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INTRODUCTION

Lush, dense jungle precludes the cultivation of hundreds of millions of acres of land in the hot, humid tropics; land for which there will soon be a pressing need in the face of the relentless, rapid rise in the population of the world, especially of the tropical world.

In Hawaii, fully 25 percent of the land area consists of little-used submarginal jungle wetlands at elevations of less than 4,000 feet (*8*). By contrast, only 7 percent of the 4.1 million acres of this state is presently cultivated (*1*). Obviously, an enormous area is not being utilized to its maximum potential.

These essentially unused Hawaiian jungle wetlands, if properly utilized, can contribute to broadening the base of the economy of this state, for these areas have the potential for producing forage and forest products and for providing recreational areas for tourists and residents (*1*). These potentials can be realized by judicious and efficient management of the land.

Before these jungle wetlands can be put to more intensive use, this huge area of 1.3 million acres must first be cleared. Aerial spraying of herbicides potentially may be an economical and effective means to do this (*5*). In fact, because of the topography and the dense stand of brush in most areas, other means of brush clearance have been economically unfeasible.

The investigations here reported were conducted to determine the feasibility of herbicidal brush clearance using aerial applications and to compare the effectiveness of some commercially available herbicides. The results of two aerial treatments of herbicide on jungle brush are presented.

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TEST 1. AERIAL HERBICIDE CONTROL OF JUNGLE AT THE KAUAI BRANCH STATION

Methods

The test site is located at an elevation of about 500 feet in a rainfall zone of 90 inches per year. The soil has been classed as a Halii gravelly silty clay, Aluminous Ferruginous Latosol (*6*).

The jungle vegetation consisted mainly of guava (*Psidium guajava*), ohia (*Metrosideros collina* var. *polymorpha*), java plum (*Eugenia cuminii* (L.) Druce), false staghorn fern (*Dicranopteris linearis*), and pandanus (*Pandanus tectorius*). These plants are described by Neal (*4*).

On October 13, 1962, aerial applications of dicamba at 6 and 12 pounds active material per acre and monuron (CMU) at 10, 15, 20, 30, and 40 pounds active material per acre in 10 to 40 gallons of water were sprayed on strips 33 feet wide by 1,320 feet long on hilly jungle at the Kauai Branch Station, Hawaii Agricultural Experiment Station.

Results and Discussions

The results 6 months after treatment are presented in table 1.

Monuron Plots

Monuron, a slow acting herbicide, requires moisture to carry it into the soil to the roots of plants to gain maximum effect (*7*). Because of a seasonal drought after application the effects of monuron were delayed. With the onset of the rainy season the plants began to defoliate.

At the lowest rate of 10 pounds per acre, monuron was ineffective on all species except staghorn fern. As the rate of monuron increased, all species showed more intense injury although most of them recovered before 6 months.

Dicamba Plots

In contrast to monuron, the dicamba plots displayed almost immediate results. Furthermore, much of the damage was still evident 6 months after treatment.

Discussion of Results

Except for the lowest rate of monuron of 10 pounds per acre, all of the treatments were effective to some degree. Generally, the effects of monuron were temporary whereas the dicamba plots still showed considerable defoliation at 6 months after treatment, especially at the higher rate (figure 1).

Monuron and dicamba appear to be effective in controlling the brush species in this test, although some of the vegetation showed substantial recovery. Eventual recovery of woody plants is expected on single applications. It is generally recognized that repeated applications spaced several weeks or months apart are required for the permanent control of most woody plants with most of the current herbicides (*3*). Indeed the data show that there are not very great differences in degree of control between rates of

TABLE 1. Aerial herbicide control of jungle, Kauai Branch Station (Response evaluation 6 months after treatment.)

