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WEED CONTROL IN LIME, AVOCADO AND MANGO GROVES

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INTRODUCTION

In Dade County, the standard method of weed control has been mowing, supplemented by hand labor to remove vines and woody plants growing near the trunks of trees. Because of the shallow rockland soil, no cultivation has been used. Recently some growers have supplemented mowing by using herbicides in bands along tree rows. Complete herbicide control over the entire area has not been used.

METHODS

Most of the investigation was conducted in 3 avocado groves, 2 lime groves and a mango grove designated Groves A to F.[1] the experiments in Groves A, B and C were formally designed.

In Grove A, a 3 year old lime grove, a test was started in February 1967 with 21 treatments replicated 4 times with 3 or 4 tree plots. There were 5 diuron, 4 terbacil, one bromacil, one ametryne, one paraquat-simazine, and 4 paraquat treatments. The others included no herbicide and some which were changed during the test (Table 1). Originally dichlobenil and dalapon were included. Dichlobenil is ineffective without incorporation which is impractical in rockdale soil so it was discontinued. Dalapon probably requires more frequent treatments than were used in this test so it was also discontinued. The major treatments were applied twice a year with some intermediate treatments with paraquat or low rates of other materials.

During the 4 years, the plots were surveyed 13 times to estimate percent bare ground and percent cover by each species of weed.

In Grove B, 16 month old grove of Simmonds avocados, a test was started in October 1967 with 9 of the same treatments as used in Grove A. There were 78 single tree plots with each treatment replicated 8 or 9 times.

In Grove C, a one year old grove of Tommy Atkins and Keitt mangos, a test was started in March 1967 with 12 of the same treatments replicated 8 times with single tree plots.

Treatments were applied with a tractor-mounted sprayer with a 6 foot boom set 10 to 16 inches from the ground. Six 8004-E nozzles were spaced 11 inches apart and a OC-06 nozzle was attached at the end of the boom. About 75 gallons of spray per acre were used. The groves were mowed occasionally, but in the lime grove an unmowed strip was generally left in the tree rows. There was very little hand weed control.

The exploratory experiments were primarily for studying control of vines, but starting in 1970, some tests of complete coverage were started. In Grove D, a 23 year old avocado grove, the plots were 75 x 75 feet. In Grove E, another old avocado grove, the plots were 54 feet by 108 feet. Grove F was a 6 year old lime grove with serious vine problems and a search was made for treatments which could be applied over the trees.

Since the weed population varied greatly from grove to grove, the emphasis was on methods of controlling particular weeds. In Grove A, the most important weeds were large grasses, bermudagrass, *Bidens* and *Sida,* but the populations of *Lantana* and Brazilian pepper increased during the test. A few other weeds such as *Panicum adspersum* which is a persistent creeping grass, *Poinsettia,* Virginia creeper, muscadine grape, balloon vine, *Passiflora pallida* and *Solanum seaforthianum* were common but not serious pests.

Most of the above weeds were found in some of the other groves but the list of principal weeds varied considerably. For example rat-tail and *Blechum pyramidatum* covered large portions of the ground in Groves D and E. Black Medic was found in areas exposed to sunlight and was sometimes the dominant weed in Grove C during the winter. Grove F had several vines not found in any of the other groves. Coral vine was found only in Grove E. In Grove A about 15 grasses and 40 broad leafed weeds were identified.

Table 2 presents a list of the weeds identified in these groves plus several other species that are fairly common in Dade County groves. One important factor is the large number of exotics that are becoming naturalized.

Table 1. Percent ground cover* in February 1971 after four years of treatment**.

