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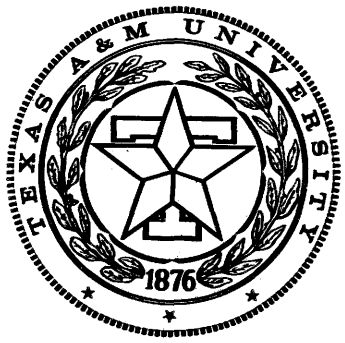

TEXAS
TRANSPORTATION
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HIGHWAY
DEPARTMENT

COOPERATIVE
RESEARCH

EVALUATION OF SOIL STERILANT HERBICIDES FOR ROADSIDES

in cooperation with the
Department of Transportation
Federal Highway Administration

RESEARCH REPORT 142-2
STUDY 2-18-69-142
ROADSIDE VEGETATION

EVALUATION OF SOIL STERILANT HERBICIDES FOR ROADSIDES

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Research Report 142-2
Establishment and Management of Roadside Vegetation
Research Project 2-18-69-142

Sponsored by
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TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

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ABSTRACT

Forty-four herbicides were used alone and in various combinations as soil sterilant treatments on roadsides. Usually three rates of application were employed, the highest rate surpassing the recommended label rate. Applications in June and August were equally effective and were superior to October treatments.

Although many of the treatments, especially mixtures of herbicides, were effective soil sterilants, they have very limited use on roadsides. In every case treatments giving acceptable soil sterilization moved downslope from the point of application, and the resultant bare soil was subject to erosion. This adverse effect could not be overcome with spray volumes up to 400 gal/A nor with asphalt emulsion as a carrier or as a cap over the treated area. Greater movement downslope was experienced with granular forms than with the same material applied as sprays. Higher rates of the same herbicide moved more than lower rates.

Key words: Roadsides, vegetation control, soil erosion, soil sterilant herbicides.

SUMMARY

Soil sterilant treatments were projected for use on roadsides to facilitate high-speed mowing near guardrails, sign posts and similar structures. Forty-four individual herbicide formulations, singly and in various combinations, were compared for soil sterilant use on roadsides. Three test sites were treated from June to October during each of two successive years.

The findings from this study may be summarized:

1. A number of treatments were satisfactory soil sterilants, although certain plants seem to recover sooner from a particular treatment.
2. Under Texas conditions adequate vegetation control can be achieved for a period of 3 to 6 months. A long summer growing season favors the recovery of tolerant species, and different plants grow with a change in season. Subsequent applications on a program basis were not done.
3. Although sterilant treatments could be recommended for flat sites, applications made at the tops of slopes denuded part or all of the slope below, creating a severe erosion hazard.
4. Applying sterilants in excessive water volumes to better put them in contact with soil, failed to confine the treatment to the target area. Also, applying these materials in or under a film of asphaltic emulsion was ineffective in preventing movement of the applied herbicide.
5. Results from this study suggest that the greatest efficiency from mixtures of these general purpose herbicides will come with prescription treatments based on weedy plants present, locality and other considerations.

IMPLEMENTATION STATEMENT

The results from these tests indicate that none of the soil sterilant herbicides compared in this study should replace the TCA and "Ammate" presently in use.

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INTRODUCTION

Maintenance engineers object to unsightly vegetation around guardrails, sign posts, bridge ends and other structures adjacent to the highway pavement. Quite often, this unwanted vegetation is a safety hazard. Previously, this weedy vegetation has been controlled by hoeing or by hand mowing. Maintaining these local areas free of vegetation has been suggested. Since both grassy and broadleaf weeds are involved, a broad-spectrum herbicidal treatment is required.

This report summarizes two years of study on the use of soil sterilant herbicides for highway use by the Texas Transportation Institute and the Texas Agricultural Experiment Station of Texas A&M University, under a cooperative research project sponsored by the Texas Highway Department and the Federal Highway Administration.

THE PROBLEM

A soil sterilant herbicide is a chemical applied to the soil to prevent any plants from growing. A temporary soil sterilant may be effective as a herbicide for only a day or so, while a permanent soil sterilant may last two or more years. Ideally, a sterilant for highway use should:

1. Have an effective herbicidal life of at least one growing season.
2. Control a large variety of plants.
3. Be safe for personnel to apply, and not damage desirable plants along the highway or adjacent property.
4. Be capable of application through existing equipment.

The length of time a soil is chemically sterilized is conditioned by the solubility of the herbicide, the amount of precipitation received and the texture of the soil material. More soluble chemicals dissolve more quickly and move through the soil profile in solution. Higher rates of the same material are specified for clay soils than for sandy soils; and materials leach through sandy soils faster than through clays.

Herbicides such as sodium TCA and dalapon [1/], presently specified for application pre-paving, are so soluble that plants will re-invade the treated area in 90 days or less. Borascu, also applied pre-paving, performs best when incorporated into the surface soil layer. The change in location of application from pavement to open soil, the limitations of the specified materials listed above, and the development of additional candidate herbicides revealed a number of potential treatments for maintenance application of soil sterilants.

PROCEDURES

Initially, 44 herbicide formulations (Appendix A) were applied alone or in mixtures. Two of the materials, cacodylic acid and paraquat, were used as contact herbicides and the remainder were applied as soil sterilants. Seven herbicides were applied in both liquid and dry form. Treatments were located on open soil in Lubbock, Smith and Wharton counties during June, August and October 1967. Plots 4' by 25' were treated using a knapsack sprayer fitted with a multi-nozzle boom.

1/ Herbicides are designated by the accepted common names throughout this report and identified chemically in Appendix A.

Fourteen of the original formulations were retained, and one additional formulated material (Fenamine) together with 6 materials under experimental labels were applied in Jasper, Tarrant and Walker counties during June and August 1968. Most applications involved herbicide mixtures to control a larger variety of plants. Materials were applied only as water sprays, and the volume applied was increased from 200 gallons the previous year per acre to 400 gallons. Seven herbicidal treatments were either applied in asphalt or the treated soil area was covered with an asphalt film. Emulsified asphalt was used and constituted either 6.25 or 62.5% of the volume of emulsion applied.

Response of individual plants and retention of applied material within the treated area were used to judge treatment effectiveness. Plants were arbitrarily rated as susceptible, moderately susceptible or resistant to the treatment applied. Movement ("shift") away from the treated area was measured.

Additional herbicidal treatments were tested at the Texas A&M Research Annex near College Station. In June 1968 a black mastic, an aluminum mastic and an asphalt emulsion, each with prometone incorporated, were applied in a replicated test to a mixture of grasses and broadleaf plants. All materials and mixtures were applied to one square yard to give a prometone rate of 40 lb/A. Treatment effects were evaluated on individual species and for the treated area through the following growing season.

In September 1969, two rates of each of seven materials were applied in a replicated test. A multi-nozzle boom was used to treat a strip 8 feet wide spanning asphalt pavement and the adjacent gravel shoulder. Treatment response was recorded for individual grasses and broadleaf plants and for the treated area.

RESULTS AND DISCUSSION

Even though herbicides employed as soil sterilants are considered "general purpose", a wide variation was noted in response of plants to treatment. The degree of control achieved with the better treatments is presented in Table 1-5, and the reactions of individual plant species encountered most frequently are shown in Figures 2-13. Some materials retain their herbicidal activity longer than others; plant responses to treatment are shown for a short term (2 to 3 months) and in the subsequent growing season (10 months after treatment). A number of herbicides are effective soil sterilants for as long as 3 months. The control achieved with the more residual materials bromacil, CBMM, karbutilate and monuronTCA persisted for 10 months (Tables 1-2).

Annual grasses such as crabgrass and ryegrass, and annual broadleaf plants such as amaranth (known also as carelessweed or pigweed), croton and kochia, were controlled by all materials tested, except some at lighter rates. The control of annual plants was extended into the following growing season by the pre-emergence action of most materials.

Perennial plants varied in their susceptibility to herbicides. Bermudagrass was controlled by more treatments than either dallisgrass or johnsongrass. Most perennial broadleaf plants were controlled for 60 days, except with TCA. After 10 months the broadleaf plants as a group were controlled to a greater extent than were the grasses. Some plants are quite tolerant of a specific material, shown by the presence of oxalis in treatments containing prometone.

Treatments involving mixtures of herbicides gave better plant control than did individual materials. Herbicides which have a contact or burning action such as paraquat, HCA or cacodylic acid are combined with materials such as bromacil, CBMM or karbutilate. The contact materials give an

immediate "knockdown" of the treated vegetation, and the control is extended by the more persistent soil sterilant. In other cases, two or more materials such as TCA and karbutilate are combined to bridge any deficiencies either material may have in controlling any plant in the wide assortment found on roadsides.