HERBICIDE	ACTIVE MATERIAL POUNDS PER ACRE	RESPONSE	PERCENT RESPONSE BY SPECIES					
			Guava	Ohia	Java Plum	Pandanus	False Staghorn Fern	Others
		Defoliated	40	50	80	—	60	Boston and Sadleria ferns, Lantana, Melastoma
Dicamba	12	Defoliated and Regrowth	30	40	20	100	—	
		none	30	10	—	—	40	
		Defoliated	50	30	33	—	—	
Dicamba	6	Defoliated and Regrowth	30	40	67	100	80	
		none	20	30	—	—	20	
		Defoliated	—	—	—	25	90	Hau, Boston fern, Lantana, Melastoma
Monuron	40	Defoliated and Regrowth	100	100	—	75	—	
		none	—	—	100	—	10	
		Defoliated	60	—	—	—	—	Melastoma, Lantana
Monuron	30	Defoliated and Regrowth	40	100	100	100	100	
		none	—	—	—	—	—	
		Defoliated	—	—	—	—	30	
Monuron	20	Defoliated and Regrowth	100	50	100	100	70	
		none	—	50	—	—	—	
		Defoliated	—	—	—	—	60	
Monuron	15	Defoliated and Regrowth	25	50	100	—	40	
		none	75	50	—	—	—	
		Defoliated	—	—	—	—	30	
Monuron	10	Defoliated and Regrowth	—	—	—	—	70	
		none	100	100	100	100	—	

FIGURE 1. Effect of monuron 40 pounds per acre on false staghorn fern at 6 months after treatment.

herbicides, with the exception of the lowest rate of monuron which displayed practically no control at all. This would suggest that much of the material in the higher treatment rates was more or less ineffective. As a corollary, two 20-pound applications of monuron, for instance, might be substantially more effective than a single dose of 40 pounds.

TEST 2. AERIAL HERBICIDE CONTROL OF JUNGLE AT HANAHANAPUNI

Methods

As an extension of the Kauai Branch Station trial reported above, other herbicides were tested at Wailua, Kauai, at a site near the Hanahanapuni Crater.

The test area lies at the foot of the Southeast face of Mount Waialeale at an elevation of about 800 feet. The annual rainfall here is about 150 inches. The soil is of the Koolau series of the hydrol humic latosol group (*6*).

The vegetation in this area of rolling to rough topography is a dense brush made up principally of melastoma (*Melastoma malabathricum*), false staghorn fern (*Dicranopteris linearis*), lantana (*Lantana camara*), ohia (*Metrosideros collina* var. *polymorpha*), guava (*Psidium guajava*); and to a minor extent, hau (*Hibiscus tiliaceus* L.), java plum (*Eugenia cuminii* (L.) Druce), and hapu (*Cibotium splendens* (*4*).

This test consisted of 17 plots, each of which was 80 feet wide by 1000 feet long. Because walking through the brush would be very difficult, trails were first cut down the full length of the center of each plot to facilitate rating of herbicide effects.

The herbicides were applied by airplane on August 8, 1964. Gallonage on each plot was not consistent because it was more expedient to increase the number of passes on those plots requiring a higher concentration of herbicide than to reload the plane with a more concentrated herbicide solution. Hence, for instance, plot 1 received 10 gallons of spray solution per acre in a single pass whereas plot 2 received 20 gallons per acre in double passes of the airplane over the same area.

Spraying of each plot required at least two passes to cover the 80-foot plot width since the width of the spray pattern of the aircraft was 40 feet. The weather on the day of application was very cloudy and drizzly with occasional showers, and as a result the vegetation was wet.

As is usual in trials of this nature, rating of herbicidal effectiveness is subjective, based on severity and extent of plant injury. The rating scale was arbitrarily determined as follows:

1. No control—No visible damage to plants.
2. Slight control—Some defoliation, damage transitory.
3. Moderate control—Leaf kill general, regrowth general.
4. Good control—Heavy defoliation, some regrowth.
5. Complete control—General defoliation, slight regrowth.

This system differs from that in the previous test. Rating was done at intervals of 1 week, 2 weeks, 1 month, 2 months, 3 months, 6 months, and 1 year after treatment.

