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PREEMERGENCE HERBICIDES TRIAL

DACTHAL, KARMEX, AND TREFLAN

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ABSTRACT

Most information regarding the effectiveness of herbicides comes from studies conducted in temperate climates. Weed response to herbicides in a humid tropical climate is not completely understood. Three preemergence herbicides--Dacthal, Karmex, and Treflan--were studied to determine their levels of weed control in the humid tropical environment of American Samoa. Square meter plots were sprayed with Dacthal at 15.7 kg/ha, Karmex at 7.0 kg/ha, a combination of Dacthal and Karmex at the above rates, and Treflan at 2.3 L/ha. After 84 to 88 d, grasses and broadleaf weeds were harvested, dried, and weighed to determine their dry matter production. Plots treated with Dacthal, Karmex, Dacthal/Karmex, and Treflan produced means of 104.8, 4.1, 5.4, and 80.5 g, respectively, of grass dry matter compared to 173.1 g for a control plot, and 38.8, 2.4, 2.6, and 34.8 g of broadleaf weed dry matter compared to 27.9 g for a control plot. Dacthal and Treflan gave poor control of weeds. This may be due to the high rainfall and temperatures of the American Samoa climate. Karmex, used alone or in combination with Dacthal, gave superior control of both grasses and broadleaf weeds.

Weeds have been the abiding companion of crops since the inception of agriculture. They compete with crops for water, nutrients, light, gases, and space. Unlike most other pests whose populations may vary widely and change rapidly, weeds are omnipresent and relatively constant

In developing countries, farmers spend the majority of their labors in controlling weeds, while losses from weeds in the United States are greater than those from either insects or plant diseases (Burnside, 1979).

Most herbicides are developed for weed species growing in temperate climates. Their effectiveness on weeds growing in the humid tropics is not thoroughly understood. Because weed contro is most efficiently and economically accomplished before weeds become established, the purpose of this study is to test the effectiveness of three preemergence herbicides for controlling weeds in American Samoa

MATERIALS AND METHODS

American Samoa comprises five volcanic islands and two coral atolls in the South Pacific. Tutuila, the largest island and site of this study, is located around 14°17'S and 170°40'W. The mean daily temperature seldom deviates from 27°C throughout the year, and about 3200 mm of rain falls annually (Nakamura, 1984).

In February 1988, a 3 m x 5 m freshly tilled and cleaned field was divided into three adjacent blocks with five 1 m x 1 plots per block. The soil was a stony clay dystrandept, pH 5.8. Each of four preemergence herbicide treatments--Dacthal W-75 (Diamond Shamrock) at 15.7 kg/ha, Karmex 80% WP (Du Pont) at 7 kg/ha, a combination of the wettable powders, Dacthal and Karmex, at the above rates, and Treflan 4EC (Elanco) at 2.3 L/ha--and a control representing no herbicide treatment were assigned plots in accordance with the Randomized Complete Block Design. (The rates are upper limits suggested on herbicide labels or in the literature.) The herbicides were applied using 2 L of spray per plot. Following label instructions, Treflan was further incorporated into the soil by raking, and the other herbicide treatments were washed into the soil by sprinkling the field with about 15 mm of water.

For this study weeds were divided into two groups: broadleaf weeds and grasses. About 99% of the broadleaf weeds were Phyllanthus amarus Sch. & Thon., a widely distributed weed native to tropical America Whistler, 1983). Cuphea carthaginensis (Jacq.) MacBr. was present at about 1%. Three grasses dominated in about equal number: Echinochloa colona (L.) Link, Paspalum conjugatum Berg., and Digitaria setigera Roth ex R. & S.

After 84 d and 1135 mm of rain, the weeds of one block were uprooted, separated by group, washed, chopped into 20 to 40 mm segments, and dried at 80°C until no change in weight was observed (about 6 to 24 h, depending on the volume of weeds The

dry weight of each group per plot was recorded Weeds from the other two blocks were treated similarly at 86 d and 88 d

Data were analyzed using the MSUSTAT Statistical Analysis Package (Lund, 1986) on an IBM-compatible computer

RESULTS AND DISCUSSION

The three herbicides of this study are recommended for a variety of crops grown in American Samoa (Table 1). All three contain a phenyl ring, halogens, and are of relatively low toxicity to mammals (Fig. 1); but each belongs to a different chemical class with a particular mode of action (Table 2).

