Effects of Tebuthiuron on Western Juniper

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Abstract

A sagebrush-bunchgrass community supporting western juniper was treated with aerial applications of 2 or 4 kg/ha (active ingredient) of tebuthiuron pellets. The treatments did not effectively control western juniper and caused appreciable damage to herbaceous vegetation. Individual tree applications of tebuthiuron at rates of 20 or 40 g a.i./tree killed most of the western juniper less than 2 m tall.

Western juniper (*Juniperus occidentalis* subsp. *occidentalis*) occupies some 717,600 ha of rangeland in eastern Oregon (Forest-Range Task Force 1972). Distribution extends east of the Cascades through eastern Oregon and includes small areas in southern Washington, southwestern Idaho, northwestern Nevada, and northeastern California (Burkhardt and Tisdale 1969).

Little information is available on the ecology or control of western juniper. In southwestern Idaho, Burkhardt and Tisdale (1969) verified the widely accepted opinion that western juniper is invading sagebrush-bunchgrass communities. This invasion process, apparently initiated about 1860 when the juniper expanded its sphere of influence beyond the climax position on rocky ridges and rimrocks onto the deeper soils of valley slopes and bottoms, has been attributed to many factors. The most commonly mentioned include overgrazing, fire control, greater seed dispersal, or an overall climatic shift (Phillips 1910; Leopold 1924; Cottam and Stewart 1940; Parker 1945). Regardless of the causes of the invasion, the need for effective control is widely accepted.

Many control techniques have been applied to junipers with various degrees of success. Most of the commonly used herbicides have been evaluated, with soil-applied formulations giving good results on some southern junipers. (Jameson and Johnsen 1964; Scifres 1972). Prescribed burning has also been effective in some areas (Wink and Wright 1973) although closed stands of western juniper usually do not support adequate fine fuel to carry an effective fire. Tebuthiuron[1] (1-5(5-tert-butyl-1,3,4-thiadizol-2-yl)-1, 3-dimethylurea) effectively controls many undesirable species. Meyer et al. (1978) stated that tebuthiuron was more effective than other soil-applied herbicides in controlling oaks (*Quercus* sp.), winged elm *(Ulmus alata),* and white ash *(Fraxinus americana).* Scifres et al. (1979) controlled whitebrush *(Aloysia lycioides)* spring hackberry *(Celtis pallida)* and Berlandier wolfberry *(Lycium berlandieri)* with aerial applications of 2.24 kg/ha of tebuthiuron. In south Texas, aerial application of tebuthiuron at 2.24 kg/ha significantly increased grass yields (Scifres and Mutz 1978). Where 1 kg/ha or more of the herbicide was applied, forb production and diversity decreased but recovered after 3 years.

The objectives of this study were to evaluate the effects on western juniper of aerial and individual-tree applications of tebuthiuron.

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[1]This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

Materials and Methods

The study area was located on the Squaw Butte Experiment Station, about 65 km west of Burns, Oregon, at an elevation of 1,370 m. This high desert range receives an average of about 30 cm of precipitation annually. Approximately 60% of this precipitation occurs during fall and winter, generally as snow, with 25% as rain during May and June. Soil on the study area is a loam that varies in thickness from 25 to 40 cm above a fractured rock layer.

Tree-layer vegetation consists of western juniper with an average density of about 120 trees/ha. Shrub vegetation is primarily low sagebrush *(Artemisia arbuscula)* with lesser amounts of green rabbitbrush *(Chrysothamnus viscidiflorus)* and occasional clumps of big sagebrush *(Artemisia tridentata).* Grass vegetation is dominated by Sandberg bluegrass *(Poa sandbergii),* Idaho fescue *(Festuca idahoensis),* bottlebrush squirreltail *(Sitanion hystrix),* bluebunch wheatgrass *(Agropyron spicatum),* and Thurber needlegrass *(Stipa thurberiana).* A wide variety of forbs are present on the study area but make up less than 10% of the herbaceous production.

Plots were established in uniform stands of western juniper. Tebuthiuron (20% a.i. pellets) was aerially applied at 2 and 4 kg/ha to duplicate square, 2-ha plots during late October 1975. Mortality was determined annually from 50 marked trees in each plot. Untreated plots were established adjacent to the treated plots.