Treatment	Limes (Grove A)						Avocados (Grove B)				Mangos (Grove C)				
	Bare	Berm.	Large grass	Pan. Adsp.	Bid.	Sida	Bare	Berm.	Other grass	Bid.	Bare	Berm.	Other grass	Bid.	Black Medic
Paraquat															
14	81	0	4	0	0	5	--	--	--	--	26	4	0	1	59
15	65	1	1	0	3	24	66	2	14	1	16	3	3	8	58
Par.-Sim.															
13	78	1	16	3	0	1	99	0	1	0	95	4	1	0	0
Diuron															
1	70	1	10	0	1	1	78	0	17	0	87	3	3	0	1
3	71	5	7	0	1	2	55	9	28	0	73	9	11	0	3
5	59	3	17	0	4	2	--	--	--	--	43	26	11	1	9
Terbacil															
8	79	0	2	3	12	1	98	0	1	0	78	0	1	17	0
9	68	1	4	4	20	1	88	1	7	3	51	0	1	41	0
10	57	1	5	1	31	0	77	1	14	7	29	0	4	61	0
Terb.-Par.															
12	89	1	1	0	3	0	--	--	--	--	88	1	1	5	0
Bromacil															
20	83	1	7	0	2	0	--	--	--	--	46	28	7	0	8
Ametryne															
21	70	10	2	0	5	7	77	9	11	0	--	--	--	--	--
Diur.-Terb.															
6	86	3	6	0	0	0	98	1	0	0	96	2	2	0	0
Amer.-Terb.															
7	89	2	5	0	1	0	--	--	--	--	--	--	--	--	--
None															
16	8	6	14	0	21	37	--	--	--	--	2	1	10	70	14

** Treatments:
1. Diuron 6.4 lb/acre 2 times a year
3. " 3.2 " 2.5 times a year
5. " 1.6 " 3.5 " " "
6. " 3.2 " , terbacil 4 lb/acre, 2 times a year (starting May 1970. Previously paraquat for two years)
7. Ametryne 4 lb/acre, terbacil 4 lb/acre 2 times a year (starting May 1970. Previously paraquat for two years)
8. Terbacil 8 lb/acre 2 times a year
9. " 4 " 2 " " "
10. " 2 " 2.5 to 3.5 times a year
12. " 4 " , paraquat 0.5 lb/acre 2 times a year
13. Simazine 8 " , " 0.5 " 2 " " "
14. Paraquat 1.0 lb/acre 4 times a year
15. " 0.5 " 4 " " "
16. No herbicide
20. Bromacil 4 lb/acre, 2 times a year (on mangos not started until May 1970)
21. Ametryne 4 lb/acre, 2 " " "

* Ground cover--List of weeds:
Large grass - mostly johnsongrass, guineagrass and crabgrass
Pan. Ads. - Panicum adspersum. This was only present in part of the grove
Bid. - Bidens pilosa
Sida - Included Malvastrum coromandelianum, Sida carpinifolia, Malvastrum corchorifolium and some Sida rhombifolia
Other grass (in avocados) - Largely johnsongrass, but also crabgrass, hairygrass, vaseygrass, smutgrass, foxtail grass, natalgrass and Paspalum fimbriatum

Table 2. Common weeds in South Dade groves.

A. Large Grasses

Panicum maximum	Guineagrass
Panicum purpurascens	Paragrass
Paspalum fimbriatum	Fimbrate Paspalum
Paspalum urvillii	Vaseygrass
Rottboellia exaltata	Hairygrass
Sorghum halepense	Johnsongrass
Trichachne insularis	Sourgrass

B. Small Grasses

Brachiaria subquadripara	South Fla. signalgrass
Cenchrus echinatus	Southern Burr-Grass
Cynodon dactylon	Bermudagrass
Digitaria sanguinalis	Largecrabgrass
Eleusine indica	Goosegrass
Panicum adspersum	Broadleaf Panicum
Paspalum conjugatum	Sour Paspalum
Paspalum notatum	Bahiagrass
Paspalum vaginatum	Sheathed Paspalum
Rhyncheletrum repens	Natalgrass
Setaria glauca	Yellow foxtailgrass
Sporobolus poiretii	Smutgrass
Stenotaphrum secundatum	St. Augustinegrass
Cyperus spp.	Nut sedge

C. Vines

Ampelopsis aborea	Pepper vine
Antignon leptopus	Coral vine
Asystasia gangetica	Coromandel
Colonyction aculeatum	Moonflower
Cardiospermum halicacabum	Ballon vine
Cassytha filiformis	Love vine
Cissus sicyoides	Possum Grape
Dioscorea bulbifera	Yam vine
Heliotropium hirsutissima	Hairy Tornefortia
Impomoea hederifolia	Scarlet Morning Glory
Jacquemontia pentantha	Sky Blue Morning Glory
Jasminum dichotomum	Gold Coast Jasmine
Jasminum fluminense	Azores Jasmine
Melothria pendula	Creeping cucumber
Merremia dissecta	White Wood-Rose
Merremia tuberosa	Wood-Rose
Momordica charantia	Wild Balsam Apple
Parthenocissus quinquefolia	Virginia Creeper
Passiflora pallida	Juniper-Berry, small Passion-Flower
Plumbago scandens	Wild Plumbaga
Podranea ricasoliana	
Porana paniculata	Christmas Vine
Rhus radicans	Poison ivy
Smilax auriculata	Earleaf briar
Smilax laurifolia	Laurel Greenbriar
Smilax havanensis	Prickly Greenbriar
Solanum seaforthianum	Brazilian Nightshade
Vitis rotundifolia	Muscadine Grape