Because crop yield loss is correlated with dry matter production of weeds, not weed numbers (Burnside, 1979 this method was used to compare the effectiveness of the herbicides (Table 3 The dry weight data are not amenable to analysis of variance (ANOVA because their variances are not homogeneous according to Bartlett's Test for Homogeneity of Variances (Little and Hills, 1978) This absence of homogeneity is due to a positive correlation between means and variances, that is, the larger the mean the larger the variance. Therefore, the data were transformed by taking the logrithm of the dry weights after multiplication by 10 to avoid negative logrithms Table 4). Bartlett's Test shows homogeneity of variances for the logrithm-transformed broadleaf weed data and the total weed data, but not for the grass data.

The dry weight of grasses for each treatment was divided by the dry weight of grasses in the control plot of each block.

This gave a fraction of grass weeds for each treatment relative to the dry weight of grasses n the control plots. When an arc-sin transformation was done on the square-root of each fraction the data satisfied Bartlett's Test but gave strong positive cor relation of means with variances (r = 0.99).

ANOVA were performed for logrithm-transformed broadleaf weed data and total weed data (Table 4), but not for grass weed data. However, it seems clear from Table 3 that Karmex was the best herbicide for controlling the dry matter production of both broadleaf weeds and grasses. Yet of the weeds in this study, only Echinochloa is among those documented as controlled by Karmex (Anonymous, 1986).

Dacthal is documented as active against annual grasses and some broadleaf weeds (Ashton and Crafts, 1981). But when applied in combination with Karmex, Dacthal did not enhance weed control compared to Karmex used alone. Dacthal did not control broadleaf weeds or total weeds at a 5% level of significance any better than did the control plot with no herbicide treatment (Table 4). This may be expected if Dacthal was rapidly lost from the soil. The ester moieties of Dacthal are subject to acid catalyzed hydrolysis in the weakly acidic soil environment, possibly rendering Dacthal susceptible to leaching. With the elevated soil temperatures and high rainfall in American Samoa, this may have occurred.

Treflan is a popular herbicide in temperate climates for the control of Digitaria spp., Echinochloa colona, other grasses, and

several broadleaf weeds (Anonymous, 1986). Its hydrophobicity and lack of potentially hydrolyzable sidechains should minimize its leaching beyond the upper few centimeters of soil where most weed seeds germinate. But Treflan is the most volatile of the three herbicides. This is why it must be quickly incorporated into the soil following application.) Its unremarkable level of weed control is probably due to increased volatility under a tropical sun

CONCLUSIONS

Though they offer good weed control in a temperate climate, Dacthal and Treflan may be of limited use in the humid tropics Dacthal may, perhaps, persist longer in neutral tropical soils where hydrolysis of its ester groups would occur at a minimal rate, but such soils are uncommon. The volatility of Treflan is a more difficult problem to circumvent. Treflan may be a viable herbicide in the tropics only at higher elevations

Karmex is best of the three herbicides for controlling both broadleaf weeds and grasses in American Samoa. It affords up to 90 d protection under conditions of high rainfall and temperature, ample time for most crops to establish a canopy to shade out latent weeds. Karmex is not recommended, however, for many vegetable crops grown in American Samoa Table 1).

Established weeds must be eliminated before treating a soil with Karmex. This may be because its effect on sprouted plants is negligible. If, therefore, a susceptible crop is transplanted

rather than sown into a clean field treated with Karmex, it might grow normally, especially if its roots are placed beneath the layer of soil treated with Karmex. Such a study is underway to determine any yield effect when broccoli is transplanted to a field treated with Karmex*. Taro, because it is grown from suckers and not from seeds, might also be unaffected by Karmex while benefiting from its excellent weed control. Another study will be conducted to test this hypothesis.

Karmex provides up to a year of weed control in temperate climates (Thomson, 1983). Observation of the plots of this study will continue to determine how long the weed control effects of Karmex persist under humid tropical conditions.

*During this study a crop susceptible to Karmex inhibition, Pak Choy Chinese cabbage, was transplanted to each plot, but all Pak Choy plants inexplicably died within days. Pak Choy was then seeded in the plots. A few seeds germinated in each plot, but again all plants quickly died.