Tebuthiuron was applied to 160 individual trees, adjacent to the aerially treated plots, at rate of 0, 10, 20, and 40 g a.i./tree in early April 1976. Trees were separated into two size classes, large (greater than 2 m tall) and small (less than 2 m tall). Ten trees receiving each treatment were considered a replicate, and the treatments were duplicated. Of the 10 trees receiving each herbicide rate, five were treated with pellets and five with bolus preparations. The herbicide was applied around the crown dripline of the trees.

Mortality data represents actual counts of marked trees. On the aerially treated plots, the effect of tebuthiuron on herbaceous production was evaluated in June by clipping 10, 1 m^2 circular quadrats per plot. Frequency of all species was recorded as described by Hyder et al. (1963). In each plot, two sampling lines were randomly located. At 10 random distances along the lines and at random distances perpendicular to the lines, 10 contiguous 900-cm^2 quadrats were evaluated. In each plot, 200 quadrats were sampled in June 1976 and June 1978. Mortality and frequency data were evaluated by chi-square analyses.

Results and Discussion

Aerial applications of tebuthiuron at either rate did not effectively control western juniper (Table 1). Although crowns of most trees were scorched, only 22% were killed by the 4 kg/ha rate.

Tebuthiuron did cause appreciable damage to the understory vegetation (Fig. 1). In 1976, one growing season after herbicide application, the plots treated with 2 or 4 kg/ha produced 62 and 42%, respectively, of the herbaceous vegetation yielded on untreated plots (Fig. 2). Two years after tebuthiuron was applied, the herbicide effects were more apparent than during the first growing season. Plots treated with 2 kg/ha of the herbicide produced about 5% and those receiving 4 kg/ha yielded slightly more than 1% of that yielded on untreated areas.

Table 1. Mortality of western juniper in eastern Oregon 3 years after aerial application of tebuthiuron pellets.

Tebuthiuron rate (kg/ha)	Mortality (%)
0	0a[1]
2	1a
4	22b

[1]Means followed by the same letter are not significantly different ($P<0.01$).

The growing season precipitation the year following application was lower than average, about 90% of average crop-year precipitation. In 1977, the second year after application, only 60% of average crop year precipitation was received. However, precipitation in 1978 was approximately 130% of the long-term annual average. These variations in moisture conditions probably affected vegetation responses to tebuthiuron. The dry conditions of 1976 and 1977 probably had a negative effect on herbaceous vegetation weakened by the herbicide. Although other published research does not reflect these strong negative effects from these rates of tebuthiuron, they have been observed in more recent studies. Scifres (1979, Personal communication) has recorded severe depressions in grass forage production with applications of 2 kg/ha or more of tebuthiuron in late winter or early spring when followed by dry conditions through the following growing season. When precipitation was above the normal long-term average during the second and third growing seasons after tebuthiuron application, Scifres and Mutz (1978) found that grass yield was increased where 2.24 kg/ha was applied, although forb production was decreased for 3 years after tebuthiuron was applied at 1 kg/ha.

Effects of tebuthiuron on the understory vegetation is also illustrated by frequency of species occurrence on treated compared to untreated plots (Table 2). Frequency of all grasses was reduced by the herbicide treatments although Idaho fescue appeared the most tolerant. Frequency of shrubs, low sagebrush, and big sagebrush, was severely reduced, even following application of the low herbicide rate. In addition, big sagebrush frequency was lower on the untreated plots. Green rabbitbrush, a plant that has resisted conventional control measures, was also damaged by the aerial application of tebuthiuron. The 4 kg/ha rate virtually eliminated green rabbitbrush and 2 kg/ha reduced its frequency from 11.5 to 3.3% in 1978. Except for *Lomatium* sp. and *Lupinus* sp., forb response generally followed the same trend as described for grasses and shrubs.

The application of tebuthiuron to individual trees was considerably more effective for western juniper control than were broadcast applications (Table 3). Young trees (< 2 m tall) were highly susceptible to the 20 and 40 g/tree rates. There was no significant differences in the response to these herbicide rates and either killed over 80% of the smaller trees. Trees less than 2 m tall are generally less than 50 years old (Britton 1979, unpublished data).

