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Control of Woody and Herbaceous Vegetation with Soil Sterilants[1]

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Abstract. Spring and fall applications of 10 soil sterilant herbicides were investigated for control of brush and herbaceous vegetation at five locations in Texas. A majority of the herbicides controlled most brush species. However, 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil), 2-methoxy-4,6-bis(isopropylamino)-*s*-triazine (prometone), and 4-amino-3,5,6-trichloropicolinic acid (picloram) were most effective at all locations. A mixture of disodium tetraborates, 3-(*p*-chlorophenyl)-1,1-dimethylurea (monuron) and trichlorobenzoic acid was very effective for at least 20 months at four of the five locations. Most herbicides controlled herbaceous vegetation for 1 year or less. Bromacil controlled herbaceous vegetation for approximately 2 years at most locations.

Introduction

The use of soil sterilants for temporary or permanent vegetation control on agricultural, industrial, and public lands is well documented, and much research has been reported (2, 3, 6, 8). In recent years, research has continued in developing effective herbicides for nonselective control of vegetation on industrial sites, military installations, firebreaks, and utility, railroad, and highway rights-of ways[3] (2, 4, 7). Many new herbicides and new combinations of herbicides have been studied in an attempt to reduce costs, increase effectiveness on a broad spectrum of species, and increase residual properties (1, 2, 3, 4, 5).

We studied the effectiveness and residual properties of several soil sterilant herbicides on a variety of woody plants and associated vegetation at five locations in Texas.

Materials and Methods

Field sites. Field plots were established near Victoria, Refugio, Llano, Carlos, and Livingston, Texas. This provided an appreciable range in climate and edaphic conditions as well as great differences in the vegetation.

At Victoria, on the Gulf Coast Prairie, a thick stand of live oak (*Quercus virginiana* Mill.) 3 to 6 ft tall was used. Herbaceous vegetation included little bluestem (*Andropogon scoparius* Michx.), brownseed paspalum (*Paspalum plicatulum* Michx.), Indiangrass (*Sorghastrum nutans* (L.) Nash), threeawn (*Aristida* spp.), lovegrass (*Eragrostis* spp.), knotroot bristlegrass (*Setaria grisebachii* Fourn.), bitter sneezeweed (*Helenium amarum* (Rafin.) H. Rock), and Lindheimer croton (*Croton lindheimeri* (Engelm. & Gray) Wood). The soil was a Katy gravelly sandy loam with a varying quantity of gravel in the lower profile. The average profile consisted of a light brownish-gray, gravelly, sandy loam surface layer about 20 in thick having a pH of 5.5 and a gravel content of 10 to 30%. The subsoil or B horizon was gray sandy clay with yellowish brown and red mottles and centered around small iron concretions. It had a moderate to coarse blocky structure and a pH of 5.0 to 6.0. The amount of sand increased with depth, and a few calcium carbonate concretions occurred at depths of 54 to 60 in in many places. The plots were located on a slight northwest slope. Mean annual precipitation is 35.7 in with a mean yearly temperature of 70.9 F.

At the Refugio site, huisache (*Acacia farnesiana* (L.) Willd.) and honey mesquite (*Prosopis juliflora* Swartz D.C., var. *glandulosa* (Torr.) Cockerell) were the major woody plant species. Brush approximately 2 to 8 ft tall was treated. Primary grasses and forbs included Rhodesgrass (*Chloris gayana* Kunth), curlymesquite (*Hilaria belangeri* (Steud.) Nash), threeawn, bristlegrass (*Setaria* spp.), little bluestem, windmillgrass (*Chloris* spp.), sandbur (*Cenchrus* spp.), (*Paspalum* spp.), (*Eragrostis* spp.), bitter sneezeweed, croton, (*Thelesperma* spp.), broomweed (*Gutierrezia* spp.), toadflax (*Linaria* spp.), and sedge (*Carex* spp.).