Any materials which effectively controlled vegetation moved away from the treated area. Formulations containing bromacil moved more readily than most others (Tables 1-5). The distances indicated for herbicidal movement are based on vegetation response downslope from the treated area. These measurements should be interpreted only as evidence of "shift" downslope from the point of application, since the precise distance often was limited by the length of the slope involved.

Several operational procedures were explored to contain the herbicide within the area treated, and none was successful. Application volumes as high as 400 gal/A were inadequate, as was asphalt emulsion as a carrier or as a cap over the treated area (Table 5).

Treatment with TCA/bromacil HCA and with TCA/karbutilate was better mixed with asphalt, while bromacil/cacodylic acid, TCA/prometone and prometone were less effective. Granular forms moved more than spray applications of the same material at equivalent rates. Higher rates of the same herbicide generally moved greater distances downslope than lower rates.

Season of application is important to herbicidal efficiency. Under the conditions of these tests, materials applied in early June were better than October treatments, and there was little difference between June and August application.

TABLE 1. Average vegetation control with individual herbicides for June and August treatments (1967) over all locations evaluated in October 1967 and May 1968. "Shift" from the treated area is the maximum observed.

Treatment	Rate/Acre (a.i.)*	June Treatment Percent control- all vegetation Oct 67	June Treatment Percent control- all vegetation May 68	August Treatment Percent control- all vegetation Oct 67	August Treatment Percent control- all vegetation May 68	Maximum "shift" (ft)
Prometone	10 lb	43	33	43	33	4
	30 lb	60	43	57	67	9
	60 lb	97	73	48	62	20
Picloram/2,4-D (1 lb/2 lb)	5 lb	25	25	52	33	4
	10 lb	65	33	43	43	12
	20 lb	70	25	70	43	25
TCA	200 lb	43	25	70	25	6
	400 lb	33	25	93	33	15
25% bromacil, 25% HCA EC	20 lb	63	50	67	33	8
	30 lb	63	63	67	57	12
	40 lb	63	55	68	68	15
Erbon	80 lb	42	25	72	43	5
	120 lb	25	25	75	43	5
	160 lb	67	50	75	43	8
CBMM	218 gal	60	63	75	68	12
	327 gal	60	63	75	58	8
	436 gal	60	63	77	58	6
MonuronTCA	10 gal	63	63	65	33	7
	15 gal	63	63	82	62	4
	20 gal	63	63	82	57	6

*Except MonuronTCA and CBMM where volume is specified.

TABLE 2. Vegetation control from herbicide mixtures averaged over all locations for June and August treatments (1967) evaluated in October 67 and May 1968. "Shift" from the treated area is the maximum observed.

Treatment	Rate/Acre (a.i.)	June Treatment Percent control- all vegetation Oct 67	June Treatment Percent control- all vegetation May 68	August Treatment Percent control- all vegetation Oct 67	August Treatment Percent control- all vegetation May 68	Maximum "shift" (ft)
Bromacil/cacodylic acid	5 lb/2.5 lb	72	49	60	52	15
	10 lb/2.5 lb	75	50	85	68	20
	15 lb/2.5 lb	75	68	67	68	15
Bromacil/Paraquat	5 lb/1 lb	68	52	42	50	22
	10 lb/1 lb	68	43	67	52	18
	15 lb/1 lb	72	45	75	58	30
Prometone/Erbon	10 lb/40 lb	43	43	48	33	3
	10 lb/80 lb	58	58	73	33	4
	20 lb/40 lb	58	58	67	33	1
	20 lb/80 lb	67	58	73	42	4
Prometone/CBMM	10 lb/109 gal	52	67	67	62	4
	10 lb/218 gal	93	62	68	33	5
	30 lb/109 gal	58	58	68	52	10
	30 lb/218 gal	75	58	67	62	10
Prometone/Atrazine	10 lb/10 lb	62	49	52	33	14
Prometone/TCA	10 lb/50 lb	25	33	75	48	4
	10 lb/100 lb	72	50	72	42	5
	30 lb/50 lb	48	58	73	48	5
	30 lb/100 lb	80	58	92	52	6
TCA/Atrazine	100 lb/10 lb	52	48	92	62	10
	100 lb/20 lb	67	48	93	73	10
Cacodylic Acid/ Fluometuron	2.5 lb/10 lb	25	25	52	33	0
	2.5 lb/20 lb	62	25	87	52	7
	2.5 lb/30 lb	43	43	75	52	8
TCA Karbutilate	100 lb/4 lb	63	63	52	42	2
	100 lb/8 lb	63	63	97	68	2
	100 lb/16 lb	90	63	98	74	10
Cacodylic acid/ 25% bromacil, 25% HCA	2.5 gal/10 lb	60	63	87	50	15
	2.5 gal/15 lb	63	63	95	58	8
	2.5 gal/20 lb	63	63	95	63	10

TABLE 3. Average vegetation control with individual herbicides applied June 1968 in Tarrant, Walker and Jasper counties. "Shift" from the treatment area is the maximum observed.

Treatment	Rate/A (a.i.)*	% Control November 68	Maximum "Shift" (ft)
Prometone	20 lb	44	2
	40 lb	75	10
	60 lb	68	10
Picloram/2,4-D (1 lb/2 lb)	5 lb	27	0
	10 lb	37	2
Sodium TCA	200 lb	48	1
25% Bromacil, 25% HCA EC	20 lb	65	2
	30 lb	67	3
	40 lb	70	5
Erbon	160 lb	77	1
CBMM	327 gal	65	2
	436 gal	67	2
MonuronTCA	10 gal	67	0
	15 gal	63	1

*Except CBMM where volume is specified.

TABLE 4. Average vegetation control with herbicide mixtures applied June 1968 in Tarrant, Walker, Jasper counties. "Shift" from the treated area is the maximum observed.

Treatment	Rate/A (lb a.i.)	% Control Nov 68	Maximum "shift" (ft)
Bromacil/cacodylic acid	5 lb/1 gal	77	2
	10 lb/1 gal	81	4
	15 lb/1 gal	83	8
Bromacil/Paraquat	5 lb/1 lb	68	3
	10 lb/1 lb	66	5
	15 lb/1 lb	68	4
TCA/Prometone	100 lb/10 lb	70	1
	100 lb/20 lb	88	2
Prometone/Erbon	10 lb/40 lb	39	1
	10 lb/80 lb	30	0
	20 lb/40 lb	35	2
	20 lb/80 lb	41	0
Prometone/CBMM	10 lb/109 gal	42	1
	10 lb/218 gal	68	7
	20 lb/109 gal	70	3
	20 lb/218 gal	63	5
Prometone/Atrazine	10 lb/10 lb	67	5
	10 lb/20 lb	35	3
	20 lb/10 lb	70	7
	20 lb/20 lb	64	7
TCA/Atrazine	100 lb/10 lb	39	3
	100 lb/20 lb	37	2
TCA/Fluometuron	100 lb/10 lb	40	3
	100 lb/20 lb	37	5
TCA/Karbutilate	100 lb/4 lb	43	1
	100 lb/8 lb	60	4
	100 lb/16 lb	66	2
TCA/25% Bromacil, 25% HCA	100 lb/10 lb	66	3
	100 lb/15 lb	65	3

TABLE 5. Relative effectiveness of several herbicides applied as water sprays, as water sprays capped with two levels of asphaltic emulsion or applied in an asphaltic emulsion carrier.