The herbicides tested were paraquat, dicamba, silvex, picloram–2,4-D mixture, and 2,4-D–2,4,5-T mixture at rates shown in table 2. Picloram–2,4-D is a mixture of 1 part picloram to 3.6 parts 2,4-D. The 2,4-D–2,4,5-T mixture is a mixture of about 1 part 2,4-D and 1 part 2,4,5-T (7). The results are presented in tables 3 to 19 in the Appendix.

TABLE 2. Rates of herbicides used in the Hanahanapuni trials

PLOT	RATES OF ACTIVE HERBICIDE, POUNDS PER ACRE
1	½ paraquat
2	1 paraquat
3	2 paraquat
4	1 dicamba, ½ paraquat
5	2 dicamba, ½ paraquat
6	4 dicamba, 1 paraquat
7	8 dicamba, 2 paraquat
8	2 dicamba
9	4 dicamba
10	8 dicamba
11	4 silvex
12	8 silvex
13	12 silvex
14	0.42 picloram, 1.58 2,4-D mixture
15	0.84 picloram, 3.16 2,4-D mixture
16	1.26 picloram, 4.74 2,4-D mixture
17	4 2,4-D, 4 2,4,5-T mixture

Results and Discussions

Paraquat Plots

Melastoma and ohia were most severely affected by paraquat, and staghorn was moderately damaged. Guava and lantana were relatively resistant.

Although paraquat is translocated within the plant, most of its activity is restricted to the area of local absorption (7). Therefore, it was expected that the effect of paraquat would be temporary; this held true except in ohia which had not recovered one year after treatment with 1 pound paraquat per acre (figures 2 and 3).

In one section of plot 3, control of melastoma 1 year after treatment was rated 4 whereas in the rest of the plot it was rated only 1.5 at best (figure 4). This section of effective herbicidal activity was at the end of the plot in a swampy area. The reason for this better control can only be conjectured. Perhaps it is the result of better coverage of herbicide because of fewer trees in that section.

Paraquat and Dicamba Plots

Again melastoma and ohia were the species most seriously affected by the herbicides. The effect on melastoma lasted up to 6 months while that on ohia still persisted at one year for all but the lowest rate of application of the mixed herbicides. Lantana, guava, and staghorn were moderately affected. Hau was also moderately affected but had recovered at the end of 6 months (figure 5).

FIGURE 2. Plot 2. Paraquat 1 pound per acre. Effect 1 month after treatment.

FIGURE 3. Plot 2. Paraquat 1 pound per acre. Recovery 1 year after application of herbicide.

