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Control of Melaleuca Seedlings and Trees by Herbicides

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ABSTRACT

Field tests of several herbicides at Lake Okeechobee, Florida, demonstrated effective control of melaleuca seedlings and mature trees. The lowest tested rates (4.5, 2.2, and 4.5 kg ai/ha) of bromacil, hexazinone, and tebuthiuron (respectively) produced complete mortality of melaleuca seedings within six weeks of treatment. The highest tested rate (13.4 kg ai/ha) of glyphosate also produced 100 percent mortality of seedlings, but 44 weeks were required to achieve these results. At lower rates, tebuthiuron pellets were not as effective as the wettable powder formulation on seedlings. Only dicamba + 2,4-D produced less than 100 percent mortality of seedlings at the highest tested rate (87%). After 15 months, at least 90 percent mortality resulted from injection applications (8 cm intervals around the trunk) of picloram+2,4-D, hexazinone, and triclopyr amine to trees in wet sites. Glyphosate produced 83% mortality, and triclopyr ester produced 70%. Aerial application of hexazinone (L) (4.5 kg ai/ha) resulted in 87% mortality of mature melaleuca after 24 months in periodically inundated habitats. Pelleted tebuthiuron and hexazinone (4.5 kg ai/ha) resulted in 95 and 97% mortality, respectively, and higher rates (11.2 kg ai/ha) of the pelleted formulations, hexazinone (L), and tebuthiuron (WP) resulted in 100% mortality of mature trees. Lower rates of tebuthiuron (WP) produced 53% mortality. Bromacil (WP) and dicamba + 2,4-D applications resulted in 5% or less mortality at any tested rate.

Key words: Melaleuca quinquenervia, hexazinone, tebuthiuron, bromacil, dicamba + 2,4-D, glyphosate, picloram + 2,4-D, triclopyr amine, triclopyr ester.

INTRODUCTION

Melaleuca (*Melaleuca quinquenervia* (Cav.) Blake) is an evergreen, arborescent member of the Myrtaceae, native to Australia, New Guinea, and New Caledonia, that has spread widely in southern Florida since its introduction in the early 1900s (Meskimen 1972). Melaleuca saplings were planted on levees and dredged material islands (tree islands) at Lake Okeechobee by the U.S. Army Corps of Engineers (USAE) starting in 1940 to prevent storm generated waves from eroding the levee system (Herbert Hoover Dike). From the tree islands, melaleuca has spread into shallow wetland areas of the lake. Because of the invasive nature of melaleuca (Craighead 1971), and subsequent impacts to native plant (Myers 1984) and animal (Deuver et al. 1979, Maffei 1994, Mmazzottii et al. 1981, Ostrenko et al 1979, Sowder and Woodall 1985) communities, and because the USAE has determined that the trees are no longer essential for bank stabilization, efforts have been underway since 1993 to control the trees and prevent further spread into adjacent wetlands.

Melaleuca has been reported to be controlled by several herbicides. Imazapyr caused melaleuca mortality 12 months after treatment (Standish and Burns 1994). Less satisfactory results with glyphosate and hexazinone were reported by Cofrancesco and Jones (1995). Laroche (1993) found some success with injections of hexazinone, and Woodall (1982) reported successful control of greenhouse-grown seedling melaleuca with bromacil, diuron, and hexazinone at rates of 9.1, 4.8, and 6.8 kg ai/ha. However, very few replicated field trials of herbicide effectiveness have been reported. Among the products tested, only the Rodeo© formulation of glyphosate is federally registered for foliar applications over standing water. Bromacil, tebuthiuron, hexazinone, dicamba + 2,4-D, picloram + 2,4-D (including injection), and triclopyr ester and amine have a wide variety of federal registrations for use in non-flooded sites. Glyphosate, picloram + 2,4-D and triclopyr are also registered for injection control of woody species.

This research was conducted to determine if herbicides could become part of a management program to reduce melaleuca in Lake Okeechobee. The objectives were to describe the effect of broadcast and injected herbicides on seedling and mature melaleuca.

MATERIALS AND METHODS

Seedling Study: In August 1978, a 9.1 by 9.1 m test site was established near the U.S. Army Engineer Jacksonville District Clewiston Area Office, Clewiston, Florida. Existing vegetation was removed mechanically, and the crushed shell and limestone substrate was covered with a 0.1 m thick layer of lake sediments. Melaleuca seeds from nearby trees were broadcast onto the seed bed. In March 1979, soil samples were collected from nine locations in the test site for pH and bulk density determination.