Treatment	Rate/A (a.i.)	WATER		ASPHALT EMULSION							
				6.25%				62.5%			
				Incorporated		Capped		Incorporated		Capped	
		Control (%)	"Shift" (ft)	"Shift" control (%)	(ft)	"Shift" (%)	(ft)	"Shift" control (%)	Movement (ft)	"Shift" (%)	Movement (ft)
Bromacil/Cacodylic acid	10 lb/2.5 lb	73	3	58	4	78	4	53	4	88	4
TCA/Prometone	100 lb/20 lb	83	0	75	3	28	0	50	3	75	3
TCA/Karbutilate	100 lb/8 lb	40	4	66	4	66	3	66	2	66	2
TCA/HCA Bromacil	100 lb/15 lb	48	0	62	2	72	4	69	4	63	4
Prometone	40 lb	63	6	55	3	50	3	45	4	50	3

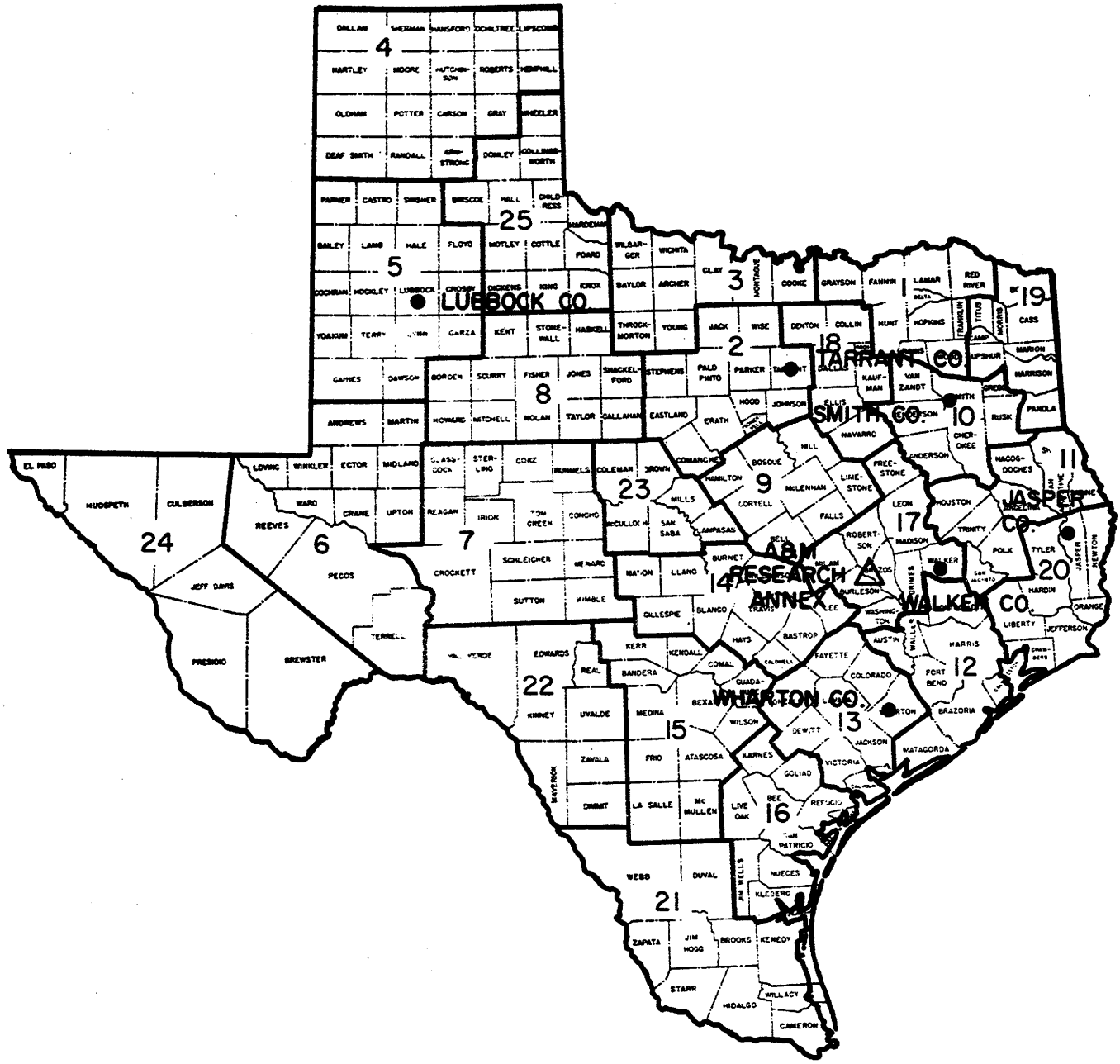


Figure 1B. Treatment locations for soil sterilant evaluations. (Overlay)

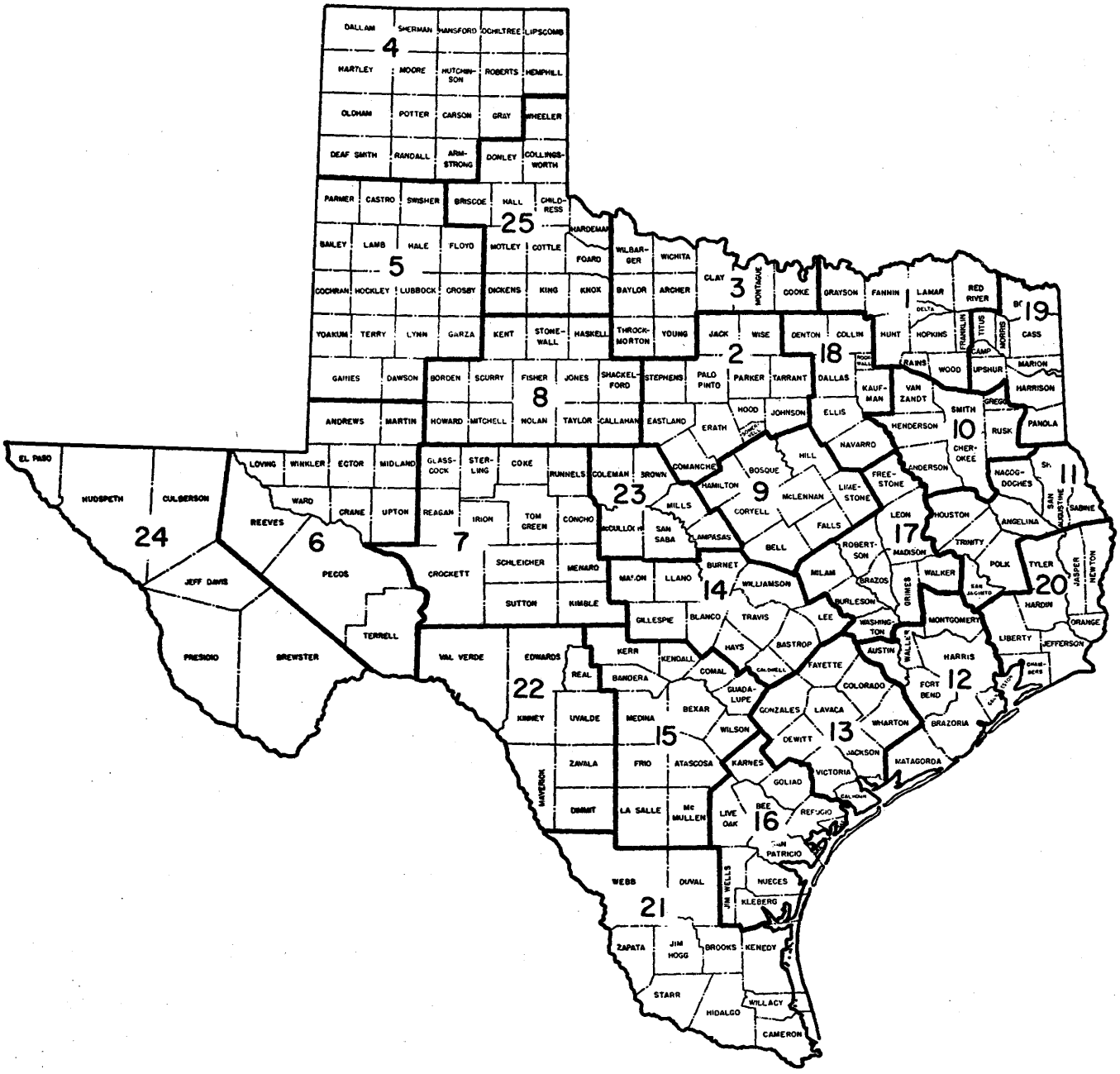


Figure 1A. The Texas Highway Department is organized into 25 districts.

APPENDIX A

Basic herbicides contained in the formulations and mixtures tested.