D. Other Broad Leaved Weeds

Acalypha ostryaefolia	Hophorn bean Copperleaf
Amaranthus hybridus	Common Pigweed
Amaranthus spinosus	Spiny Amaranth
Ambrosia artemesiifolia	Common Ragweed
Argemone mexicana	Mexican Prickly Poppy
Asclepias cinerea	
Baccharis halimifolia	Eastern Baccharis
Bidens pilosa	Hairy Beggartick, Shepherd's needles
Blechum pyramidatum	Blechum
Borreria ocimoides	Slender Borreria
Centella erecta	Coinwort
(Euphorbia) Chamaesyce hirta	Garden Spurge
(Euphorbia) Chamaesyce hypericifolia	(Similar to Hyssop Spurge)
(Euphorbia) Chamaesyce hyssopifolia	Hyssop Spurge
(Euphorbia) Chamaesyce opthalmica	(more upright & greener than C. Hirta
(Euphorbia) Chamaesyce prostrata	Prostrate Euphorbia
Centrostachys (Achyranthes) indica	Rat-tail
Chenopodium album	Lambs Quarters
Chiococca alba	Snowberry
Commelina longicaulis	Dayflower (Wandering jew)
Conyza (Erigeron) canadense	Horseweed
Crepis japonica	Hawksbeard
Desmodium canum	Tick Trefoil
Emilia coccinea	Tassel-Flower
Erigeron quercifolius	Southern Fleabane
Eupatorium capillifolium	Dog-Fennel
Eupatorium leptophyllum	False-Fennel
Flaveria trinerva	Cluster Flaveria
Fumaria officianalis	Fumitory
Geranium carolinianum	Carolina Geranium
Hydrocotyle umbellata	Pennywort
Indigofera endecaphylla	Trailing Indigo
Lantana camara	Lantana
Lantana (Hybrid) Sp.	Lantana
Leonurus sibiricus	Motherwort
Lepidium virginicum	Virginia Pepperweed
Lippia nodiflora	Mat Lippia
Malvastrum chorchorifolium	False Mallow
Malvastrum coromandelianum	(Spine Seeded) False Mallow
Medicago lupulina	Black Medic
Melia azedarach	China berry
Morinda roioc	Yellow Root
Oxalis corniculata	Wood Sorrel
Oxalis intermedia	Cuban Purple Wood Sorrel
Phaseolus (Macroptilium) lathyroides	Wild Pea Bean
Phyllanthus amarus	Phyllanthus
Phyllanthus tenellus	Phyllanthus
Poinsettia heterophylla	Wild Poinsettia
Portulaca oleraceae	Purslane
Priva lappulaceae	Velvet Bur
Ptilminium capillaceum	Mock Bishop's weed
Rhynchosia minima	Small Rhynchosia
Richardia scabra	Florida Purslane
Schinus terebinthefolius	Brazillian Pepper
Seneciodes cinera	Seneciodes
Sida carpinifolia	Weed Mallow (tea weed)
Sida rhombifolia	Arrowleaf sida
Solanum nigrum	Black Nightshade
Solidago sp.	Goldenrod Sp.
Sonchus asper	Spiny Sow-Thistle
Sonchus oleraceus	Annual Sow-Thistle
Spermacoce tenuor	Glabrous Spermacase
Spermacoce tetraquetra	Hairy Spermacoce
Tridax procumbens	Tridax

RESULTS

Table 1 shows a summary of a typical survey. This survey was made in February 1971 and with limes, it was the 12th of 13 surveys. A study of this table together with all of the other available data indicates that several herbicides appear useful, but none of the treatments gave completely satisfactory control under all conditions. Table 1 includes 2 combination treatments which were started a year ago in an attempt to control a

broader spectrum of weeds than are controlled by single herbicides. These combinations of terbacil with diuron or with ametryne appear promising but need further evaluation. In discussing the results, the data from the various tests are combined to give information about the control of specific weeds or groups of weeds.