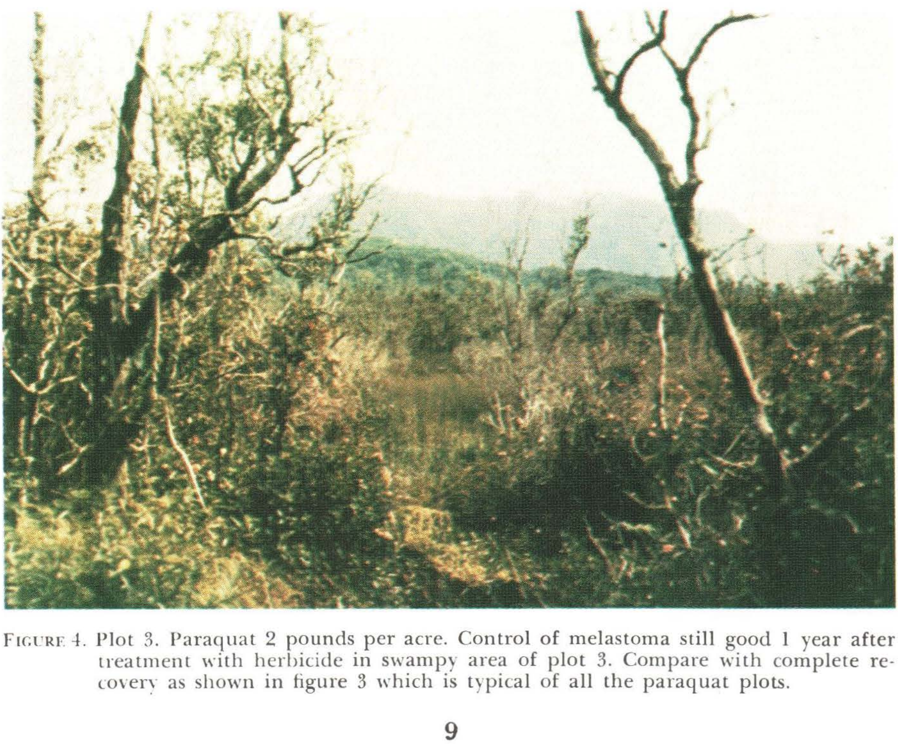

FIGURE 4. Plot 3. Paraquat 2 pounds per acre. Control of melastoma still good 1 year after treatment with herbicide in swampy area of plot 3. Compare with complete recovery as shown in figure 3 which is typical of all the paraquat plots.

FIGURE 5. Plot 7. Dicamba 8 pounds and paraquat 2 pounds per acre. Five months after treatment the melastoma (shrubs) and ohia (trees in foreground) still show severe injury. Hau in background has fully recovered from initial foliar burn.

Dicamba Plots

Control of ohia and guava was good although guava was slow to succumb. Melastoma and staghorn were affected moderately as was hapu. Lantana control was fairly good at the start but showed nearly full recovery at the end of 1 year.

Plots 7, 8, 9, and 10 terminated on a little hill which was solidly covered by staghorn fern and a few ohia trees. In this small area the herbicides were more effective than in the rest of the plots, hence the reading of 1–4 and 1–3 for staghorn at one year in tables 10 to 13 (figures 6, 7, 8). It is not known why staghorn in this small area should succumb to treatment while showing only a moderate response on the rest of the same plot. Perhaps it may have been due to better coverage of herbicide because of the open stand of trees and tall shrubs, or perhaps it may be the result of a smaller mass of ground vegetation in the area which then resulted in a greater amount of herbicide on a plant-weight basis although not on a per-acre basis.

Silvex Plots

On the silvex plots the melastoma, ohia, and staghorn were severely injured, and lantana and guava control was moderate to good. In addition, hau and java plum at the highest rate were severely affected although they eventually recovered. Guava and lantana recovered in a year, melastoma was only moderately controlled, and control of ohia and staghorn was moderate to good at 1 year (figures 9 and 10).

FIGURE 6. Plot 9. Dicamba 4 pounds per acre. Control of false staghorn fern on hillside is still good 1 year after application. Compare with figure 7.

FIGURE 7. Plot 9. Dicamba 4 pounds per acre. False staghorn fern has fully recovered on most of the treated plot with the exception of the part on the hillside shown in figure 6.

FIGURE 8. Plot 7. Dicamba 8 pounds and paraquat 2 pounds per acre. One year after application, false staghorn fern is still severely suppressed on the hillside at the end of the plot. This hill runs through the ends of plots 7, 8, 9, and 10 at a right angle to them. In other parts of these plots staghorn has practically fully recovered.

FIGURE 9. Plot 12. Silvex 8 pounds per acre. False staghorn fern control was good 1 year after treatment.

FIGURE 10. Plot 13. Silvex 12 pounds per acre. Melastoma still showing effects of the herbicide 1 year after treatment. Note the recovery of guava on the right.

Picloram–2,4-D Mixture Plots

Good initial control of ohia and guava was obtained for 4 and 6 pounds of picloram–2,4-D mixture. The effect on melastoma, lantana, staghorn, and java plum was slight to moderate at the low rate, and moderate to good at the high rate. Except for ohia, however, the effects were not persistent; the plants showed recovery at the end of 1 year.

2,4-D–2,4,5-T Mixture Plots

Control of melastoma, lantana, guava, and ohia was good up till 6 months, after which the plants recovered. Similarly staghorn was moderately controlled for the first 6 months.

