Bastidas (1994) investigated the relationship between farm size and adoption of agricultural practices which minimize undesirable environmental impacts. These technologies were compared by how capital and management intensive they are. They found that size alone is not a good measurement for adoption of sustainable practices. When size is compared to the costs of implementing a technology or the intensiveness of management, a higher degree of certainty in predicting adoption can be had. Comparing the size and capital investment demonstrated to be the most reliable predictor.

This study was conducted to test one hypothesis that may help explain the adoption of sustainable practices in the commercial ornamental plant nurseries in Florida. Our prediction is that capital or management intensive technologies are adopted by larger nurseries and that smaller nurseries adopt technologies that do not require large capital investments or management time, which may also include training and education.

Our focus is on the adoption of practices in the nurseries that are considered "sustainable," particularly those that protect the environment. Only the results of those growing plants, versus liners, are included in this paper. These practices include improved water management, improved nutrient

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management, and IPM. The specific practices targeted for this paper are: (1) reasons for irrigating at certain times of the day; (2) desired improvements over current irrigation systems; (3) recycling of water; (4) use of plant tissue culture tests; (5) incorporation of fertilizer; and (6) factors influencing pest management decisions.

Materials and Methods

The sample was selected from the Florida Department of Agriculture and Consumer Services' Registry of Certified Nurseries. This list was updated as of 1993 and was the most current available at the time of the study. There are very few nurseries that are not certified, and therefore would not be included in this list.

The nursery industry is highly stratified in the state of Florida. The bulk of the production is concentrated in the largest nurseries, those producing over 500,000 plants per year. Because of this, we selected independent samples from each of three size classes. This made analyses within and between size classes possible.

A total of 118 nursery owners/operators were included in the sample. All data were collected by personal interviews. The sample size and the response rate were sufficient to produce a 95% confidence level for the findings reported. This paper looks only at the nurseries producing plants and does not analyze the effects liners have on these technologies. Because of this, five nurseries that produce only liners were excluded from this group, leaving a total of 113 nurseries.

Description of the sample. Three size classes were selected by the number of plants produced. Size Class 1 were those nurseries producing less than 100,000 plants per year. Size Class 2 were the nurseries producing between 100,000 and 500,000 plants per year. Size Class 3 were those producing over 500,000 plants per year. There were a total of 39 nurseries in Size Class 1, or 34.5% of the total. In Size Class 2 there were 38 nurseries, 33.6% of total. Size Class 3 had 36 nurseries, 31.9% of the total.

The primary decision makers were questioned regarding personal characteristics. These individuals were usually the owner/operator, but sometimes the individual was an employee.

Results and Discussion

Overall, the results indicate that there is considerable movement towards adopting sustainable agricultural practices in the commercial nursery industry of Florida. For example, the results show very high adoption rates, over 75% of all growers, use primarily controlled release fertilizer.

Our hypothesis is that adoption rates of technologies that are capital or management intensive would be highest among the larger sized nurseries (Size Class 3). Technologies that are less capital or management intensive would have similar adoption rates by all producers, regardless of size. We define capital intensive as those technologies that require large capital outlays. An example would be a state of the art, highly water efficient irrigation system. Conversely, media and plant tissue testing require little capital and could potentially offer immediate financial benefits by reducing fertilizer costs if rates of application are reduced.

Factors influencing time of day to irrigate. Best management practices (BMP) recommend irrigation sometime between early morning and mid-day to prevent excess water loss to evaporation. In actual practice, 39.8% of all respondents irrigated at this time. Another 19.5% irrigated in the evening. A total of 59.3% of the growers irrigated at these water saving times. This supports our hypothesis that practices that are not costly are adopted by all. But, contrary to belief that water reduction was the reason for irrigation timing, reducing diseases was primary concern.