Also in 1979, the site was subdivided into 120, 0.6 by 0.6 m plots, arranged in 8 rows of 15 plots each, with walkways between the rows. Adjacent plots were separated at the ground level by placing aluminum stripping at least 0.1 m into the soil. Since the seedings varied in height from an

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average of about 0.2 m on the west end to about 0.6 m on the east end, the site was divided into three blocks based on seedling height. Ten individuals in each plot were selected randomly and tagged with an identifying number.

Three application rates of six herbicide formulations were tested. All rates are reported on an active ingredient basis. Rates of 4.5, 9.0. and 13.4 kg ai/ha were used for all formulations except dicamba + 2,4-D combination and hexazinone (WP), which were applied at lower rates (Table 1). Treatments were allocated to plots using a randomized complete block design with one replicate in each of the three blocks. Three control plots were treated with water in each block. A 5.6 L hand-held sprayer and cone nozzle were used to apply all wettable powder and liquid formulations. Herbicides were diluted with water, and applied at a rate of 4,244 L/ha (diluent determined by the amount required to spray to wet in the very dense stands).

Test plots were monitored 6, 23, 32, and 44 weeks post-treatment. On each sampling date, vitality (live versus dead) of each tagged individual was recorded. Statistical comparisons were made within treatment rates, among herbicides, for each sampling date. Values for percent individuals killed were treated using the arcsine square root transformation and analyses of variance were performed on the transformed data.

Injected Herbicides: The effectiveness of five herbicides, applied to openings made in the bark, was evaluated on mature melaleuca in standing water. The test site was dense stands (heads) of melaleuca on the western shore of Lake Okeechobee, approximately 5 to 11 km east of Moore Haven. The test site normally had standing water, but the soil was exposed during the exceptionally dry spring and summer of 1981. Three blocks, each containing 60 tagged trees, were established in the test site. Block 1 was approximately 2 km from the levee, and consisted of perimeter trees in three heads. Block 2 was approximately 600 m from the levee, and consisted of perimeter trees from one head, and perimeter and interior trees from a second, less dense, head. Block 3 was located in a stand spreading from planted trees along the levee and formed a dense, nearly continuous, closed-canopy forest. Trees selected for inclusion in Block 3 were on the perimeter of the densest growth, approximately 300 m from the levee. Each test tree was considered a sample plot, and a minimum distance of 5 m was maintained between plots. Only trees with a diameter at injection height of at least 0.1 m were included in the test.

Pretreatment data were collected during 10-12 March 1980. Measurements consisted of diameter at injection height, distance to nearest neighboring melaleuca, and water depth. Each of five herbicides and a water control was

TABLE 1. AVERAGE PERCENT SEEDLING MELALEUCA MORTALITY FOLLOWING HERBICIDE APPLICATION AT CLEWISTON, FL NURSERY.

			Weeks Post Treatment			
Herbicide	Formulation	Rate	6	23	32	44
		kg ai/ha	percent mortality*			
Control (water)	Liquid		11.1	18.9	20.0	25.6
Low rate applications (2.2-4.5 kg ai/ha)						
Bromacil	Wettable powder	4.5	100 A	100 A	100 A	100 A
Tebuthiuron	Wettable powder	4.5	100 A	100 A	100 A	100 A
Hexazinone	Wettable powder	2.2	100 A	100 A	100 A	100 A
Glyphosate	Liquid	4.5	23 B	47 BC	53 BC	60 B
Tebuthiuron	Pellet	4.5	50 B	73 B	77 B	77 B
Dicamba+2,4-D	Liquid	3.4	33 B	43 C	43 C	43 B
Medium rate applications (4.5-9.0 kg ai/ha)						
Bromacil	Wettable powder	9.0	100 A	100 A	100 A	100 A
Tebuthiuron	Wettable powder	9.0	100 A	100 A	100 A	100 A
Hexazinone	Liquid	4.5	100 A	100 A	100 A	100 A
Glyphosate	Liquid	9.0	70 B	90 AB	93 AB	93 AB
Tebuthiuron	Pellet	9.0	83 B	93 AB	93 AB	93 AB
Dicamba+2,4-D	Liquid	6.7	67 B	70 B	70 B	70 B
High rate applications (9.0-13.4 kg ai/ha)						
Bromacil	Wettable powder	13.4	100 A	100 A	100 A	100 A
Tebuthiuron	Wettable powder	13.4	100 A	100 A	100 A	100 A
Hexazinone	Liquid	9.0	100 A	100 A	100 A	100 A
Glyphosate	Liquid	13.4	63 B	90 AB	93 AB	100 A
Tebuthiuron	Pellet	13.4	83 B	100 A	100 A	100 A
Dicamba+2,4-D	Liquid	13.4	80 B	83 B	87 B	87 B