The soil at the Refugio site was a Miquel fine sandy loam, shallow phase. The average thickness of the surface of the crusty fine sandy loam is 6 in; the subsoil is dense and very slowly permeated. The treatments were located on level land. Mean annual precipitation is 33.8 in with a mean annual temperature of 71.8 F.

The experimental site near Llano, Texas was located on the Edwards Plateau. The primary brush species were whitebrush (*Aloysia lycioides* Cham.) with scattered plants of mesquite, Texas persimmon (*Diospyros texana* Scheele), pricklypear (*Opuntia* spp.), and tasajillo (*Opuntia leptocaulis* DC.). Among the major grasses in the area were sideoats grama (*Bouteloua curtipendula* Michx. Torr.), curlymesquite, vine-mesquite (*Panicum obtusum* H.B.K.), and buffalograss (*Buchloe dactyloides* (Nutt.) Engelm). Several annual grasses and broadleaf species also were present.

These granite soils contained from 30 to 50% gravel. The surface soil was deep with 18 to 24 in of a light brown gravelly, loamy sand. The subsoil was a red or yellow and gray clay. The surface soil absorbed water well, but the heavy subsoil took it slowly. Annual rainfall averages 28.6 in and the mean annual temperature is 66.8 F.

The predominant brush species at the Carlos site were yaupon (*Ilex vomitoria* Ait.) 2 to 6 ft tall, post oak (*Quercus stellata* Wangenh.), and blackjack oak (*Quercus marilandica* (Muenchh.) 2 to 15 ft tall. Predominant herbaceous species were little bluestem, bristlegrass, (*Paspalum* spp.) and bitter sneezeweed. The soil at the Carlos site was an Axtell fine sandy loam, shallow variant. The A horizon was a gray fine sandy loam to a depth of 5 to 10 in. The dark, heavy clay of the B horizon caused a

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[3]McCully, W. C. and W. J. Bowmer. 1966. Controlling vegetation in asphalt pavements. Texas A&M Univ., Texas Trans. Inst. Summary Rept. 13-3 (S).

perched water table in rainy seasons, but the C horizon gave excessive subdrainage. Consequently, the soil had characteristics of both a wet and dry soil. The mean annual temperature is 68.3 F with a mean annual rainfall of 38.9 in.

At Livingston, Texas, the main brush species were sumac *(Rhus* spp.), sassafras *(Sassafras albidum* (Nutt.) Nees), American beech *(Fagus grandifolia* Ehrh.), Allegheny chinkapin *(Castanea pumila* Mill.), saw greenbriar *(Smilax bonanox* L.), and sweetbay magnolia *(Magnolia virginiana* L.). The woody species were growing on cutover timber land and were 3 to 8 ft tall at time of treatment. The Segno fine sand soil due to its great depth allows rapid drainage downward. The soil contains little organic matter, and plant nutrients are readily leached out. Mean annual temperature at the Livingston site is 67.0 F with an annual rainfall of 48.4 in.

Herbicides. Soil sterilants evaluated in this experiment include 3-phenyl-1,1-dimethylurea (fenuron), 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil), 3-phenyl-1,1-dimethylurea trichloroacetate (fenuronTCA), 3-(*p*-chlorophenyl)-1,1-dimethylurea-TCA (monuronTCA), disodium tetraborates-monuron-trichlorobenzoic acid (hereinafter referred to as BBM-TBA)[4] sodium chlorate, sodium arsenite, 4-amino-3,5,6-trichloropicolinic acid (picloram), 2-methoxy-4,6-bis(isopropylamino)-*s*-triazine (prometone), and 2-(2,4,5-trichlorophenoxy)ethyl-2,2-dichloropropionate (erbon).

Method of application and evaluation. Fenuron, fenuron-TCA, monuronTCA, BMM-TBA, and picloram were applied as granules. Sodium chlorate and sodium arsenite were mixed with sand and broadcast. Bromacil, prometone, and erbon were applied to the foliage in water with a hand-boom sprayer. All herbicides were applied on duplicated, square rod plots at each location.