Discussion of Results

Generally, ohia and melastoma were most susceptible to the herbicides used in this test whereas lantana and guava were the most resistant.

Although all of the herbicides used in this test did show some promise for brush clearing, it was obvious that one application was not enough. The effects were too temporary. As mentioned earlier, one foliar application will not give adequate control of resistant jungle vegetation. As in the test at the Kauai Branch Station, the Hanahanapuni test has shown that no great difference results from different rates of any of the herbicides tested, which again suggests that the cumulative effect of repeated small dosages may prove more effective than a single large application.

Of the herbicides evaluated, silvex appears to be the most effective. The 2,4-D–2,4,5-T mixture was almost as effective as silvex. Dicamba shows promise for control of lantana and guava. Picloram–2,4-D would probably be effective at higher rates than the 2-, 4-, and 6-pound rates used. Low rates were used in this test because of the reported resistance of picloram to decomposition in soils. However, since plant recovery had begun after 1 year on the picloram–2,4-D plots, higher rates or repeated applications appear safe. It has been reported that picloram readily leaches through the soil, which should make its use in humid, well-drained areas safe as far as the treated area is concerned (*2*).

Paraquat appears to be a very effective and fast-acting defoliant. However, its effects are temporary, except on ohia which is apparently susceptible to it. This compound could find use where quick defoliation is wanted but where permanent kill is not required.

The paraquat and dicamba mix is only slightly more effective than dicamba alone and thus it would appear to be more economical to use only dicamba.

EFFECTS OF RESIDUAL HERBICIDES

To determine if residual herbicides might damage tree seedlings and to evaluate the growth of seedlings in the test area, the Hawaii State Division of Forestry planted monkey pod (*Samanea saman*) seedlings in each of the test plots 6 months after herbicide application. At 1 year after application these trees still displayed no injury symptoms which indicates that herbicide residues in the soil created no toxicity problem.

Earlier, about 5 months after treatment, seeds of sweet sudangrass and the legume *Desmodium intortum* were broadcast in small subplots in some of the plots. None of the seeds survived. Although this may be due to herbicidal activity, it is felt that the seeds succumbed to damping-off diseases since there was no evidence of germination and the area was constantly wet because of the winter rains.

At 6 months after herbicides were applied, pangolagrass (*Digitaria decumbens*) cuttings together with lime were similarly broadcast in some of the plots. No fertilizers were added. In 6 months the grass had grown as high as 5 feet. However, the stand was thin since there were no lateral runners. This restricted upright growth of a grass otherwise characterized by a spreading habit and many lateral runners may be attributed mostly to competition for sunlight (figure 11).

Of note in this test is the fact that wild grasses in the plots were not affected by the herbicide applications. Hence establishment of grass stands by aerial seeding while the brush is still severely injured is clearly possible. Once forage has been established, cattle can then be grazed on the land to further control the brush by trampling. An experiment in the initial stages of establishment at the Kauai Branch Station will test this proposal, using silvex in two aerial applications about 6 months apart, followed by fertilization and planting also done by airplane.

FIGURE 11. Plot 15. Picloram–2,4-D mixture at 4 pounds per acre. Vigorous pangolagrass 6 months old, showing no injury from herbicide applied 1 year earlier.

SUMMARY AND CONCLUSION

Two trials were conducted to determine the feasibility of using aerial treatment of herbicides to clear brush from heavily infested jungle wetlands, and to evaluate some brush-clearing herbicides.

All of the herbicides tested were effective in varying degree. Silvex was rated most effective in killing or retarding growth of the jungle species encountered in this study. However, single application of any of the herbicides tested was shown to be inadequate in gaining complete control of persistent woody plants.

Grass planting appears to be readily feasible in the treated areas while the herbicides are still highly active on the jungle vegetation.

A trial is now in progress to test a method of land clearing by aerial application of herbicide followed by aerial seeding to establish grass stands and then by releasing cattle into the treated area to trample the brush and suppress reinfestation.