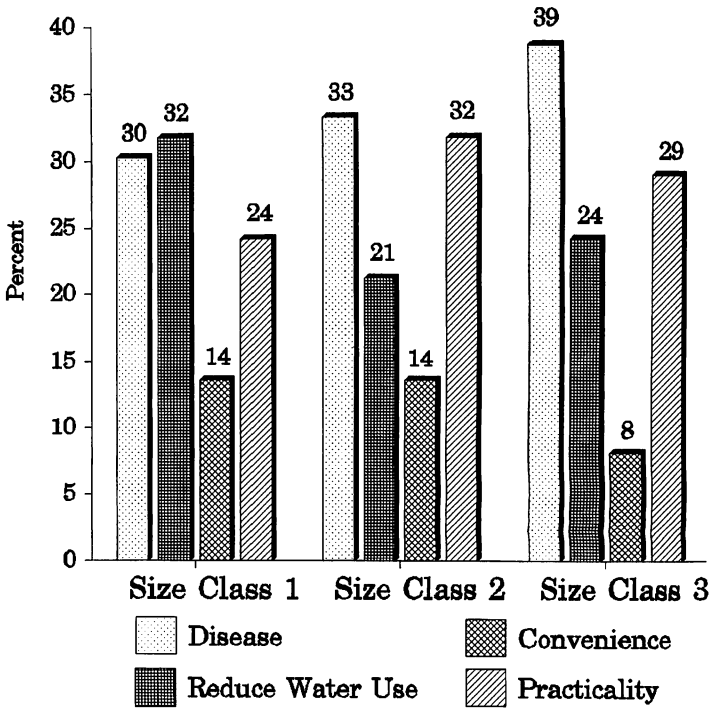

Figure 1. Factors influencing time of day to irrigate

Growers in both Size Class 2 and 3 (Fig. 1) said that reducing disease incidence (38.7% Size Class 3 and 33.3% Size Class 2) was the most important factor in determining what time to irrigate. Size Class 1 said reducing water use (31.8%) was the main factor, ranking reducing disease incidence a close second (30.3%). Practicality, for example irrigating when people are away, was the second factor for Size Class 2 (31.8%) and Size Class 3 (29%).

Desired improvements over current irrigation systems. Over half (50.5%) of those surveyed would like to change the irrigation systems of their nurseries (Fig. 2). Most use combinations of overhead sprinklers, low volume and microjet, or mist systems. Size Class 3 were the ones most anxious to change with 58.3% wanting a better system. Fewer in Size Class 2 (48.6%) wanted change and Size Class 1 had the smallest (46.1%). These figures are significant in that they support our hypothesis that cost intensive technologies would be adopted by larger nurseries. It is also of interest that there is such a desire, especially Size Class 3, to upgrade or improve their irrigation systems.

The reasons cited for wanting change (Fig. 3) were mainly because they want a more efficient system (Size Class 3 with 27.5%, Size Class 2 with 26.5%, and Size Class 1 with 28.9%). Size Class 2 nurseries cited reducing costs as equally important (26.5%). Size Class 1 mentioned that they would like a system more suitable for the crop (26.3%). Only the larger nurseries (Size Class 3) ranked meeting anticipated water use restrictions as high (25%).