*Values in each column (within each rate group) with letters in common are not significantly different at the $P < 0.05$ level using Duncan's Multiple Range Test. N = 3 for all treatments.

randomly assigned to 10 trees in each of the three blocks, for a total of 30 trees for each treatment (180 trees total). Injections were made immediately after pretreatment data had been collected (10-12 March 1980) and were spaced around the trunk at 8 cm intervals, approximately 0.5 to 1.2 m above the soil line, and 0.2 to 0.4 m above the existing water line.

Plastic 10 ml syringes (needles removed) were used to apply undiluted herbicide into openings in the bark made with a Jim-Gem© Tree Injector. Each opening received 600 mg of active ingredient, or 2 ml for the water control.

Trees were monitored 4, 7, and 15 months after treatment. Percent defoliation and cambium color for totally defoliated trees were evaluated. Trees were presumed dead if the cambium was dark brown at all points checked on the trunk.

Statistical comparisons were made among treatments for each sampling date, using a two-way analysis of variance (five treatments with 10 replicates in each of three blocks) of transformed data and Student-Newman-Keuls test, which tests for significant differences among means. An arcsine square root transformation was used for percent defoliation data, and a square root of X + 1 transformation was used for mortality, which was recorded as 0 = alive, 1 = dead (Snedecor and Cochran 1967). Results of the control applications were used to allow a more complete interpretation of the experiment, but they were not included in the statistical analyses.

Mature Tree Study: The test site was a series of tree islands that parallel the northwest shore of Lake Okeechobee between Fisheating Creek and the Kissimmee River (22.5 km). Melaleuca was planted in this area during the 1950s and 1960s, and the main trunks of most trees were cut to promote branching. The original plantings were in 4 to 6 rows on approximately 2.4 m centers.

Seven blocks, each containing 13 test plots, were established in the test site. Adjacent blocks of plots were separated by a minimum distance of 180 m. Each test plot was approximately 15 by 61 m, with the long axis paralleling the shoreline. Within each block, plots were established in pairs (except controls). The plots forming each pair were separated from each other by 61.0 m, and adjacent pairs of plots were separated by a distance of 122 m.

Pretreatment data were collected from 18 May to 3 June 1979. Ten individual melaleuca trees, each having a minimum basal diameter of 0.1 m, were selected from the two inner-most rows of trees in each plot and were numbered 1 to 10. Dead and/or stressed trees were found in three plots and these trees were excluded. The basal diameter of each marked individual, the distance from the trunk to the edge of the canopy to the northeast and northwest, and the number of living trees in each plot was recorded.

Each of the six herbicide formulations used in this study (Table 3) was randomly allocated to a pair of plots in each of six blocks of treatment plots. In the resulting split-plot design, a low rate of 4.5 kg ai/ha and a high rate of 11.2 kg ai/ha of a herbicide formulation were randomly allocated to a set of paired plots in each block. One plot in each block was an untreated control.

Application of the liquid herbicide formulations was made on 11 and 19 June 1979. Applications were made using a helicopter and microfoil boom applying a total volume of 187 L/ha. All six plots that received the low rate of a formulation were treated first, followed by the high rate of that same formulation. Applications were made during the early morning hours when wind velocity was minimal.

Pelletized formulations were applied during 9 to 12 June 1979. Tebuthiuron pellets were applied to plots in each of the six blocks using a Cyclone Seeder©. The 1.5- by 2.5-cm rectangular, pillow-shaped hexazinone pellets were distributed uniformly by hand.

Treated trees were monitored 29 September to 2 October and 11 to 13 December 1979, 4 to 6 March and 21 to 28 June 1980, and 13 to 14 June 1981. Quarterly posttreatment data included estimates of percent defoliation for each of the 10 tagged trees in each plot. The color of the cambium was observed for totally defoliated specimens by making small scrapings through the bark, and trees were presumed dead if the cambium was dark brown at all points checked on the trunk.

