INFLUENCE OF TEBUTHIURON FORMULATION ON CONTROL OF WOODY PLANTS AND FORAGE PRODUCTION[1,2]

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Abstract: Tebuthiuron (N-(5-(1,1-dimethylethyl)-1,3,4-thiadiazol)-N,N'-dimethylurea), formulated as cylindrical pellets 3.2 or 4.8 mm in diameter and containing from 10 to 60% active ingredient was applied at rates ranging from 0.6 to 4.5 kg ai/ha to determine the effects of formulation on control of woody plants and forage production. Tebuthiuron killed an increasing percentage of velvet mesquite (Prosopis juliflora var. velutina (Woot.) Sarg.) plants as the rate of application increased from 0.6 to 4.5 kg ai/ha. Rates of 2.2 kg ai/ha and above killed 46% or more of the velvet mesquite plants. Tebuthiuron killed an increasing percentage of catclaw acacia (Acacia greggii A. Grey) plants as the rates of application increased from 0.6 to 2.2 kg ai/ha with rates of 2.2 and 4.5 kg ai/ha killing all plants. Tebuthiuron killed over 90% of the wait-a-minutebush (Mimosa biuncifera Benth.) plants at all rates of application. Concentration and size of pellet generally did not significantly affect the percentage of woody plants killed but the formulation containing 10% ai was consistently less effective at the same rates than formulations containing higher concentrations. Forage production the first year after treatment was generally reduced on plots treated with pellets containing 10 or 20% ai when applied at rates of 2.2 kg ai/ha. However, by the third year after treatment forage production was usually higher on plots treated at rates of 2.2 kg ai/ha than on plots treated at lower rates. Forage production increased with time after treatment on plots treated with tebuthiuron and usually peaked between three and five years after treatment.

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[1]ARS/USDA, Tucson, AZ.

[2]Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agric. and does not imply its approval to the exclusion of other products that may also be suitable.

Introduction

Tebuthiuron is a thiadiazole urea herbicide which has been shown to be effective for control of many herbaceous and woody plants in pastures and rangelands (1, 4, 5, 7, 8, 9, 10, 11). The formulated products used for weed and brush control on rangelands are cylindrical clay pellets 3.2 mm in diameter and approximately 4.8 mm in length. The pellets are formulated with tebuthiuron concentrations of 10, 20, or 40% active ingredient (ai). All the commercial formulations have a bulk density of about 1 kg/cubic decimeter (60 lb/ft^3) (6). There are about 17,500 particles per kg. When the 10, 20, and 40% pellets are broadcast, there are about 17.6, 8.8 and 4.4 pellets/m^2/kg ai applied. While pelleted formulations reduce drift of aerially applied herbicides, they also increase selectivity. As the number of particles applied per unit area decreases, there is less likelihood that a pellet will be deposited upon a non-target plant. This study was conducted to determine the effects of concentration and size of tebuthiuron pellets on the control of woody plants, injury to herbaceous plants, and forage production.

Materials and Methods

The first study site was in the Alambre Valley of the Papago Indian Reservation, Pima County, AZ. The elevation is 1060 m and average annual precipitation is 325 mm. The soils are a moderately deep to deep gravelly sandy loam and are Typic Torrifluvents, coarse-loamy, mixed thermic. The site is classified as a semi-desert grassland (2) but has experienced a dramatic increase in density of wait-a-minutebush, velvet mesquite, and catclaw acacia which are now the dominant plants. The herbaceous vegetation was a thin stand of perennial grasses composed primarily of blackgrama (Bouteloua eriopoda Torr.), Arizona cottontop (Digitaria californica (Benth.) Henr.), and Rothrock grama (B. rothrockii Vassey). Annual grasses present were sixweeks threeawn (Aristida adscensionis L.) and feather finger grass (Chloris virgata Swartz). Tebuthiuron pellets 3.2 mm in diameter containing 10, 20 and 40% ai were each applied by hand at rates of 0.6, 1.1, 2.2, and 4.5 ai kg/ha to plots 15 by 30 m on February 22, 1974. Grazing was excluded from the treated plots after the second year.

The second study site was on the Santa Rita Experimental Range, Pima County, AZ. The elevation is 1200 m and average annual precipitation is 350 mm. The soils are a Whitehouse, gravelly fine sandy loam, (Ustollic Haplargids, fine, mixed, thermic). The dominant woody plant was velvet mesquite. The half-shrub, false mesquite (Calliandra eriophylla Benth.) was also uniformly present on the plots. The most abundant herbaceous plants were Lehmann lovegrass (Eragrostis lehmanniana Nees), Arizona cottontop, plains bristlegrass (Setaria macrostachya H.B.K.), slender grama (B. filiformis (Fourn.) Griffiths), sideoats grams (B. curtipendula (Michx.) Torr.), Rothrock grama, and poverty threeawn (A. divericata Hum. & Bonpl.). Tebuthiuron was applied in pellets which were 3.2 mm in diameter and contained 20% ai, and in pellets which were 4.8 mm in diameter and contained 20, 40, or 60% ai. Each formulation was applied at rates of 1.1,

and 2.2 kg ai/ha to plots 15 by 60 m on August 27, 1976. This study site was grazed as prescribed by the 3-pasture 1-herd, Santa Rita Grazing System, which scheduled grazing during the summer growing season 1 year out of 3. At both study sites woody plant mortalities were estimated about 3 years after treatment by counting dead and living plants of each species and calculating percentage of plants killed. Forage production was estimated using the weight-estimate method 2 and 3 years after treatment at the Alambre site and 1, 3 and 5 years after treatment on the Santa Rita Experimental Range site. The experimental design was a randomized complete block with three replications. Data were subjected to analyses of variance and when appropriate, means were evaluated for significant differences by Duncan's multiple range test.