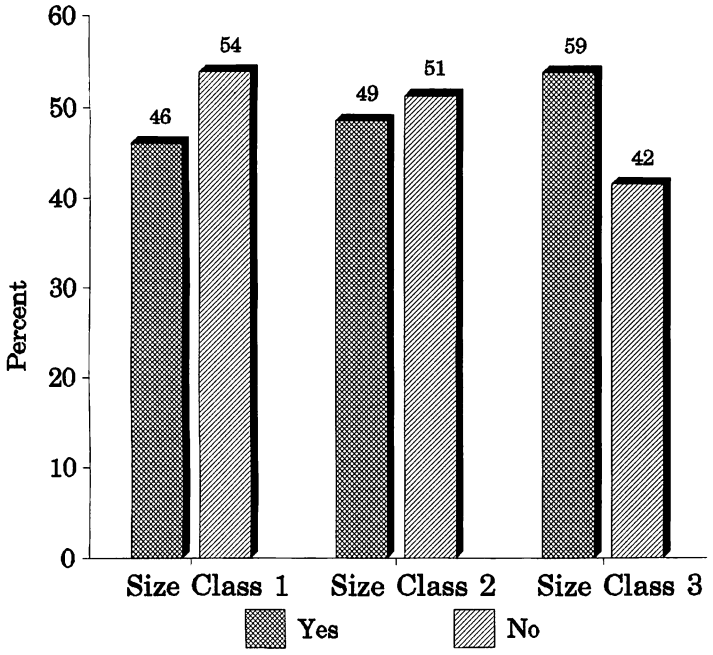

Figure 2. Nurseries wanting to change irrigation system

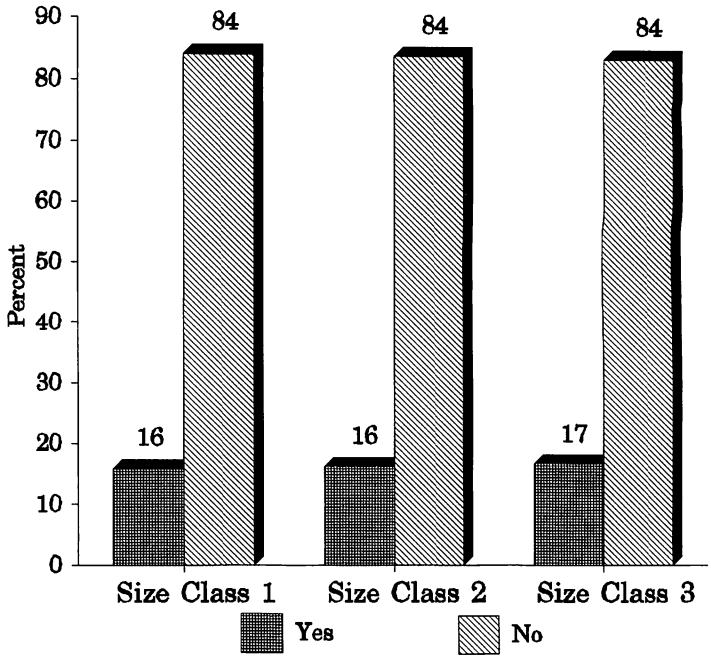

Figure 4. Nurseries that recycle water

Recycling of water. This will become a greater issue in the future in Florida. We can expect even greater competition for water by an increasing population, industry and agriculture. Currently 15.5% of the nurseries recycle or reuse most (75% or more) of their water (Fig. 4). With our hypothesis, we would expect the large (Size Class 3) nurseries to be the ones recycling because of the costs involved. But recycling is almost identical in all groups. Of those recycling more than 75% of their water 15.8% are from Size Class 1, 16.2% from Size Class 2, and 16.7% from Size Class 3.

Use of plant tissue tests. To use the nutrients as efficiently as possible, the recommended practice is to first start with media or soil tests to determine what a grower is planting into. Once this has been determined, then periodic plant tissue tests are very effective in determining fertilizer needs. Tissue analysis allows the operator to apply the nutrients needed. Currently 80.5% of all growers use this method on a regular basis (Fig. 5). In Size Class 1, 89.7% used tissue tests, in Size Class 2, 89.5% used it, and, in Size Class 3, 62.9% regularly do