Statistical comparisons were made within treatment rates among treatments for each sampling date. Analyses of variance and Duncan's New Multiple Range Test were performed on percentages (percent of individuals killed) following an arcsine square root transformation (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Seedling Study: Although plant height varied greatly, bulk density (1.4 to 1.5) and pH (7.4 to 7.6 for A horizon; 7.7 to 7.8 for B horizon) of the soil varied little within the site. Difference in plant height was probably related to thicker amounts of lake bottom sediments in parts of the site.

Bromacil, hexazinone, and tebuthiuron (WP) provided complete control of melaleuca seedlings within 6 weeks of application (Table 1), and the lowest rates (4.5, 2.2, and 4.5 kg ai/ha, respectively) were as effective as higher rates. After 23 weeks, the highest rate (13.4 kg ai/ha) of tebuthiuron (20P) had produced 100 percent control; the only additional formulation that provided 100 percent control was the highest rate (13.4 kg ai/ha) of glyphosate at 44 weeks. Dicamba + 2,4-D failed to provide 100 percent control at any treatment rate.

Tebuthiuron (20P) provided less effective control than did the wettable powder formulation, and the response time was longer for the pellets. The effectiveness of concentrated pellets is dependent upon extensive root systems to ensure herbicide contact with scattered individuals, and the root systems of the seedlings were still small at the time of application. The response time to the pellets could also have been increased by the time required for the herbicide to dissipate into the soil.

Injected Herbicides: Mean melaleuca diameter at injection height was 27.2 cm (standard error = 12.2) and there was no significant difference among treatment means. There was a significant difference in stem diameter among blocks. The largest mean diameter was actually associated with the block located farthest from the levee plantings, but it was mainly due to the presence of a few very large individuals and not a condition of the block in general. The general area of Block 3 contained the largest and presumably oldest trees, but many of the largest individuals branched at or below the water level and were not used in the study.

Mean distance to nearest neighboring melaleuca was 2.5 m (standard error = 1.5). There were no significant differences for nearest neighbor distance among treatment means for all blocks combined. There was a significant difference among blocks, with the densest stand (Block 3) closest to the levee. Since trees selected for this test were at or near the perimeter of each stand, these nearest neighbor distances only approximate conditions in the whole stand.

Mean water depth was 89.7 cm (standard error = 7.4). The lake bottom is relatively flat, with a gentle slope from slightly higher spots (Block 1) to the surrounding basins. Water depth varied from 83 (Block 1) to 96 cm (Block 2), and differences among blocks were significant. Differences among treatment means were not significant.

At 4 months posttreatment, defoliation was at least 93 percent for all herbicide treatments, with no significant differences among the means (Table 2) and values did not change greatly on the subsequent monitoring dates. Defoliation of control trees decreased from 7 percent after 4 months to 0 percent after 15 months. The partial defoliation was probably due to xylem severed by the injection process. Defoliation for both picloram + 2,4-D and hexazinone rose to 100 percent by 7 months posttreatment, and remained complete at 15 months posttreatment. Defoliation remained above 93 percent for all herbicides, and there was no significant difference among treatments on the final monitoring date. Defoliation did not accurately reflect mortality, since the least effective herbicide, triclopyr ester, resulted in a mean defoliation of 99.7 percent after one year. Rapid defoliation and low mortality rates could indicate that excessively high application rates were used for glyphosate and triclopyr ester.

Regrowth after initial defoliation was most noticeable with glyphosate, with the regrowth in the form of small, chlorotic leaves which appeared more dense and less chlorotic below the injection site. With the possible exception of hexazinone, which principally moves acropetally, all the test herbicides are ordinarily xylem and phloem mobile (Weed Science Society of America 1994). However, most of the trees that were still alive at the end of the study were dead above the injection site, and had living branches below it. Applications were made in March, when transport in the plant is primarily toward the growing shoots. Applications in the fall may have been more effective. Stress produced by severing normal translocation pathways could also have reduced the amount of material translocated to the base of the tree.

Most rapid control was with picloram + 2,4-D and triclopyr amine (Table 2), with 43 and 27 percent mortality, respectively, within 4 months. Picloram + 2,4-D produced significantly higher mortality than triclopyr amine, and these two herbicides were significantly more effective at this date than the other herbicides. Only hexazinone did not kill any trees by this time, however mortality induced by glyphosate and triclopyr ester was only 3 and 7 percent, respectively.