Results and Discussion

Alambre Study Site. The percentage of velvet mesquite plants killed increased with increasing rates of tebuthiuron application (Table 1). There were statistically non-significant, but consistently greater percentages of velvet mesquite plants killed by the 20% formulation than by the 10 or 40%.

Table 1. Percentage of velvet mesquite plants killed 42 months after treatment with three formulations of pelleted tebuthiuron applied at four rates[a]

Formulation		Rate of application kg a.i./ha				
conc.	dia.	0.0	0.6	1.1	2.2	4.5
(%)	(mm)	----------(%)----------				
10	3.2	-	12c	50ab	60ab	98a
20	3.2	-	65ab	78ab	88ab	100a
40	3.2	-	42b	68ab	95ab	98a
0	-	6c				

[a]Means ~~in the same growing season~~ followed by the same letter are not significantly different at the 5% level of probability.

Tebuthiuron did not consistently kill catclaw acacia plants at the 0.6 and 1.1 kg ai/ha rates (Table 2) but killed all plants at the 2.2 and 4.5 kg ai/ha rates.

All formulations of tebuthiuron killed more than 90% of the wait-a-minutebush plants at all rates (Table 3).

Table 2. Percentage of catclaw plant killed 42 months after treatment with three formulations of pelleted tebuthiuron applied at four rates[a]

Formulation		Rate of application kg a.i./ha				
conc.	dia.	0.0	0.6	1.1	2.2	4.5
(%)	(mm)	----------(%)----------				
10	3.2	-	20cd	85ab	100a	100a
20	3.2	-	60abc	40bcd	100a	100a
40	3.2	-	75ab	75ab	100a	100a
0	-	16d				

[a]Means ~~in the same growing season~~ followed by the same letter are not significantly different at the 5% level of probability.

Forage production generally increased with increasing rates of tebuthiuron (Table 4). However, forage production was variable in both the third and fourth growing seasons after treatment. Highest forage production was usually found on plots treated at the 1.1 kg ai/ha rates in the third growing season but more frequently were found on the plots treated at 2.2 and 4.5 kg ai/ha in the fourth growing season after treatment. This suggests that with time the forage plants were increasing in density and vigor on the plots treated at the higher rates. Forage production was about two to three times higher in the fourth year after treatment than in the third. Total precipitation in the thirfd and fourth years of the study were 434 and 307 mm, respectively. The higher forage production in the fourth year was probably due to increasing density of forage plants; and as Cable (3) pointed out, forage production is influenced by both current year and previous year precipitation.

Table 3. Percentage of wait-a-minutebush plants killed 42 months after treatment with three formulations of pelleted tebuthiuron applied at four rates[a]

Formulation		Rate of application kg a.i./ha				
conc.	dia.	0.0	0.6	1.1	2.2	4.5
(%)	(mm)	----------(%)----------				
10	3.2	-	98a	100a	95a	98a
20	3.2	-	92a	98a	100a	100a
40	3.2	-	100a	100a	100a	100a
0	-	14b				

[a]Means ~~in the same growing season~~ followed by the same letter are not significantly different at the 5% level of probability.

Correlation coefficients were calculated between percentage woody plants killed and forage production. They showed that production increased with increasing percentages of mesquite and catclaw acacia killed (Table 5). The relationship was not true for wait-a-minutebush because this plant proved to be very sensitive to tebuthiuron and even the lowest rate was very effective. Multiple correlation calculations were made involving forage production and the three shrub species but no significant correlations were found.

Santa Rita Study Site. Tebuthiuron killed more velvet mesquite plants at the 2.2 than at the 1.1 kg ai/ha (Table 6). The 20%, 3.2 mm tebuthiuron formulation killed more velvet mesquite plants than the other formulations.

Forage production during the year of treatment was lowest on the plots treated at the 2.2 kg ai/ha rate with 20%, 3.2 mm formulation and highest on the plots treated at 1.1 kg/ha rate with the 20% 4.8 mm pellets. As pellet size and concentration of tebuthiuron increased, forage production increased, suggesting that the lower number of pellets applied to each plot caused less injury to forage plants. This trend was also evident in the

Table 4. Forage production during the third and fourth growing seasons after treatment with three formulations of tebuthiuron at four rates[a]

Formulation		Rate of application kg a.i./ha				
conc. (%)	dia. (mm)	0.0	0.6	1.1	2.2	4.5
		(Dry wt kg/ha)				
		Third Growing Season				
10	3.2	-	385bc	307c	376c	604abc
20	3.2	-	274c	865ab	590abc	398abc
40	3.2	-	142c	1056a	368c	424bc
-	-	278c				
		Fourth Growing Season				
10	3.2	-	627cd	1062bcd	1044bcd	1319abc
20	3.2	-	711cd	1004bcd	1720ab	1889a
40	3.2	-	431d	1444abc	981bcd	873cd
-	-	530d				

[a]Means in the same growing season followed by the same letter are not significantly different at the 5% level of probability.