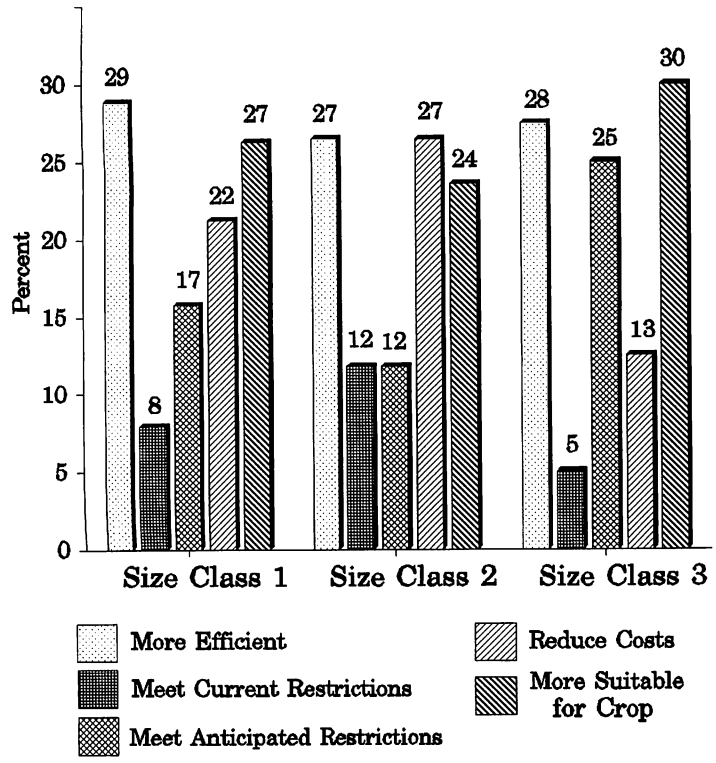

Figure 3. Reasons for wanting to change irrigation system

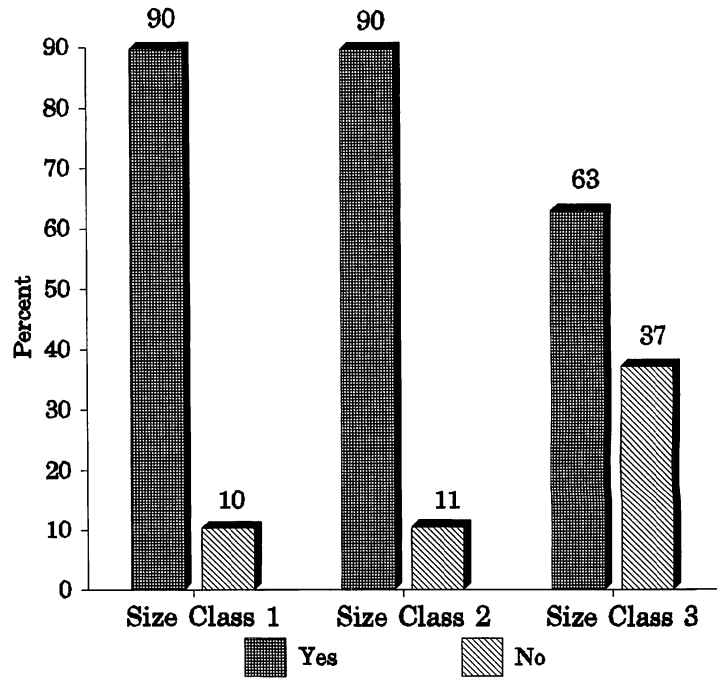

Figure 5. Use of plant tissue testing

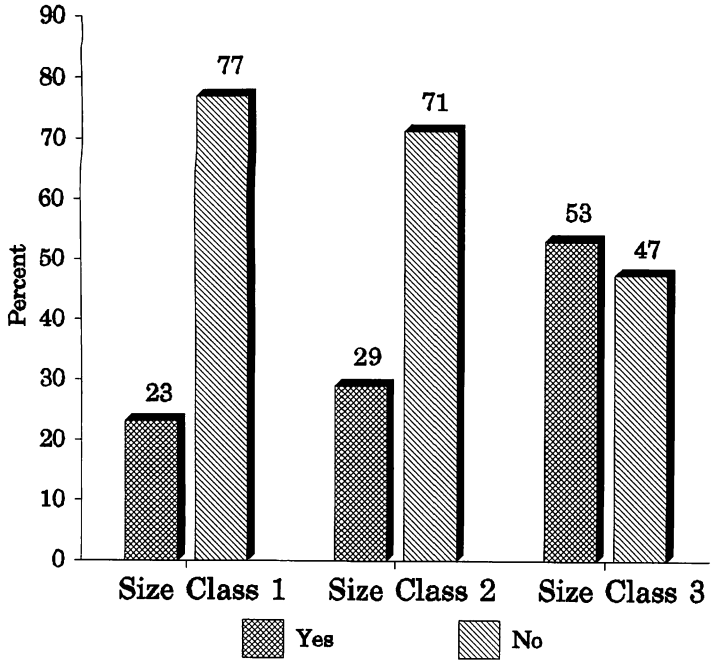

Figure 6. Incorporation of more than 75% of fertilizer into planting medium

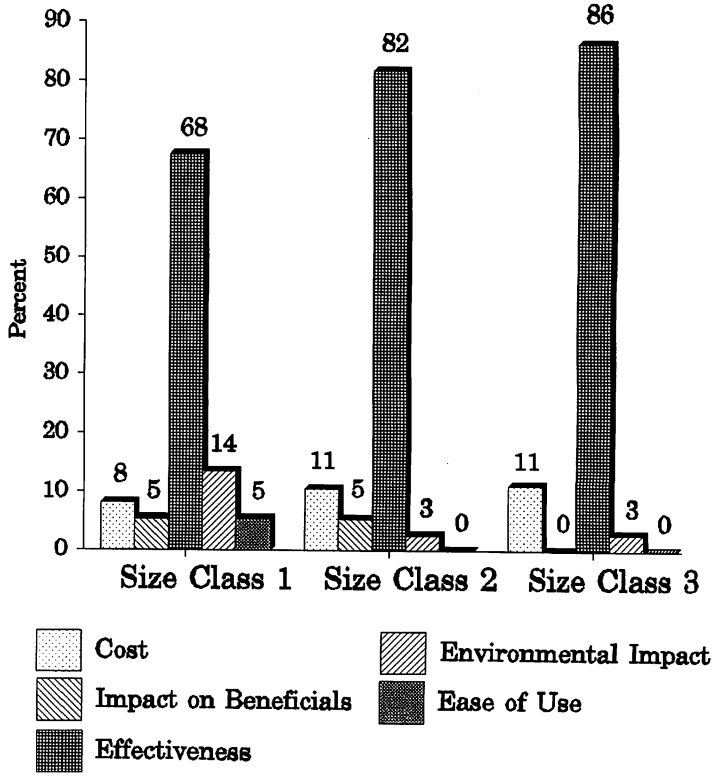

Figure 7. Factors influencing pest management decisions

tissue culture tests. This partially supports our hypothesis that the less costly technologies would be adopted by the smaller nurseries, which is the case. We also expected all to equally adopt technologies of this kind, but there was a lower adoption in Size Class 3.

Incorporation of fertilizers. Incorporating fertilizers, especially controlled release fertilizers, into the planting medium helps reduce fertilizer loss when plants are blown over by wind. Of all the nurseries, 55.4% incorporate some of their fertilizer (Fig. 6). Of those nurseries incorporating over 75% of their fertilizer, Size Class 3 showed the highest adoption rates, 52.8%, of their fertilizer. Size Classes 2 and 1 illustrated much lower rates, 28.9% and 23.1%, respectively. This would be expected by our hypothesis that a practice that is capital or management intensive would be adopted by the larger nurseries.

Factors influencing pest management decisions. The operators were asked to rank several factors in order of importance for making decisions about how to manage pest problems (diseases, insects, weeds, and nematodes). Effectiveness was by far the most important factor in all groups with 67.5% of Size Class 1, 81.6% of Size Class 2, and 86.1% of Size Class 3, ranking it the most important (Fig. 7). Size Class 1 showed the following ranking; (1) effectiveness, (2) environmental impact, (3) costs, (4) impact on beneficial insects, (5) ease of use. Size Class 2 