COMMON NAME OR DESIGNATION	CHEMICAL NAME
Amitrole	3-amino-s-triazole
Ametryne	2-(ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine
AMS	Ammonium sulfamate
Atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
Bromacil	5-bromo-3-sec-butyl-6-methyluracil
Cacodylic	Hydroxydimethylarsine oxide
CBMM	18.5% sodium chlorate + 10.0% sodium metaborate
Dalapon	2,2-dichloropropionic acid
Erbon	2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate
Fenac	(2,3,6-trichlorophenyl)acetic acid
Fluometuron	1,1-dimethyl-3-(, , ,-trifluoro-m-tolyl) urea
HCA	1,1,1,3,3,3,-hexachloro-2-propanone
Karbutilate	m-(3,3-dimethylureido)phenyl tert-butylcarbamate
MBC	68% sodium metaborate + 30% sodium chlorate
MonuronTCA	3(p-chlorophenyl)-1, 1-dimethylurea mono (trichloroacetate)
Paraquat	1,1'-dimethyl-4,4'dipyridinium ion
Picloram	4-amino-3,5,6-trichloropicolinic acid
Simazine	2-chloro-4,6-bix (ethylamino)-s-triazine
TCA	Trichloroacetic acid
Terbacil	3-tert-butyl-5-chloro-6-methyluracil

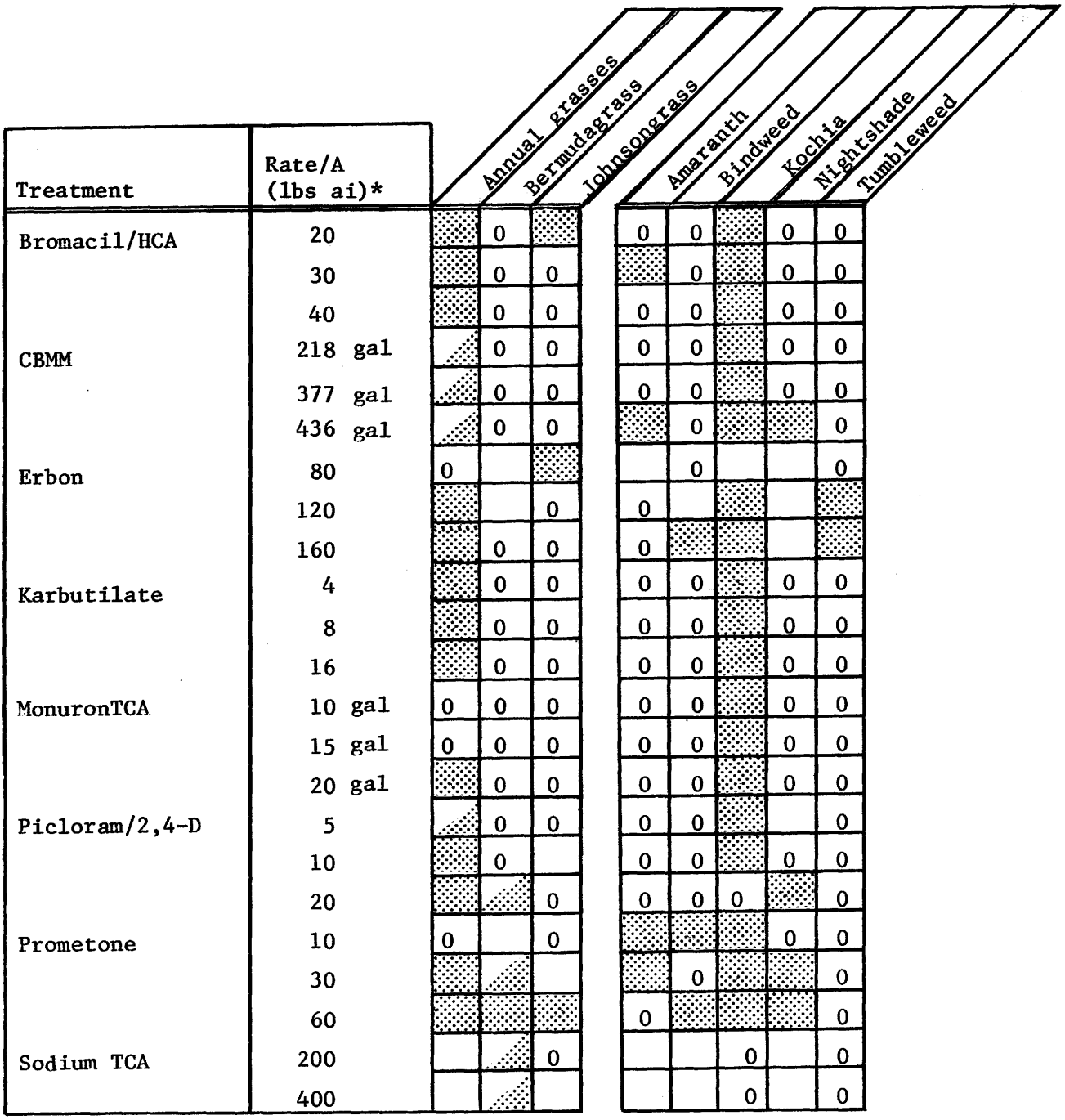


Figure 2. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June, 1967, Lubbock County.

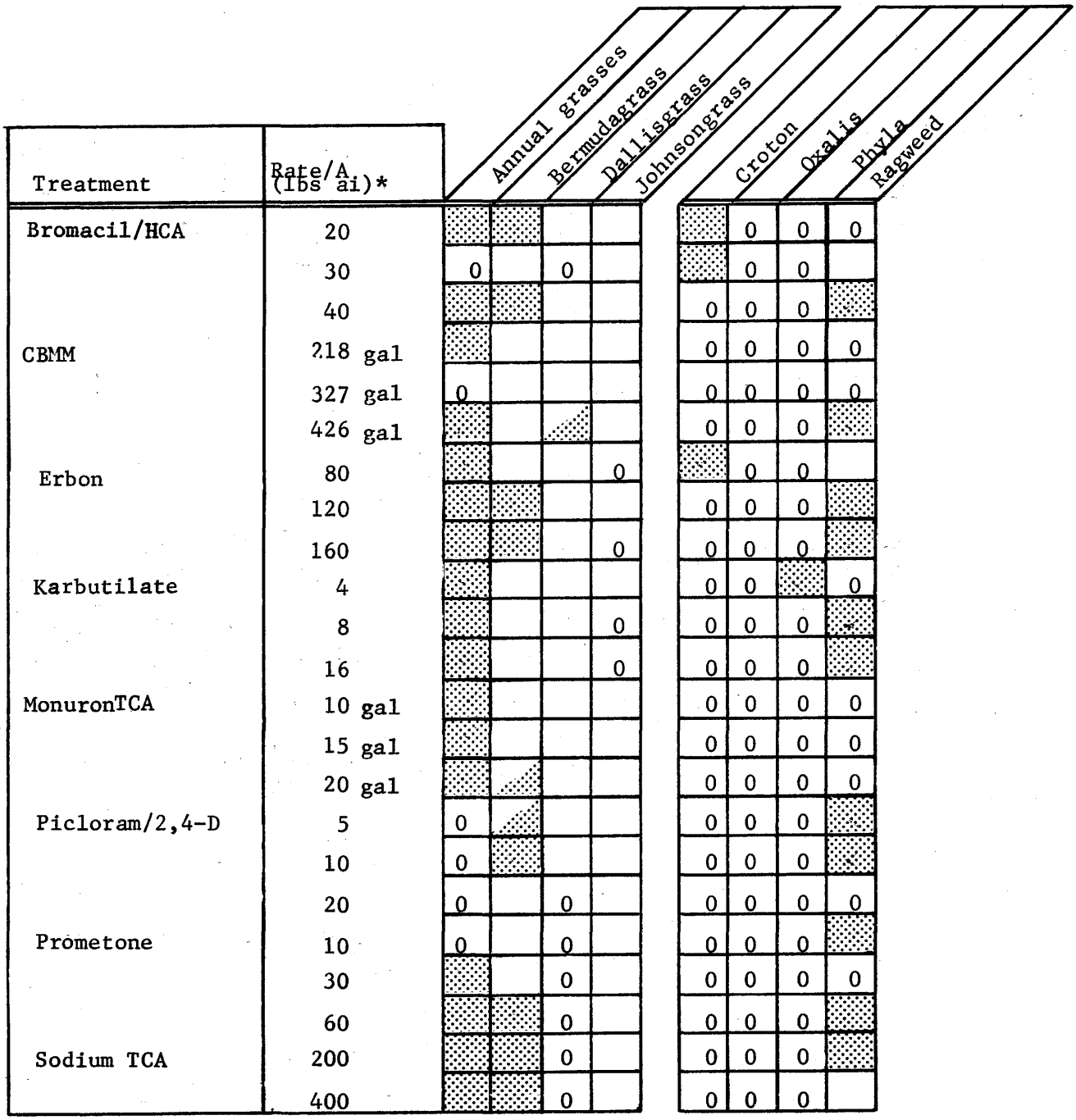


Figure 3. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June 1967, Wharton County.

Treatment	Rate/A (lbs ai)*	Annual grasses	Bermudagrass	Dallisgrass	Johnsongrass	Croton	Oxalis	Phyla	Ragweed
Bromacil/HCA	20				0	0	0	0	
	30			0	0	0	0	0	0
	40				0	0	0	0	0
CBMM	218 gal			0	0	0	0	0	
	327 gal	0		0	0	0	0	0	
	426 gal	0		0	0	0	0	0	0
Erbon	80				0	0	0	0	
	120				0		0	0	
	160	0			0	0		0	
Karbutilate	4	0		0	0	0	0	0	
	8	0		0	0	0	0	0	
	16	0		0	0	0	0	0	
MonuronTCA	10 gal				0	0	0	0	0
	15 gal			0	0	0	0	0	0
	20 gal			0	0	0	0	0	0
Picloram/2,4-D	5				0	0		0	
	10				0	0		0	
	20							0	
Prometone	10			0	0	0		0	0
	30			0	0	0		0	0
	60			0	0	0		0	
Sodium TCA	200			0			0	0	
	400			0		0	0	0	

*Except where the rate is expressed in gallons of formulated material.