Large Grasses.—All of the large grasses except guineagrass and paragrass seemed to respond similarly to the herbicides. As indicated in Table 1, they are quite well controlled by all the treatments except diuron and paraquat-simazine mixtures, but even these treatments gave considerable control. The better control by paraquat alone than by a paraquat-simazine mixture reflects the effect of frequency of application. Tall grasses in the tree rows could only be controlled by contact herbicides and they were only partially covered at each application, Terbacil and bromacil have both contact and pre-emergence action on grasses.

Guineagrass.—Terbacil gave very poor control of this grass. Paraquat was much more effective. Bromacil was not tested on guineagrass.

Paragrass.—One of the peculiarities of paragrass is that it is scarcely affected by paraquat; it is readily controlled by terbacil, however.

Panicum adspersum.—This is a vigorous creeping grass which may become a serious problem. It was only partially controlled by terbacil. The grass was not widely distributed in the plots, so further evaluation will be required.

Bermudagrass.—No herbicide controlled this grass with a single application, but most gave some control after several applications. At the first survey on July 11, 1967 after the first herbicide application on February 28, 1967, the percent of ground cover by bermudagrass for the 16 treatments survey ranged from 21 to 38%. As a typical example of the slow control, the results for the 2 Ib rate of terbacil are listed below:

Survey 1 2 3 4 5 6 7 8 9 10 11 12 13

Percent cover by bermudagrass

31 7 12 4 0 4 1 0 1 2 0 1 0

It is seen that control was not complete until after the fourth survey on June 5, 1968. As shown in Table 1, terbacil and bromacil gave nearly complete control whereas most other treatments except ametryne and low rates of diuron gave fair control.

Bidens.—In the check plots in the lime grove, *Bidens* were generally 25-50% of the ground cover. Twice a year treatments with 0.5 Ib paraquat plus 8 Ibs simazine gave almost complete control throughout the four years. Diuron at 3 to 6 Ibs gave very good control most of the time. Paraquat alone at either rate, ametryne or low rates of diuron frequently left 4 to 10% of ground cover. With 0.5 paraquat, the control improved some in the fourth year and with 1.0 Ib, it was almost complete then. *Bidens* population increased in terbacil plots during the second and third years and with the low rates there was actually more *Bidens* than in the check plots. Bromacil gives considerably better control of *Bidens* than terbacil, but it is not complete.

Sida.—The term *Sida* was applied to *Sida carpinifolia, Sida rhombifolia, Malvastrum corchorifolium* and *Malvastrum coromandelianum,* all of which were found in Grove A. These four species have similar growth habits and appear to respond similarly to

herbicides. Although woody in nature, these plants are annuals, or at least short lived plants, so they are susceptible to pre-emergence herbicides. All treatments except paraquat gave fair control. With 0.5 Ib paraquat, the *Sida* coverage ranged from 20 to 40%, about the same as in the check plots. With 1.0 Ib paraquat more than half of the *Sida* was eliminated. Since the weeds aie tall, some of the foliage is usually missed by the spray and paraquat has no pre-emergence action.

Lantana and Brazilian Pepper.—These woody perennials were not controlled by any of the herbicide treatments. *Lantana* foliage is scarcely affected by paraquat. These plants can be killed by girdling and painting the exposed stems with 2,4,D or 2,4,5T. *Lantana,* a very shallow rooted plant, can be pulled out by hand much easier than most people realize.

Amaranthus.—These plants are widely distributed, but only in Groves D and E were they more than 5% of the ground cover. In May 1971, the two large terbacil plots in Grove E had 42 and 70% of the ground covered by *A. spinosus* and *A. hybridus.* Both in that grove and in Grove D, there was considerable *Amaranthus* also in the ametryne and paraquat plots. There was fair control by' diuron and by paraquat-simazine.

Commelina longicaulis.—This creeping plant was interesting in that it built up to 30% of the area in the diuron plots of Grove A even though it was scarcely found elsewhere in the grove. The foliage was burned each time diuron was applied, but recovery occurred quickly, particularly with low rates.

Oxalis.—The common yellow *Oxalis corniculata* seemed to be fairly well controlled by most treatjments, but in one diuron plot population of the large purple *Oxalis intermedia* increased at times, very much as did *Commelina longicaulis.*

Black Medic.—This weed was controlled by the pre-emergent herbicides used except low rates of diuron. It also was controlled by paraquat. Its high incidence in the February survey of Grove C (Table 1) represents plants which grew after the paraquat treatment of November 19, 1970.