After 7 months, melaleuca mortality with picloram + 2,4-D injection reached the highest level (97 percent) recorded in the test (Table 2), thus the fastest acting herbicide also resulted in the highest mortality rates. Mortality of melaleuca treated with glyphosate was the lowest (57 percent) of the herbicides.

After 15 months, percent mortality increased for all herbicides except picloram + 2,4-D, which remained at 97 percent. Slower acting hexazinone injections also resulted in 97 percent mortality by this time. Mortality with glyphosate was significantly lower than for picloram + 2,4-D and hexazinone (83 percent versus 97 and 97 percent, respectively), but not significantly lower than for triclopyr amine (90 percent). Mortality for triclopyr ester (70 percent) was significantly lower than for all other herbicides. It is possible that percent mortality for all herbicides tested may have increased after the study was concluded, especially considering the continuing high level of defoliation.

There was a significant difference in percent mortality produced by the two formulations of triclopyr. The greater efficacy of the amine salt compared to esters in general, and for triclopyr specifically, has been noted in other injection studies (Mann and Haynes 1978), and is probably due to the more rapid translocation of amine salts.

Mature Tree Study: Although the blocks of plots were separated by distances of up to several kilometers, means for each treatment block were more uniform than expected. Variation among blocks was statistically significant in average basal diameter for low rate plots, and in average basal diameter and average number of trees for high rate plots. However, there was no significant difference in pretreatment characteristics among treatments.

Average percent mortality of melaleuca following herbicide application is presented in Table 3. Three months after application the only dead tree observed was in a plot that received the high rate liquid application of tebuthiuron. However, both tebuthiuron and hexazinone killed trees after six months. At that time there was a higher average percent mortality of melaleuca among plots treated with the high rates of liquid tebuthiuron and hexazinone than in plots receiving the other formulations, and these treatments continued to have higher melaleuca control at both low and high rates than other tested formulations until one year after application for the high rate, and two years after application for the low rate. By the last sampling date, pelletized formu-

TABLE 2. AVERAGE PERCENT MELALEUCA DEFOLIATION AND MORTALITY FOLLOWING HERBICIDE INJECTION.

	Months Post Treatment					
	4		7		15	
Active Ingredient	Def[1]	Mort[2]	Def	Mort	Def	Mort
Picloram + 2,4-D	97 A[3]	43 A	100 A	97 A	100 A	97 A
Hexazinone	96 A	0 C	100 A	70 BC	100 A	97 A
Triclopyr amine	99 A	27 B	98 AB	87 AB	96 A	90 AB
Glyphosate	97 A	3 C	96 B	57 C	99 A	83 B
Triclopyr ester	93 A	7 C	95 B	63 BC	100 A	70 C
Control (water)	7	0	2	0	0	0

[1]Def = Average percent defoliation
[2]Mort = Average percent mortality
[3]Values in each column with letters in common are not significantly different at the $P < 0.05$ level using Student-Newman-Keuls Test. N = 30 for all treatments.

TABLE 3. AVERAGE PERCENT MELALEUCA MORTALITY FOLLOWING HERBICIDE APPLICATION.

Active Ingredient	Formulation	Months Post Treatment 6	12	24
		percent mortality*		
Control		0	0	0
Low rate applications (4.5 kg ai/ha)				
Hexazinone	Pellet	3 B	65 AB	97 A
Tebuthiuron	Pellet	3 B	67 AB	95 A
Hexazinone	Liquid	20 A	82 A	87 AB
Tebuthiuron	Wettable powder	10 AB	43 B	53 B
Bromacil	Wettable powder	0 B	0 C	0 C
Dicamba + 2,4-D	Liquid	0 B	0 C	0 C
High rate applications (11.2 kg ai/ha)				
Hexazinone	Pellet	2 B	75 B	100 A
Tebuthiuron	Pellet	2 B	83 AB	100 A
Hexazinone	Liquid	36 A	97 A	100 A
Tebuthiuron	Wettable powder	30 A	82 AB	100 A
Bromacil	Wettable powder	0 B	3 C	5 B
Dicamba + 2,4-D	Liquid	0 B	0 C	0 B

*Values in each column with letters in common are not significantly different at the $P < 0.05$ level using Duncan's Multiple Range Test. N = 6 for all treatments.

lations were at least as effective as liquid formulations, and were more effective than liquid formulations at the lower treatment rate. There were no visible herbicidal effects in control plots.