Controlled | Partially Controlled | Not Controlled | 0 No Rating

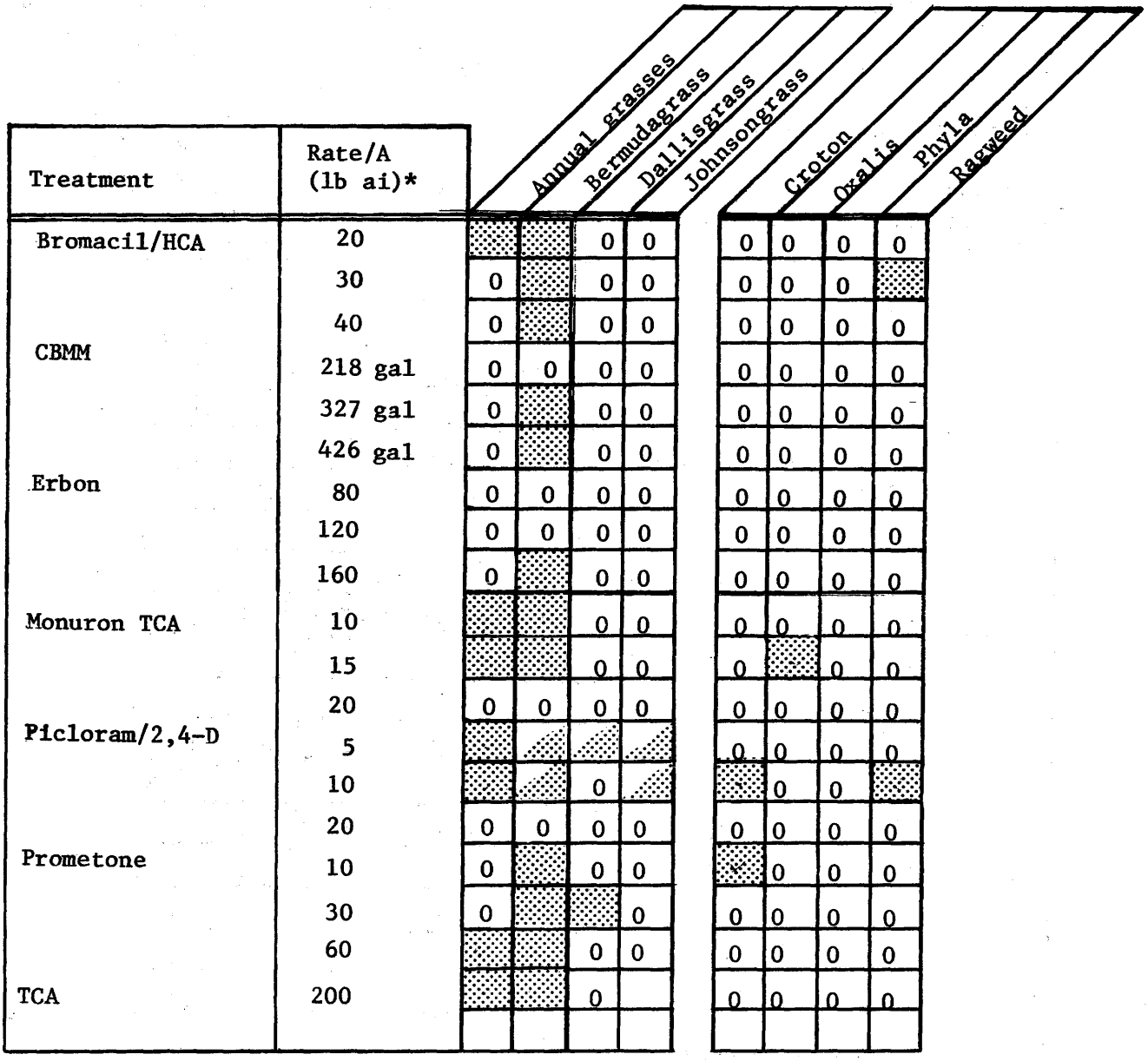
Figure 4. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June 1967, Smith County.

Treatment	Rate/A (lb ai)*	Annual grasses	Bermudagrass	Dallisgrass	Johnsongrass	Croton	Oxalis	Phyla	Ragweed
Bromacil/HCA	20	▒		0	0	0	▒	0	0
	30	▒			0	0	▒	0	0
	40	▒			0	0	▒	0	0
CBMM	218 gal	▒		0	0	0	▒	0	0
	327 gal	▒			0	0	▒	0	0
	436 gal	0	0	0	0	0	0	0	0
Erbon	80	0	0	0	0	0	0	0	0
	120	0	0	0	0	0	0	0	0
	160	0	▨		0	▒	0	0	0
Monuron TCA	10	0			0	▒			▒
	15	0			0	0			0
	20	0	0	0	0	0			0
Picloram/2,4-D	5	0		0		0		0	0
	10				0	0	0	0	▒
	20	0	0	0	0	0	0	0	
Prometone	10	▒				0	▒	0	▒
	30	▒	▨	▒	▒	0	▒	0	▒
	60	0	0	0	0	0	0	0	0
TCA	200	0			0	0	▒	0	▒

* Except where the rate is expressed in gallons of formulated material.

▒ Controlled ▨ Partially Controlled □ Not Controlled 0 No Rating

Figure 5. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June 1968, Jasper County.



Treatment	Rate/A (lb ai)*	Annual grasses	Bermudagrass	Dallisgrass	Johnsongrass	Croton	Oxalis	Phyla	Ragweed
Bromacil/HCA	20			0	0	0	0	0	0
	30	0		0	0	0	0	0	
	40	0		0	0	0	0	0	0
CBMM	218 gal	0	0	0	0	0	0	0	0
	327 gal	0		0	0	0	0	0	0
	426 gal	0		0	0	0	0	0	0
Erbon	80	0	0	0	0	0	0	0	0
	120	0	0	0	0	0	0	0	0
	160	0		0	0	0	0	0	0
Monuron TCA	10			0	0	0	0	0	0
	15			0	0	0		0	0
	20	0	0	0	0	0	0	0	0
Picloram/2,4-D	5					0	0	0	0
	10			0			0	0	
	20	0	0	0	0	0	0	0	0
Prometone	10	0		0	0		0	0	0
	30	0			0	0	0	0	0
	60			0	0	0	0	0	0
TCA	200			0		0	0	0	0

* Except where the rate is expressed in gallons of formulated material.

Controlled — Partially Controlled — Not Controlled — 0 No Rating

Figure 6. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June 1968, Tarrant County.