Table 5. Correlation coefficients (r) and linear regression equations for the mortalities of three brush species versus forage production.

Relationship	r	Regression equation
% killed mesquite (X) vs. forage production (Y)	0.63*	Y = 454.8 + 8.0 X
% killed catclaw (X) vs. forage production (Y)	0.55*	Y = 455.3 + 7.0 X

Table 6. Percentage of velvet mesquite plants killed 38 months after treatment with four pelleted formulations of tebuthiuron applied at two rates[a]

Formulation		Rate kg a.i./ha		
Conc. (%)	dia. (mm)	0.0	1.1	2.2
			(%)	
20	3.2		17c	66a
20	9.5		12c	47b
40	9.5		11c	59ba
60	9.5		7c	46b
-check-		0c		

[a]Means followed by the same letter are not significantly different at the 5% level of probability.

Table 7. Forage production during year of treatment with ~~three~~ four pelleted formulations of tebuthiuron at two rates[a]

Formulation		Rate of application (Kg/ha)		
Conc. (%)	dia. (mm)	0.0	1.1	2.2
			(Kg/ha)	
20	3.2	-	707abc	336c
20	4.8	-	1111a	763abc
40	4.8	-	725abc	958ab
60	4.8	-	585bc	935ab
0	-	694abc		

[a]Means followed by the same letter are not significantly different at the 5% level of probability.

third year after treatment (Table 8), but the differences in forage production were not evident during the fifth year after treatment (Table 9). This was due to the reestablishment of forage plants on the plots treated at the 2.2 kg ai/ha rate and the dominance of the area by Lehmann lovegrass.

From this study, I conclude that the effectiveness of tebuthiuron for brush control is not consistently affected by pellet size or tebuthiuron concentration, but these factors do influence injury to forage plants and can influence forage production for up to 3 years after treatment.

Table 8. Forage production three years after treatment with four pelleted formulations of tebuthiuron at two rates[a]

Formulation		Rate (Kg/ha)		
Conc. (%)	dia. (mm)	0.0	1.1	2.2
		----------(Kg/ha)----------		
20	3.2	-	1364a	846b
20	4.8	-	1260ab	1098ab
40	4.8	-	890b	1170ab
60	4.8	-	1110ab	1500a
0	-	1245a		

[a]Means followed by the same letter are not significantly different at the 5% level of probability.

Table 9. Forage production five years after treatment with ~~three~~ four pelleted formulations of tebuthiuron at two rates[a]

Formulation		Rate (Kg/ha)		
Conc. (%)	dia. (mm)	0.0	1.1	2.2
		----------(Kg/ha)----------		
20	3.2	-	1172	920
20	4.8	-	924	1381
40	4.8	-	1214	1291
60	4.8	-	1058	1212
0	-	1048		

[a]Means not significantly different at the 5% level of probability.

Literature Cited

1. Britton, C.M. and F.A. Senva. 1983. Big sagebrush control with tebuthiuron. J. Range Manage. 36:707-708.

2. Brown, D.E. 1982. Biotic communities of the American southwest-United States and Mexico. Desert Plants 4:123-131.

3. Cable, D.R. 1975. Influence of precipitation on perennial grass production in the semidesert southwest. Ecology 56:981-986.

4. Crowder, S.H., A.W. Cole, and V.H. Watson. 1983. Weed control and forage quality in tebuthiuron treated pastures. Weed Sci. 31:585-587.

5. Duncan, K.W. and C.J. Scifres. 1983. Yaupon and associated vegetation response to seasonal tebuthiuron applications. J. Range Manage. 36:568-571.

6. Elanco Products Company. 1983. Grasian technical manual. Eli Lilly and Co. Indianapolis, IN.

7. Jacoby, P.W. and C.H. Meadors. 1982. Control of sant skinnery oak (Quercus harvardii) with pelleted picloram and tebuthiuron. Weed Sci. 30:594-597.

8. Johnson, G.B., D.J. Stoud, and T.L. Gee. 1976. Low rate tebuthiuron combinations for foxtail and kochia control. Proc. North Central Weed Control Conf. 31:122-124.

9. Lynn, L.B., W.E. Rogers and M.L. Jones. 1978. Tebuthiuron for control of multiflora rose. Proc. North Central Weed Control Conf. 32:265-269.

10. Scifres, C.J., J.L. Mutz, and W.T. Hamilton. 1979. Control of mixed brush with tebuthiuron. J. Range Manage. 32:155-158.

11. Sosebee, R.E., C.S. Brumley and W.E. Boyd. 1976. Use of EL-103 to control honey mesquite. IN: Noxious Brush and Weed Control Research Highlights. Texas Tech. Univ. 7;38.