APPENDIX:

EFFECT OF HERBICIDES ON JUNGLE VEGETATION FOR VARIOUS INTERVALS AFTER AERIAL TREATMENT, TEST 2. HANAHANAPUNI, KAUAI[1]

TABLE 3. Plot 1. Paraquat 0.5 pound per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4	4	4	1	1.5
Lantana	1	1	1	1	1	1	1
Guava	1	4	1	1	1	1	1
Ohia	3	4	3.5	3.5	4	3.5	3.5
Staghorn	3	3	3	1	1	1	1

TABLE 4. Plot 2. Paraquat 1 pound per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4.5	4	4	1	1.5
Lantana	1.5	1	1.5	1	3	1	1
Guava	1.5	3	3	1	1.5	4	1
Ohia	3	4	4	4	3.5	3.5	2
Staghorn	3	3	3	1	1	2	1

TABLE 5. Plot 3. Paraquat 2 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4.5	4.5	4	3.5	1.5
Lantana	1.5	3	1.5	1	1.5	1	1
Guava	1.5	3	3	1	1	4	1
Ohia	3	4	4	4	4	4.5	4
Staghorn	3	3	3	1	1	1	1

TABLE 6. Plot 4. Dicamba 1 pound + paraquat 0.5 pound per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4	4	4	2	1
Lantana	1.5	3	3	3	3	1	1
Guava	1.5	3	3	4	2	3	1
Ohia	3	3.5	3.5	4	3.5	3.5	1.2
Staghorn	3	3	3	1.5	3	2	1

TABLE 7. Plot 5. Dicamba 2 pounds + paraquat 0.5 pound per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4	4.5	4	2	2
Lantana	1.5	3	3	3	3	1	1
Guava	1.5	3	3	3	3	4	2
Ohia	3	3.5	4	4	4	4.5	4
Staghorn	3	3	3	1.5	3	2	1

[1] Subjective rating scale: 1—No Control, 2—Slight Control, 3—Moderate Control, 4—Good Control, 5—Complete Control.

TABLE 8. Plot 6. Dicamba 4 pounds + paraquat 1 pound per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4	4.5	4.5	4	4	2
Lantana	3	3.5	4.5	3	3	4	1
Guava	1.5	3	3	3	2	4	1
Ohia	3	4	4	4	4	4	4
Staghorn	3	3	3.5	1.5	3	3	1

TABLE 9. Plot 7. Dicamba 8 pounds + paraquat 2 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	4	4.8	4.5	4.5	4.5	4	2
Lantana	3	3.5	4.5	3.5	4.5	1	1
Guava	1.5	3	3	4	3.5	4	3
Ohia	3.5	4	4.5	4.8	4.8	4.5	4.5
Staghorn	3	3.5	4	4	4	3	1–4

TABLE 10. Plot 8. Dicamba 2 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	3.5	4	4	4	4.5	4	1*
Lantana	1	3	3	3	4.5	1	1
Guava	1	3	1.5	3	2	3.5	4
Ohia	1	3.5	3.5	4	4	4	3.2
Staghorn	1	3	3	3.5	3	3	1–3

* Drift from plot 7.

TABLE 11. Plot 9. Dicamba 4 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	3.5	3.5	4	3.5	1
Lantana	1	3	4.5	4	4	3.5	1
Guava	1	1	1.5	1.5	2	3.5	4
Ohia	3	3.5	3.5	4	4	4.5	4
Staghorn	–	–	3	1.5	3	–	1–4

TABLE 12. Plot 10. Dicamba 8 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	3.5	3.5	4	3.5	1
Lantana	1	3	4.5	4.5	4.8	1	1
Guava	1	1	3	3	2	3.5	4
Ohia	3	3.5	3.5	4	4	4	4
Staghorn	1	1	3	1.5	3	3.5	1–4