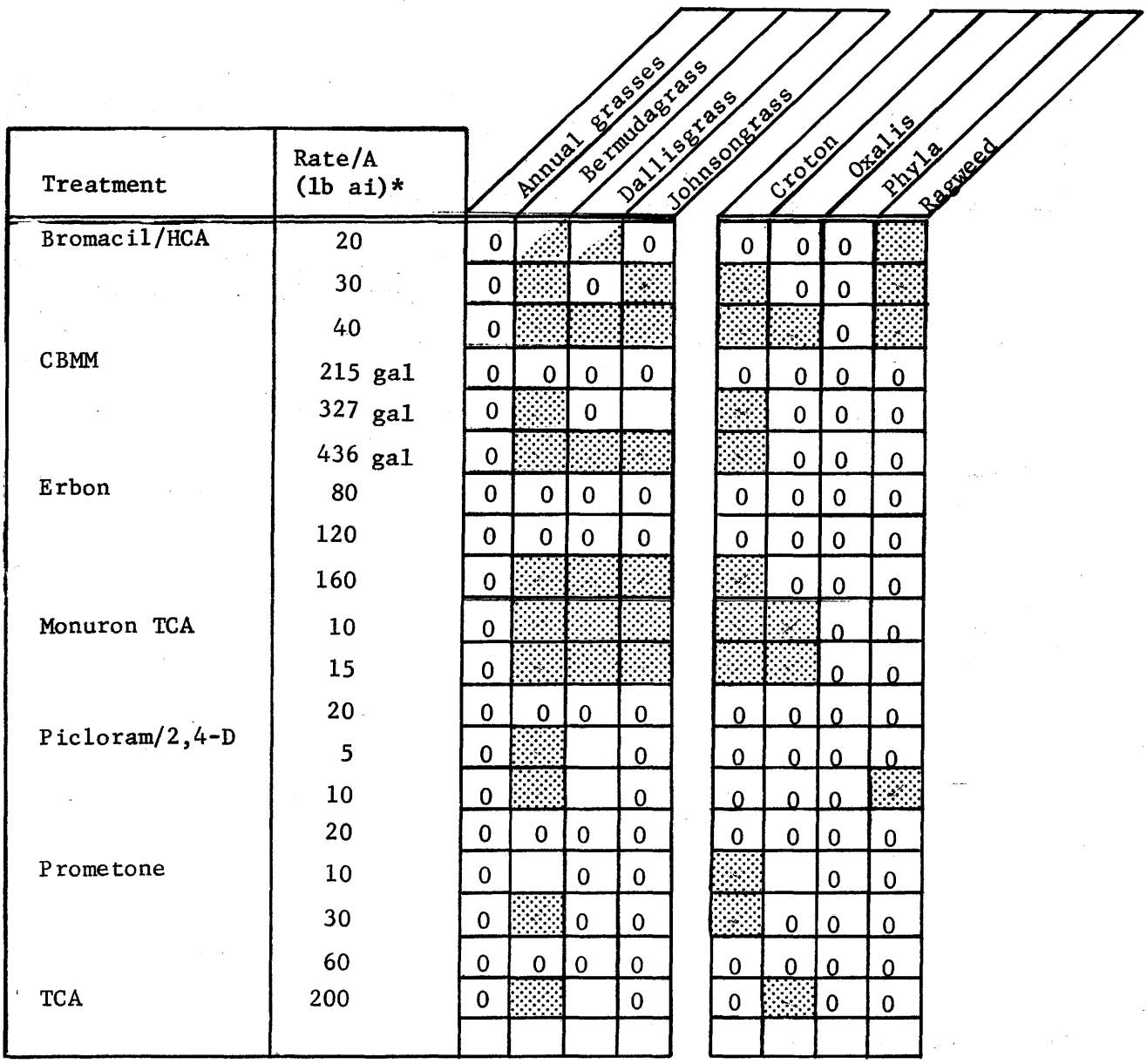


Figure 7. Response of selected plants after 100 days to treatment with a designated herbicide formulation in June 1968, Walker County.

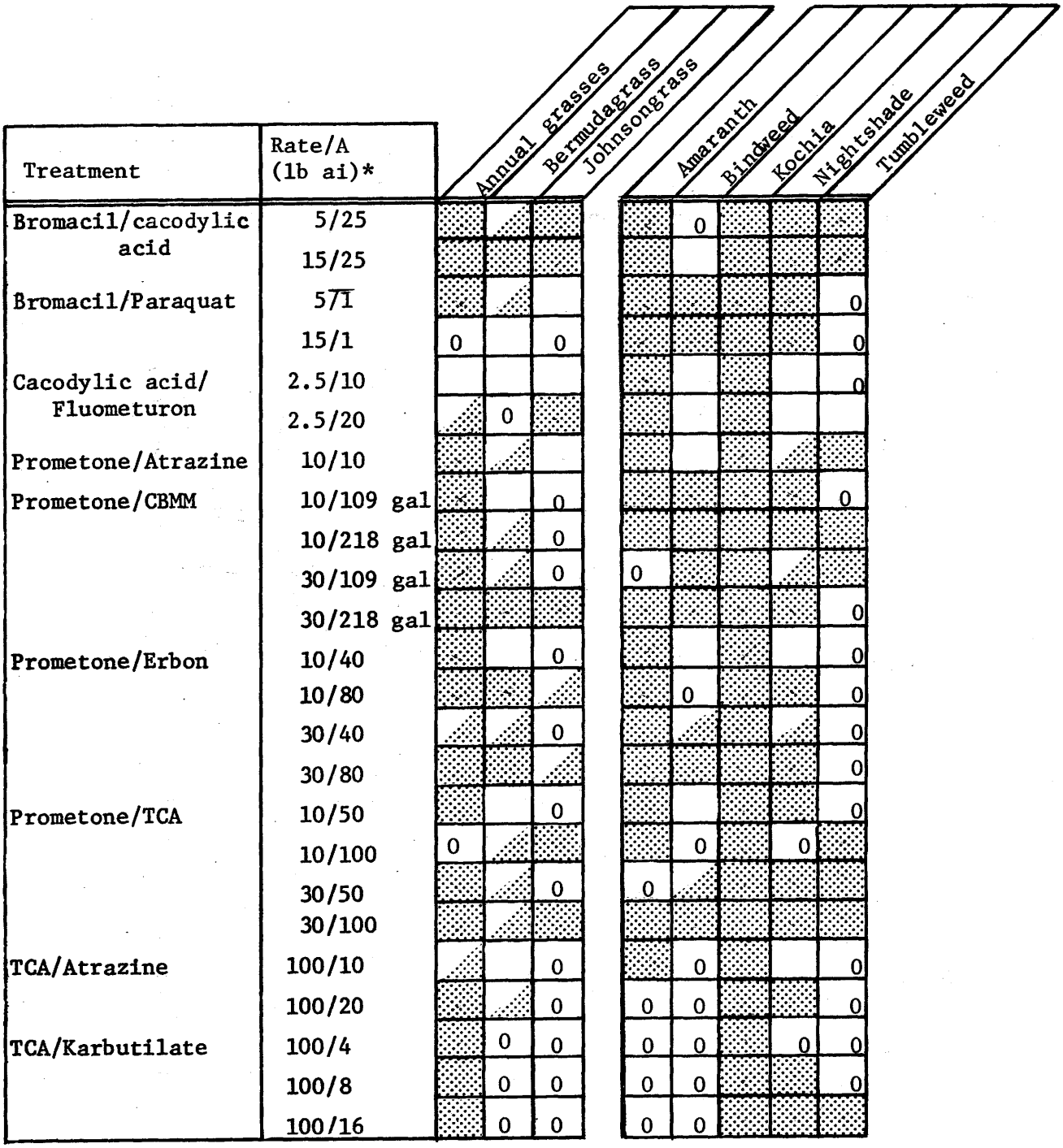


Figure 8. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1967, Lubbock County.