Spring treatments were applied in June, 1964, and fall treatments in October, 1964. Plots were evaluated approximately 1/2, 1, and 2 years after treatment. Brush control evaluations were based on percent defoliation. We estimated percentage ground cover in each plot to measure effects of herbicides on herbaceous vegetation.

[4]Disodium tetraborates-93.5%; monuron-3.0%; 2,3,6-TBA and other trichlorobenzoic acid isomers 1.0%.

Results and Discussion

One to 2 weeks after treatment, sodium arsenite, prometone, bromacil, and erbon had killed most woody and herbaceous leaf tissue. All other treatments were ineffective at this early stage.

The data in Tables 1 and 2 show the number of months each herbicide was effective. The criterion for effectiveness was at least 90% control of all species. Most materials were effective on brush at the Victoria, Refugio, Llano, and Carlos sites from both spring and fall applications (Table 1). Final evaluations were made 24 months after the spring applications and 20 months after the fall treatments at Victoria, Refugio, and Llano. Effective control of brush at these locations probably will continue for much longer periods of time with some herbicides. Data at Carlos were taken 2, 6, and 27 months after the spring treatments and 21 months after the fall applications.

Bromacil and prometone were the only herbicides effective at the termination of the experiment at the Livingston site. Apparently, the high rainfall and sandy soils were responsible for the rapid loss of the herbicides, since 14 of the 20 treatments gave better than 90% control of brush 5 months after the spring treatment.

The majority of the herbicides controlled herbaceous species for no more than 1 year (Table 2). Bromacil, sodium arsenite, and prometone often remained effective for longer periods.

Table 1. Number of months after application that 10 herbicidal treatments were effective in maintaining 90 to 100% control of brush at five locations in Texas.

Treatment		Victoria		Refugio		Llano		Carlos		Livingston	
Herbicide	Rate lb/A	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Fenuron	40	24	20	24	20	3	0	27	21	5	—
Fenuron	160	24	20	24	20	24	20	27	21	5	—
Bromacil	40	24	20	24	20	24	20	27	—	5	—
Bromacil	160	24	20	24	20	24	20	27	21	26	21
FenuronTCA	40	24	20	24	20	0	0	27	21	5	—
FenuronTCA	160	24	20	24	20	12	8	27	—	5	—
MonuronTCA	35	24	20	24	20	0	0	0	21	0	—
MonuronTCA	141	24	20	24	20	24	20	0	21	5	—
BMM-TBA	392	24	20	24	20	24	20	27	21	0	—
BMM-TBA	980	24	20	24	20	24	20	27	21	5	—
Sodium chlorate	396	0	0	24	0	24	20	0	—	—	—
Sodium chlorate	990	0	20	0	0	24	20	0	—	—	—
Sodium arsenite	371	24	20	0	20	12	8	6	—	0	—
Sodium arsenite	940	24	20	0	20	12	1	27	21	0	—
Picloram	10	24	12	24	0	24	20	27	21	5	—
Picloram	80	24	20	24	20	24	20	27	21	5	—
Prometone	40	16	20	24	20	24	20	27	21	26	21
Prometone	160	24	20	24	20	24	20	27	—	26	21
Erbon	80	24	20	24	0	24	8	0	—	5	—
Erbon	160	24	20	24	0	12	8	6	21	5	—
Number of effective treatments at termination of experiment		17	18	17	15	13	12	13	13	3	3

Table 2. Number of months after treatment that 10 herbicidal treatments were effective in maintaining the soil 90 to 100% free of herbaceous vegetation at four locations in Texas.