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Table 1. Crops grown in American Samoa for which the three preemergence herbicides are registered (Page and Thomson, 1983).

	DACTHAL	KARMEX	TREFLAN
Banana		x	
Broccoli	x		x
Citrus		x	
Cabbage	x		x
Corn	x		x
Cucumber	x		x
Eggplant	x		
Lettuce	x		
Okra			x
Onion	x		x
Papaya		x	
Pepper	x		x
Pineapple		x	
Sweet potato	x		
Tomato	x	x	x

x indicates the herbicide is registered for this crop

Table 2. Modes of action of the herbicides (Ashton and Crafts, 1981, and Ware, 1978).

Dacthal	Readily absorbed by the roots, but not translocated. Produces auxinlike growth effects that persist in their action: cell elongation and tissue proliferation without cell division, induced adventitious roots, and modified arrangement of leaves and other organs.
Karmex	Readily absorbed by the roots and rapidly translocated to the upper plant parts. The primary site of action is the inhibition of the Hill reaction of photosynthesis. It is theorized that a secondary toxic substance is formed in the oxygen-releasing pathway of photosynthesis.
Treflan	Readily absorbed by both roots and shoots but only slightly translocated to other plant parts. It limits root growth, especially the lateral roots. It stimulates increased production of nucleic acids in both roots and shoots. It uncouples oxidative phosphorylation and inhibits the production of several hormone-induced enzymes.

able 3. Means and s ndard rrors for the t production of grasses and roadle f weeds on 1 prayed with four herbicide t atment and a contro

	DRY WEIGHT (g) Mean + SE		
TREATMENT	BROADLEAF WEEDS	GRASSES	TOTAL WEEDS
Karmex	2.4 ± 0.5	4.1 ± 2.1	6.5 + 2.0
Dacthal/Karmex	2.6 ± 0.3	5.4 ± 2.9	8.0 ± 3.2
Dacthal	38.8 ± 4.5	104.8 ± 6.6	143.6 ± 6.9
Tref an	34.8 ± 3.6	80.5 + 25.5	115.3 ± 27.4
Control	27.9 ± 2.0	173.1 ± 39.2	200.9 ± 41.1

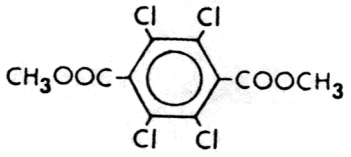
Table 4. Logrithm transformation of dry weight data of Table 3. The dry weights were first multiplied by 10 before being transformed.

	log(10 * DRY WEIGHT) Mean ± SE		
TREATMENT	BROADLEAF WEEDS	GRASSES*	TOTAL WEEDS
Karmex	1.35 ± 0.10a	1.37 ± 0.40	1.77 ± 0.14a
Dacthal/Karmex	1.41 ± 0.06a	1.40 + 0.49	1.80 + 0.23a
Dacthal	2.58 ± 0.05b	3.02 ± 0.02	3.16 + 0.02b
Treflan	2.54 + 0.06b	2.85 ± 0.16	3.03 ± 0.12b
Control	2.44 ± 0.03b	3.21 + 0.11	3.28 + 0.10b

Means and SE followed by a common letter within a column do not differ significantly at the 0.05 probability level according to Duncan's Multiple Range Test.

*Data not amenable to ANOVA (see text

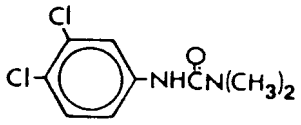
Figure 1. Structure, alternative names, and toxicity (mg/kg) of the active ingredient in each preemergence herbicide.



DACTHAL (DCPA)

dimethyl tetrachloroterephthalate

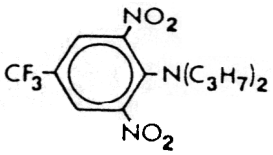
Oral LD_{50} > 3000
Dermal LD_{50} > 10000



KARMEX (Diuron)

3-(3,4-dichlorophenyl)- 1-dimethy

Oral LD_{50} = 3400



TREFLAN (Trifluralin)

α,α,α-trifluoro-2,6-dinitro
N,N-dipropyl-para-toluidine

Oral LD_{50} > 10000