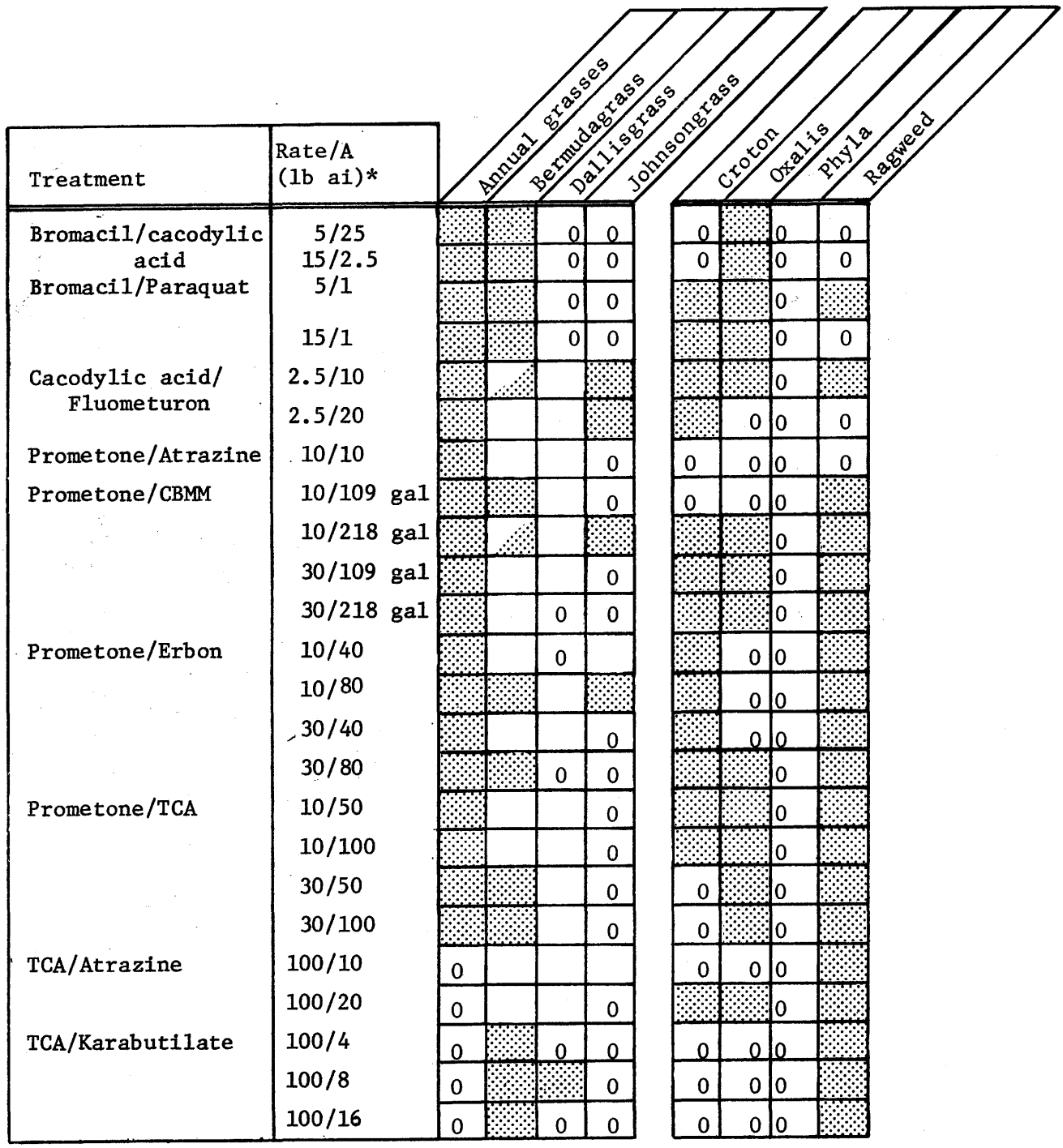


Figure 9. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1967, Smith County.

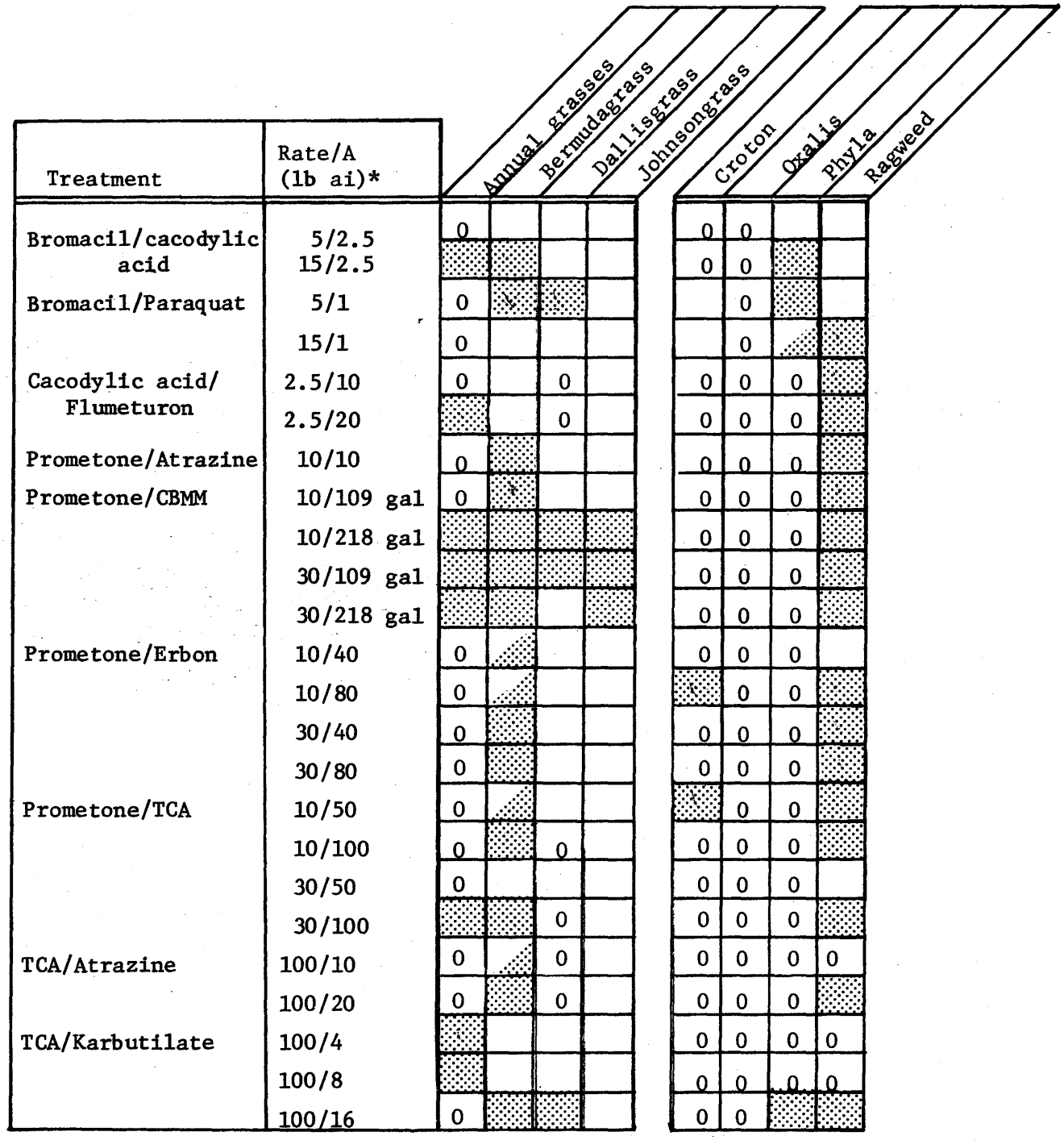


Figure 10. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1967, Wharton County.

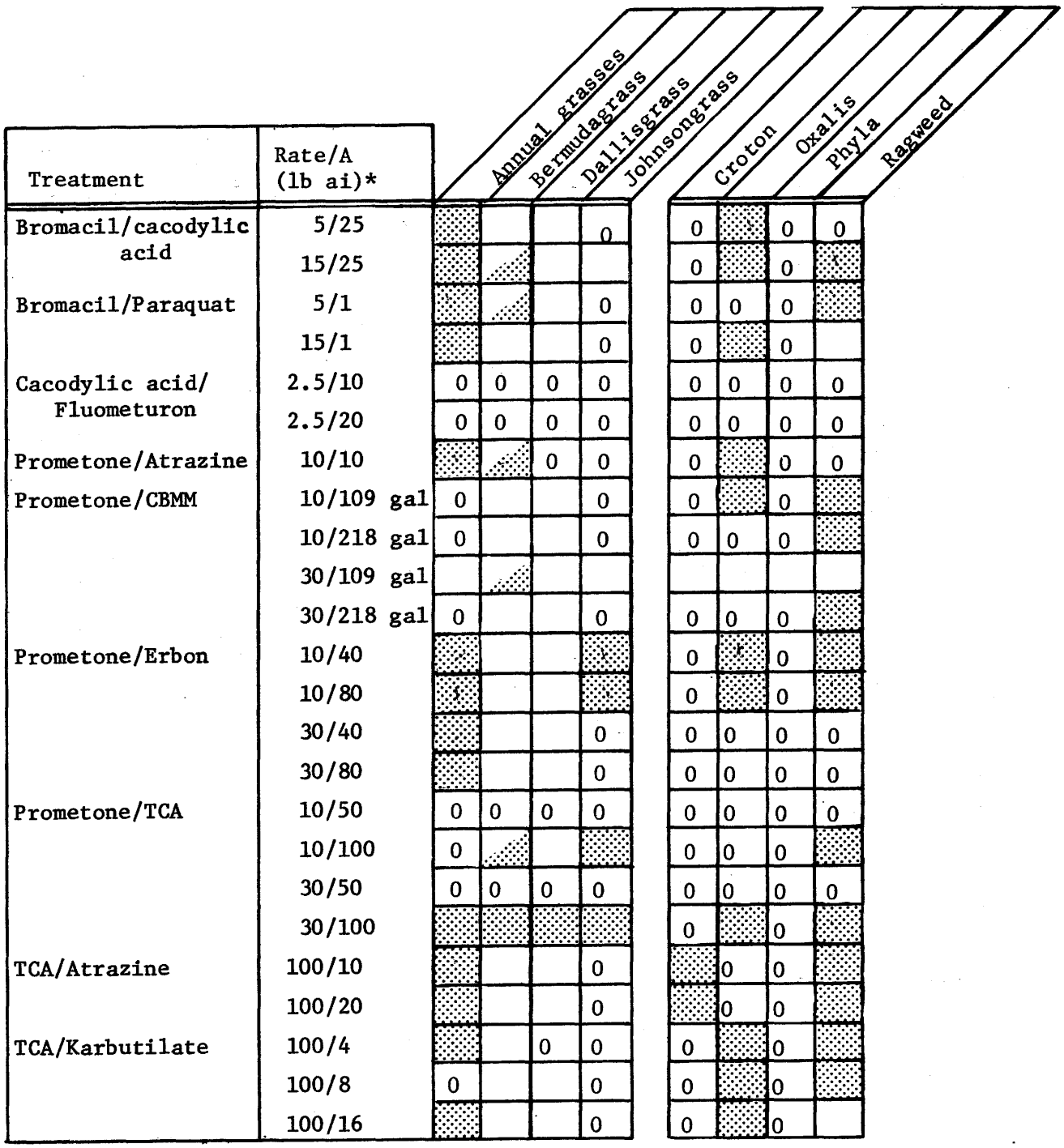


Figure 11. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1968, Jasper County.