Although liquid formulations of hexazinone, tebuthiuron, and bromacil were effective in controlling melaleuca seedlings, bromacil and dicamba + 2,4-D were ineffective on mature melaleuca. The highest average mortality produced by bromacil was 5 percent after 2 years, while none of the trees treated with dicamba + 2,4-D were controlled.

Only the high rate of the liquid hexazinone formulation produced more than 90 percent control after one year. Although defoliation was rapid, mortality was slow for the pelletized formulations during the first year after application. The slow response of melaleuca to all tested herbicide formulations may have been typical for south Florida, where repeated cycles of defoliation and refoliation for over a year following herbicide treatment have been observed in demonstration plots. The slow action of the pelletized formulations may have been related to the unusually dry summer of 1979.

Melaleuca can be successfully controlled with herbicides at several different growth stages, and under a range of soil moisture conditions. Additional study is needed to determine if herbicide rates for seedling applications can be reduced and retain their effectiveness, how to increase the effectiveness of injected herbicides, and if season of application affects degree of control.

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LITERATURE CITED

Craighead, F. C., Sr. 1971. The Trees of South Florida. University of Miami Press, Coral Gables. 212 pp.

Cofrancesco, A. F. and H. L. Jones. 1995. Evaluation of mechanical and chemical methods for control of *Melaleuca quinquenervia* in southern Florida. Techn. Rept. WRP-SM-15, US Army Corps Engr., Waterways Exper. Station, Wetlands Res. Prog. Vicksburg, MS. 34 pp.

Deuver, M. J., J. E. Carlson, J. F. Meeder, L. C. Deuver, L. H. Gunderson, L. A. Riopelle, T. R. Alexander, R. F. Myers, and D. P. Spangler. 1979. Resource inventory and analysis of the Big Cypress National Preserve. Center for Wetlands, Univ. Fla., Gainesville, Fla., and Ecological Research Unit, National Audubon Society. 1225 pp.

Laroche, F. B. 1993. Evaluation of the fiscan plug for melaleuca control. Aquatics 15(2): 16-18.

Maffei, M. D. 1994. Invasive non-indigenous species on national wildlife refuges in Florida, pp. 179-185. In, Schmitz et al, eds., An assessment of invasive non-indigenous species in Florida's public lands. Florida Department of Environmental Protection, Tallahassee, Florida. 303 pp.

Mann, W. F., Jr. and M. J. Haynes. 1978. Status of some new herbicides. USDA Forest Service Publ., General Technical Report SO-21. 18 pp.

Meskimen, G. A. 1972. A silvical study of the melaleuca tree in south Florida. M.S. Thesis, University of Florida, Gainesville. 176 pp.

Mmazzottii, F. J., W. Ostrenko, and A. T. Smith. 1981. Effects of the exotic plants *Melaleuca quinquenervia* and *Casuarina equisetifolia* on small mammal populations in the eastern Florida Everglades. Florida Scientist 44(2): 65-71.

Myers, R. L. 1984. Ecological compression of *Taxodium distichum* var. *Nutans* by *Melaleuca quinquenervia* in southern Florida. In, Cypress Swamps, ed. by K. C. Ewel and H. T. Odum, p. 358-364, University Presses of Florida, Gainesville, Florida. 472 pp.

Ostrenko, W., B. Rothstein, and F. Mazzotti. 1979. The utilization of *Melaleuca quinquenervia* hammocks by native south Florida USA small mammals and description of their population dynamics. Florida Scientist 42(Suppl 1): 34.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods, Sixth Edition. Iowa State University Press, Ames, Iowa. 593 pp.

Sowder, A. and S. Woodall. 1985. Small mammals of melaleuca stands and adjacent environments in southern Florida. Florida Scientist 48(1): 44-46.

Standish, M. and A. Burns. 1994. Imazapyr for controlling shoreline, marginal and ditchbank vegetation. 34th Annual Meeting Aquatic Plant Management Society, Inc. and 6th Annual Meeting Texas Aquatic Plant Management Society, San Antonio, TX, July 10-13, 1994, pp. 6 (abstract).

Steele, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw Hill, New York. 481 pp.

Weed Science Society of America. 1994. Herbicide Handbook, Seventh Edition. WSSA Publication. 352 pp.

Woodall, S. L. 1982. Herbicide tests for control of Brazilian-pepper and melaleuca in Florida. U.S. Dept. Agric., Forest Ser. Res. Note SE-314, Southeastern Forest Exper. Sta., Asheville, NC. 8 pp.