and 3 rankings were similar. Size Class 2 showed the following ranking: (1) effectiveness, (2) costs, (3) impact on beneficial insects, (4) environmental impact, and (5) ease of use. Size Class 3 showed the following ranking: (1) effectiveness, (2) cost, (3) environmental impact, (4) impact on beneficial insects, and (5) ease of use. Smaller nurseries ranked environmental impact as more important than did Size Class 2 and 3 nurseries. These data tend to show that smaller nurseries have a more environmentally "friendly" pest management attitude than do the larger nurseries. Despite this attitude, our hypothesis would predict that the adoption of IPM practices by smaller nurseries may be lower than among larger nurseries because it is management intensive and requires extra education or training for implementation. The results are inconclusive at this point.

Conclusions

Overall, the results indicate that there is considerable movement towards adopting sustainable agricultural practices in the commercial nursery industry of Florida. The results show very high adoption rates for some technologies. For example, over 75% of all growers used primarily controlled release fertilizer.

Our results show that size alone is not enough to predict adoption of practices and technologies. When size is related to capital investment and management intensive practices or technologies, we are able to predict adoption with more certainty. Future studies should look at how the amount of time an owner or operator dedicates to nursery activities and how these influence adoption of sustainable practices.

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PREEMERGENCE HERBICIDES FOR CALADIUMS

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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

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