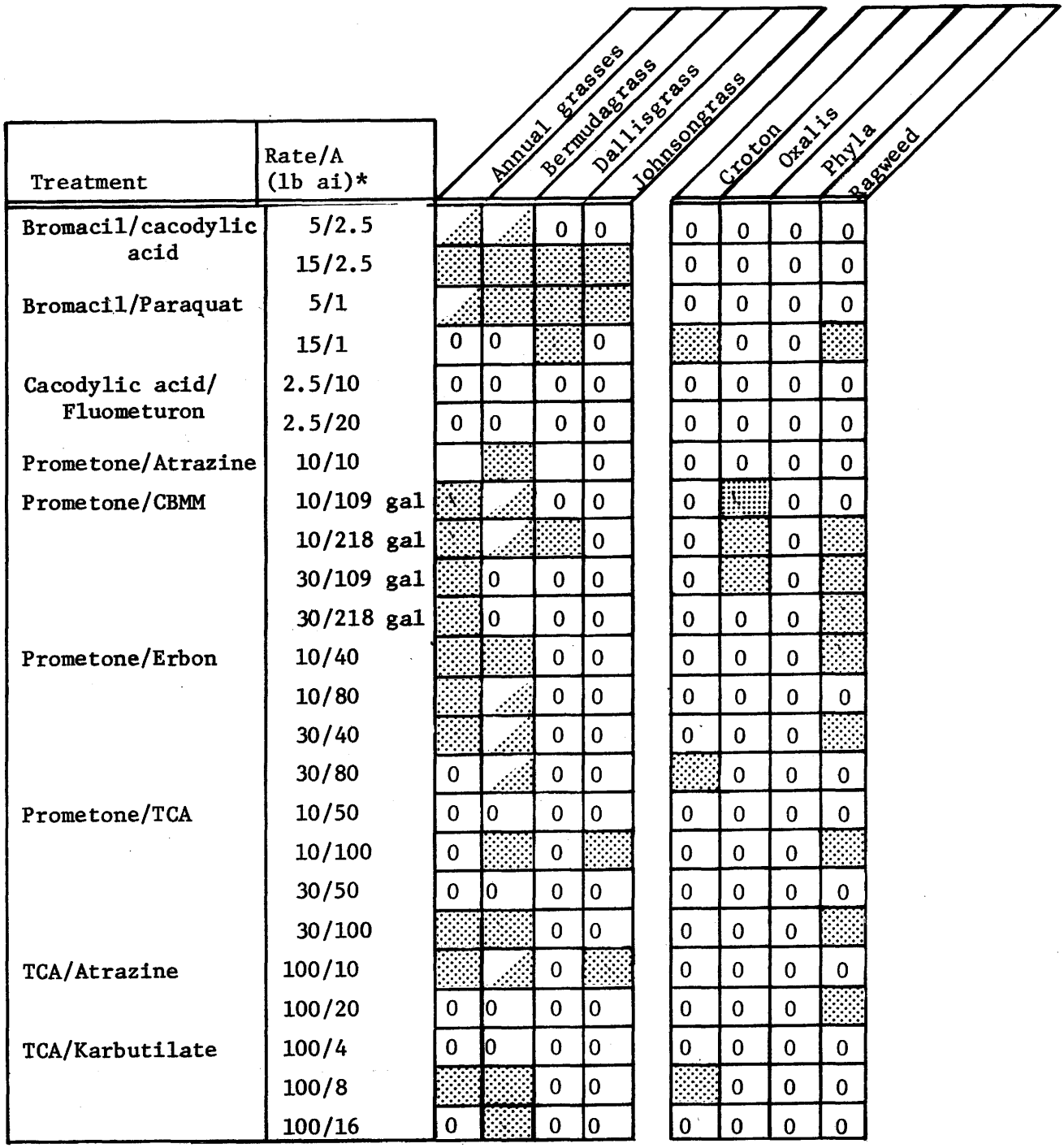


Figure 12. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1968, Tarrant County.

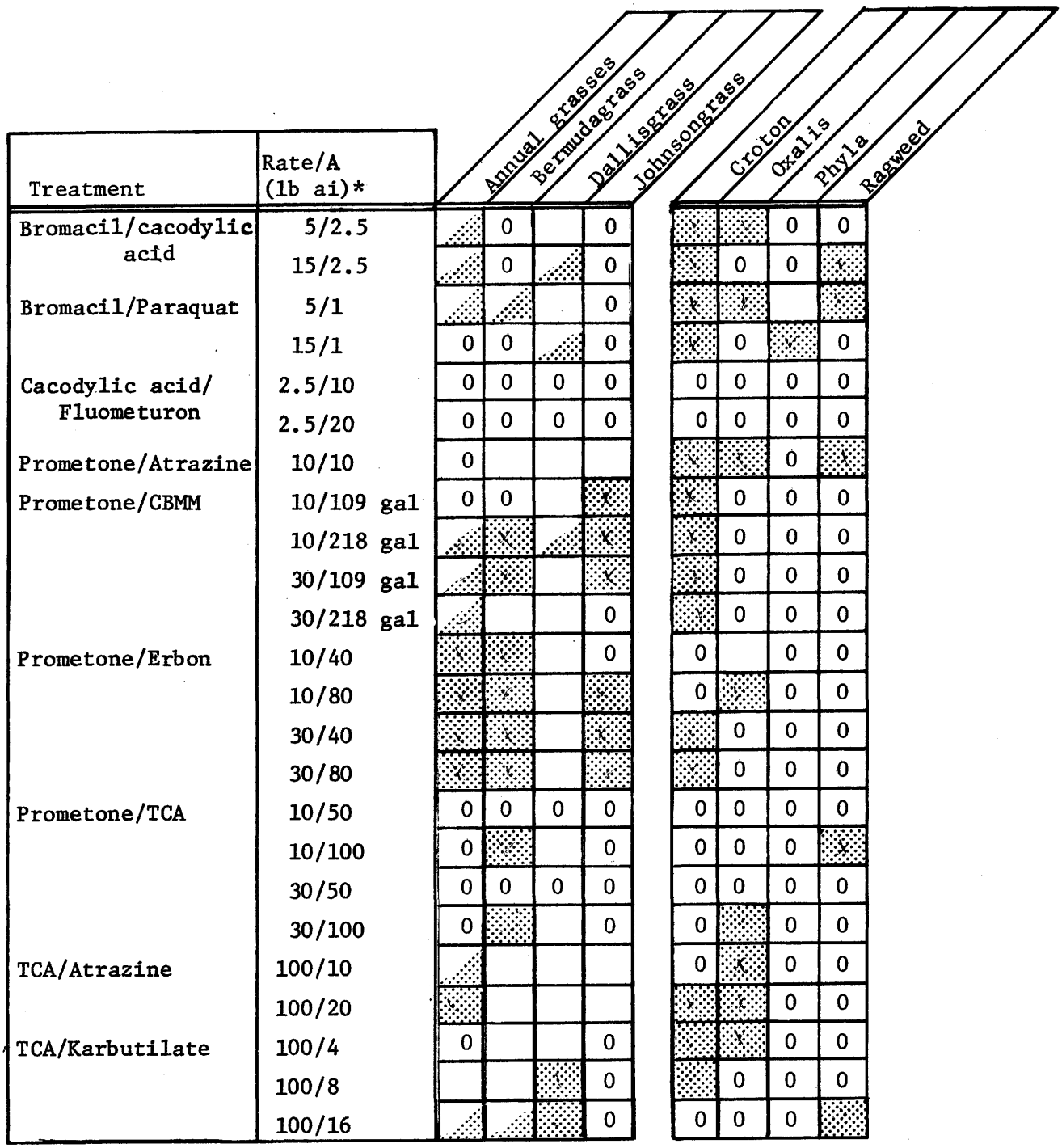


Figure 13. Response of selected plants after 100 days to treatment with herbicide mixtures in June 1968, Walker County.