TABLE 13. Plot 11. Silvex 4 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	4	4	4.5	4	3.5
Lantana	1	3.5	3.5	4	3	3.5	1
Guava	1.5	3	3.5	3	3	4	1
Ohia	1	1	3.5	4	4	4	3
Staghorn	1	1	3	1.5	2	4.8	1

TABLE 14. Plot 12. Silvex 8 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	4.5	4.5	4.8	4	3.5
Lantana	1.5	3.5	4	4	3	4	1
Guava	1.5	3	3.5	3	3	4	1.2
Ohia	1	1	3.5	4	4	4.5	4
Staghorn	1	1.5	3	4	4	4.8	4

TABLE 15. Plot 13. Silvex 12 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	4.5	4.5	4.8	4	4
Lantana	1.5	3.5	4.5	4	4	4	1
Guava	1.5	3	3.5	3	4.5	4	1
Ohia	1	1	3.5	4	3.5	4.5	3
Staghorn	1	3.5	3.5	3.5	4	4.8	4

TABLE 16. Plot 14. Picloram–2,4-D Mixture 2 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	2	3.5	4	3	3.5	2
Lantana	1.5	2	3	3	4.5	1	1
Guava	1	2	1	2	2	4	1
Ohia	1	1	3	4	3	4	1.5
Staghorn	–	–	3	1.5	2	–	1

TABLE 17. Plot 15. Picloram–2,4-D Mixture 4 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	2	3.5	3.5	3	4	3
Lantana	1.5	3.5	3	3	3	1	1
Guava	1	3.5	1.5	4	3.5	4	1
Ohia	1	3	3	4	4	4	4
Staghorn	1	1.5	3	1.5	2	4	2

TABLE 18. Plot 16. Picloram–2,4-D Mixture 6 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	3.5	4	3	3.5	2
Lantana	1.5	3.5	3.5	4	3.5	1	1
Guava	1	1.5	3.5	3	4	4	2
Ohia	1	1	3	4	3.5	4	4
Staghorn	1	1.5	3	4	2	4	3

TABLE 19. Plot 17. 2,4-D–2,4,5-T Mixture 8 pounds per acre

	1 Wk.	2 Wk.	1 Mo.	2 Mo.	3 Mo.	6 Mo.	1 Yr.
Melastoma	2	3.5	3.5	4	4.5	4	1.5
Lantana	1.5	3.5	3.5	4	4	4	1
Guava	1.5	1.5	3.5	4	3	4	–
Ohia	1	1	1	4	3	4	2
Staghorn	–	–	3.5	3	–	3	1

LITERATURE CITED

1. Forestry Research Planning Committee. 1960. A Wildland Research Plan for Hawaii. Dept. of Agriculture and Conservation, State of Hawaii. 71 pp.

2. Goring, C. A. I., C. R. Youngson, and J. W. Hamaker. 1965. Tordon Herbicide-Disappearance from Soils. Down to Earth 20 (4) : 3–5. The Dow Chemical Co.

3. Klingman, G. C. 1961. Weed Control: As a Science. New York: John Wiley and Sons, Inc. 416 pp.

4. Neal, M. C. 1965. In Gardens of Hawaii. Special Publication 50. B. P. Bishop Museum, Honolulu. 924 pp.

5. Ripperton, J. C., and Noel S. Hanson. 1952. The Control of Woody Plants on Hawaiian Ranges. Hawaii Agr. Exp. Sta. Prog. Notes. No. 78. 11 pp.

6. Soil Survey of the Territory of Hawaii. 1955. Soil Survey Series 1935, No. 25. U. S. Dept. Agr.-Hawaii Agr. Exp. Sta. cooperating. 644 pp. Maps.

7. Thomson, W. T. 1964. Agricultural Chemicals—Book II: Herbicides. Davis: The Simmons Publishing Co. 236 pp.

8. Younge, O. R. 1964. Departmental Research Objectives. Dept. of Agronomy and Soil Science, Hawaii Agr. Exp. Sta., University of Hawaii. (Unpublished.)

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