Rat-tail and *Blechum pyramidatum.*—These weeds covered considerable ground in Groves D and E. Rat-tail was controlled fairly well by all treatments, but *Blechiym* was resistant to ametryne and diuron.

Poinsettia heterophylla.—This weed is widely distributed but fortunately it always grows as scattered plants rather than in solid stands. It was somewhat resistant to most treatments.

Vines (in general).—Vines become problems in all groves after a few years and most of them are not controlled by the standard twice a year treatments tested in Groves A, B and C.

Balsam apple and Virginia creeper.— These are found in practically all groves and gradually become serious problems if not controlled. Balsam apple may be partially controlled by some of the treatments which have been described. Virginia creeper is very resistant.

Coral vine.—This is a vine which has escaped from ornamental plantings around homes and fortunately is not widely distributed. Potentially it is our worst vine because its rapid

growth can completely cover a medium sized tree within a few months. If the vines are cut to the ground, they may send shoots three feet high within three or Ifour weeks.

Terbacil and ametryne showed some control in preliminary tests but much additional work needs to be done to develop an effective control for coral vine. Two applications of terbacil over an avocado tree covered with coral vine resulted in about 75% loss of vigor without injury to the avocado. In another experiment, 4 applications of terbacil, at 4 Ibs per acre, were applied to coral vine foliage covering the ground, but not to that in the trees.

Most of the coral vine was eliminated, but the kill was not complete. These applications caused slight toxicity to a few avocado trees. Ametryne at 4 Ibs per acre caused less damage to the coral vine than did the terbacil, but because of the greater tolerance of avocado trees for these material, higher rates might be useful. Diuron, simazine, paraquat, 2,4D and 2,4,5TP were of little value.

Moon vine.—This fast growing vine was the only one in the list of about 20 vines that was appreciably affected by 1000 ppm of 2,4,D or 2,4,5TP. Lime trees were not damaged when sprayed with sufficient 2,4,D to kill moon vine.

Other vines.—Most vines are quite difficult to control and it may be necessary to remove the climbing portion in order to make the roots and ground covering portion susceptible to herbicidal treatment. At least one vine, *Cissus sicyoides,* will rejuvenate itself from aerial portions disconnected from the ground. Preliminary tests of terbacil, bromacil, ametryne and diuron gave partial control of some vines. It is likely that particular vines will have to be treated as special problems.

Toxicity of herbicides.—The only toxicities noticed during the four years of the tests were caused by terbacil and bromacil. At one time, a very slight toxicity of these materials was noticed on limes but it soon disappeared and was not seen again. Severe chlorosis was caused on avocado trees by 4 Ib per acre of bromacil in the summer of 1968. Less chlorosis was caused by 8 Ib terbacil and still less, but noticeable was caused by 4 Ib of terbacil. The bromacil treatment was discontinued and later changed to ametryne. The terbacil treatments were continued and all chlorotic trees became normal in a few months. Mild symptoms occasionally have been seen on the 8 Ib terbacil treatment since then, but usually all trees are free of symptoms. No toxicity has been observed on mango trees from terbacil up to 8 Ib per acre. Bromacil has not caused toxicity either, but it was not used until May 1970.

Uses approved by Pesticide Regulation Division, U. S. Dept. of Agric, are as follows:

For mangos, the only approved material is dichlobenil.

For avocados the only approved materials are dichlobenil and paraquat, although simazine and silvex (2,4,5TP) are approved for use in California.

For limes, dalapon, dichlobenil and paraquat are approved.

For citrus other than limes, ametryne, bromacil, diuron, simazine and terbacil may also be used.

This paper describes experimental tests of usages which are not approved. Such usage of these herbicides on these fruits is not recommended or endorsed for general use.

[1]Groves A and B were owned by W. H. Krome and located near 288 St. and 172 Ave., Homestead.
Grove C was in Block 3 of the Center for Research and Education at Homestead.
Grove D was at 288 St. and 197 Ave. and owned by E. W. Harkness.
Grove E was at 280 St. and 197 Ave. and owned by Harold K Kendall.
Grove P was near 332 St. and 217 Ave. and owned by Calavo, Incorporated.

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