Treatment	Rate (lb/A)	Victoria		Refugio		Llano		Carlos	
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Fenuron	40	4	7	4	7	3	0	6	—
Fenuron	160	4	12	4	12	3	8	6	—
Bromacil	40	16	12	24	20	12	20	6	—
Bromacil	160	24	20	24	20	12	20	27	21
FenuronTCA	40	0	0	12	0	3	8	6	—
FenuronTCA	160	4	12	12	7	12	8	6	—
MonuronTCA	35	4	12	4	0	0	8	—	—
MonuronTCA	141	12	12	12	12	12	8	0	—
BMM-TBA	392	0	12	12	7	3	8	0	—
BMM-TBA	980	4	12	16	12	12	8	6	—
Sodium chlorate	396	4	0	16	0	0	0	0	—
Sodium chlorate	990	0	7	4	0	12	0	0	—
Sodium arsenite	376	16	12	12	0	12	0	6	—
Sodium arsenite	940	16	20	24	7	12	0	27	—
Picloram	10	0	0	12	0	0	0	6	—
Picloram	80	12	12	24	7	12	8	6	—
Prometone	40	16	12	12	0	3	8	0	—
Prometone	160	24	12	4	7	24	8	0	—
Erbon	80	4	20	4	0	3	1	0	—
Erbon	160	0	7	16	7	3	1	6	—
Number of effective treatments at termination of experiments		2	3	4	2	1	2	2	1

Fenuron. Fenuron at 40 lb/A controlled brush effectively at Victoria, Refugio, and Carlos, and at all sites except Livingston when applied at 160 lb/A. Fall applications of fenuron at 40 lb/A were ineffective at Llano. Control of herbaceous vegetation at 40 or 160 lb/A was 1 year or less when applied in the spring or fall.

FenuronTCA. FenuronTCA was not effective on brush at 40 lb/A at Llano. There was no advantage of 40 or 160 lb/A of fenuronTCA over comparable rates of fenuron in either spring or fall treatments for vegetation control.

MonuronTCA. MonuronTCA gave results similar to fenuronTCA except that applications in the spring at Carlos and Livingston were not effective.

Bromacil. Bromacil was one of the most effective and most persistent soil sterilants studied. At 160 lb/A, bromacil controlled brush and most herbaceous species at all locations in both spring and fall applications for the duration of the experiment. Curlymesquite and vinemesquite were the first grass species to reenter treated areas. Lateral movement of bromacil onto adjacent areas occurred after heavy rainfall, particularly at the Victoria, Carlos, and Llano sites. Bromacil was ineffective on cacti (*Opuntia* spp.).

BMM-TBA. BMM-TBA controlled brush for the duration of the experiment, except at the Livingston site. Herbaceous vegetation usually was controlled for 1 year or less.

Sodium chlorate. Brush species were effectively controlled in spring and fall treatments at Llano, fall treatments at Victoria, and spring applications at Refugio. Control of brush at other locations and dates was unsatisfactory. Sodium chlorate usually was ineffective in controlling herbaceous vegetation.

Sodium arsenite. Sodium arsenite was effective on live oak and associated vegetation at Victoria. It did not control brush at Llano or Livingston. In some instances, sodium arsenite controlled herbaceous vegetation as well as bromacil, but it was not consistent.

Picloram. Picloram at 80 lb/A consistently controlled brush. At Livingston, brush was controlled for at least 5 months and probably longer; no data were taken, however, until 26 months after the spring treatment. Control of herbaceous vegetation at 80 lb/A was not outstanding at any location. A fall application of 10 lb/A did not control mesquite at Refugio. Excellent stands of little bluestem at Victoria followed spring applications of picloram at 10 lb/A. At most sites, native grass stands were found after application of picloram at 10 lb/A.

Prometone. Prometone, like bromacil, controlled brush at all five sites. At the Livingston site, control was excellent with prometone at 40 lb/A applied both in spring and fall. Except in some isolated cases, prometone was not as effective as bromacil in controlling herbaceous vegetation. Common yellow woodsorrel (*Oxalis stricta* L.) was one of the first species to grow on prometone plots after treatment.

Erbon. The most effective brush control with erbon occurred at Victoria. Both in spring and fall, it gave acceptable control during the experiment. Applications of erbon in fall were not effective at Refugio. Treatments at Llano were less effective in fall than in spring. Erbon seldom controlled herbaceous vegetation for long periods.

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