Fig. 1. *Plot-line contrast 2 years after aerial application of tebuthiuron pellets at 4 kg/ha (left) for western juniper control with untreated plot (right).*

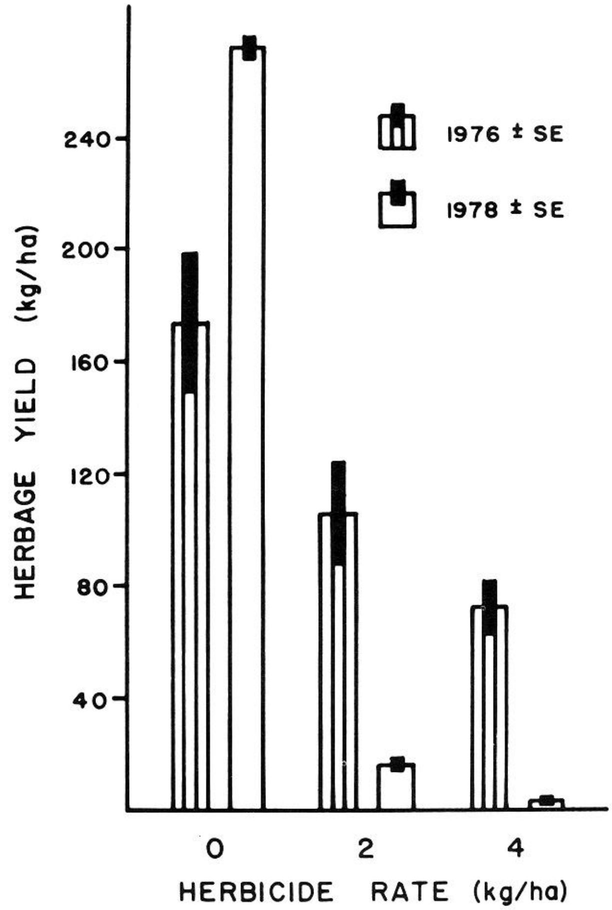

Fig. 2. *Average herbaceous yield in 1976 and 1978 following aerial application of various rates of tebuthiuron in 1975.*

No significant difference in western juniper mortality could be attributed to tebuthiuron formulation, bolus or pellet. Visually, there appeared to be a more consistent and greater degree of crown damage from the pelleted preparation. This can probably be attributed to improved distribution of the herbicide when applied in the pelleted, compared to the bolus, formulation.

Aerial application of tebuthiuron pellets does not appear to be a practical management technique for areas supporting scattered western junipers and appreciable quantities of herbaceous vegetation. However, closed stands of juniper, where most control tech-

Table 2. Frequency (%) of occurrence of grasses, forbs, and shrubs as measured following aerial application of tebuthiuron pellets in eastern Oregon.

	Tebuthiuron rate (kg/ha)		
	0	2	4
Poa sandbergii	85.5a[1]	16.0b	1.8b
Festuca idahoensis	12.0a	4.5a	4.3a
Agropyron spicatum	11.8a	0.3b	0.0b
Stipa thurberiana	9.8a	2.0b	0.0b
Bromus tectorum	0.3a	0.5a	0.0a
Sitanion hystrix	12.5a	2.5b	0.0b
Koeleria cristata	12.0a	0.0b	0.0b
Poa cusickii	1.3a	0.0a	0.0a
Annual forbs	20.9a	3.6b	0.8b
Perennial forbs	4.8a	1.5ab	0.2b
Artemisia tridentata	0.2a	0.0a	0.0a
Artemisia arbuscula	27.3a	0.3b	0.3b
Chrysothamnus viscidiflorus	11.5a	3.3b	0.3b

[1]Frequencies within rows followed by the same letter are not significantly different ($P<0.05$).

Table 3. Mortality[1] (%) of western juniper in eastern Oregon after individual tree treatment with tebuthiuron.

Tree height (m)	Herbicide rate (g/tree) 0	10	20	40
>2	0a	0a	5a	10a
<2	0a	45b	80bc	85c

[1]Means followed by the same letter are not significantly different ($P<0.05$).

niques are too expensive and/or hazardous, tebuthiuron at rates greater than 4 kg/ha might be a feasible control technique. This should be evaluated by future research. Rate of herbaceous vegetation replacement may be regulated by timeliness and extent of rainfall. Under below average rainfall conditions, however, the effects may be manifested for more than 2 years after herbicide application. Individual small trees can be selectively controlled with applications of either 20 or 40 g a.i./tree. Thus, many areas where small invading trees are considered a problem, tebuthiuron can be used effectively.

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