Economic Returns from Treating Sand Shinnery Oak with Tebuthiuron in West Texas

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Abstract

Net returns from control of sand shinnery oak *(Quercus havardii)* with tebuthiuron [*N*-(5-1,1-dimethylethyl 1,3,4,-thiadiazol-2-yl)-N, N'-dimethylurea] were evaluated for Southern High Plains ranges. A forage yield function was estimated with regression using 5 years of herbage yield data from the region. The present value of production was determined for 3 calf prices, 3 discount rates, and 4 tebuthiuron treatment rates. Discounted net returns were generally positive with high and moderate calf prices and low and moderate discount rates. The optimum tebuthiuron treatment rate varies with calf prices, discount rate, and treatment cost.

Key Words: sand shinnery oak, brush control, economic evaluation

Sand shinnery oak *(Quercus havardii)*, an undesirable shrub for livestock producers, is found on rangeland in west Texas, eastern New Mexico, and southwestern Oklahoma. It grows on deep sandy soils or on sand underlain by clay or caliche. The deciduous oak is rarely over 1 m tall and it grows in a precipitation zone from 30 cm/yr in southeastern New Mexico to 66 cm/yr in western Oklahoma (Jones 1982). Forage production may be reduced more than 60% below that of noninfested range (Robinson and Fisher 1968) and may cause livestock poisoning in the spring following dry winters when grasses are not green (Pettit 1979).

Conventional control for oak has been silvex [2-(2,4,5-trichlorophenoxy) propionic acid] and 2,4,5-T [(2,4,b-trichlorophenoxy acetic acid], but only top growth is usually killed and increased grass yields may last only 2-3 years (Scifres 1972a, 1972b). Control of sand shinnery oak with tebuthiuron is long-term. Results in west Texas indicate oak reductions of 79–99% (Pettit 1979; Jones 1982; Jones and Pettit 1980; Herndon and Pettit 1978) with no reinfestation after 13 years. Thus, the technical feasibility of tebuthiuron for oak control has been shown. The objective of this study was to determine potential economic returns from using tebuthiuron on oak ranges in west Texas.

Methods and Procedures

The approach for the analysis was (a) estimating forage response after using tebuthiuron, (b) valuing the added grass through livestock production, and (c) discounting net income over time. The model used was similar to that of Ethridge, Dahl and Sosebee (1984). The forage response relationship was estimated using ordinary least squares multiple regression. Seventy-two forage yield observations in different locations over 5 years were taken from the most typical oak site in Yoakum County, Texas. The response is representative of the west Texas-eastern New Mexico High Plains region. Four years of data were from Jones (1982) and the fifth year's data were from Jones and Pettit (1984). All data were taken on Brownfield fine sand, an Arenic Aridic Paleustalf. The experimental design was completely randomized with 3 replications of the 2.5-ha plots. Thirty 0.5-m^2 quadrats were clipped in each treatment. Independent variables to explain forage yield included tebuthiuron treatment rates (0.2, 0.4, 0.6, 0.8, 1.0 kg/ha), number of years since treatment, rainfall in different periods of the year, and sand depth in the soil profile.

Total forage (grass plus usable forbs) production (TFP) from tebuthiuron treatment was converted to added forage by subtracting the 200 kg/ha produced with no treatment; MFP = TFP – 200, where MFP is additional forage production from tebuthiuron in kg/ha. To determine value of added forage, a cow-calf operation with a 90% calving rate, 1% death loss, 14% heifer replacement, and marketing 181 kg calves was used. An animal producing unit (APU) was a 454-kg cow with calf, 5% of a 726-kg bull, and 14% of a 295-kg replacement heifer. An estimated 9,526 kg of herbage is required annually to support an APU with continuous grazing, which is typical in the area (Ethridge et al. 1984). This reflects proper use, forage disappearance, trampling, and other losses. Given the calving rate, death loss, and heifer replacement pattern, 138 kg of calf was marketed from each APU. This gives a conversion of 1 kg of herbage = .0145 kg of marketed calf. Thus, MLP = .0145 MFP, where MLP is additional livestock production in kilograms of marketable calves.

Treatment returns were determined using 3 different calf prices and adjusting for (a) added production costs with a higher stocking rate and (b) income from the sale of cull cows. The added production costs consist of the additional feed, medical, marketing and other variable costs which are increased when APUs are added to the ranch. Cull cow income was adjusted because cow prices fluctuate as calf prices fluctuate; PC = .1165 + .4674 PB (Ethridge et al. 1985), where PC is the price of cull cows in \$/kg and PB is the price of 181 kg calves in \$/kg. Revenue from sale of cull cows was deducted from the variable cost of producing calves. Thus, cull cow value was: CCV = PC (408)(.14)(.99) where CCV is cull cow revenue per APU, 408 kg is the weight of cull cows, .14 is heifer replacement proportion, and .99 is the survival rate (1 minus death loss proportion). The added production cost (additional supplemental feed, labor, veterinary costs, interest cost on the cattle, etc.) was estimated to be \$132.44/APU (Tex. Agr. Extension Serv. 1984). The added cost per kg of calves sold (VCC) was: VCC = (\$132.44 – 44 – CCV)/(181)(.76) = .912 – .192 PB, where 181 is the weight of calves in kilograms and .76 is the proportion of calves sold per APU (calving rate minus heifer replacement rate). The net price of beef sold was NPB = PB – VCC = 1.192 PB –.912. Further, the additional revenue from the tebuthiuron treatment, VMP, was VMP = (MLP)(NPB), where VMP is in \$/ha and is a function of time (years) if TFP changes over time.

With the forage response function, calf production and marketing conditions, and given rainfall, treatment rate, and calf prices, added revenue was estimated for each future year in which the treatment was effective. This added revenue was discounted and cost of tebuthiuron application was subtracted to get a net present value of oak control; $PVMP = \sum_{t=1}^{n} [VMP_t/(1 + r)^t]$, where PVMP is the present value of the stream of added revenue over n, the life of treatment in years, VMP_t is the added revenue in year t, and r is the discount rate (the cost of the investment capital in the treatment). Tebuthiuron cost is \$66.14/kg of active ingredient and cost of application is \$2.47/ha plus \$6.66/ha for each kg of active ingredient. Thus, CT = 72.8 TR + 2.47, where CT is treatment cost in \$/ha and TR is tebuthiuron treatment rate in kg/ha, and NPV = PVMP – CT, where NPV is the net present value of the net returns from the treatment over its useful life. Tebuthiuron appears to permanently kill oak in the area, but the life of the treatment in this

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Table 1. Net present value from treating sand shinnery oak with tebuthiuron in west Texas with different cattle prices and discount rates.

Tebuthiuron treatment rate	Calf prices, $/kg											
	1.43 discount rate				1.65 discount rate				1.87 discount rate			
	7.5%	10%	12.5	15%	7.5%	10%	12.5%	15%	7.5%	10%	12.5%	15%
-kg/ha-	$/ha											
0.28	12.22	6.78	2.47	−0.99	23.76	16.53	10.80	6.21	35.30	26.69	19.14	13.72
0.56	13.80	4.91	−2.12	−7.77	32.58	20.76	11.41	3.91	51.35	37.27	24.94	16.08
0.84	1.57	−8.67	−16.77	−23.25	23.02	9.41	−1.35	−9.97	44.47	28.24	14.07	3.87
1.12	−24.51	−33.99	−41.48	−47.47	−4.93	−17.53	−27.49	−35.45	14.65	−0.41	−13.50	−22.93

analysis was 15 years. Net returns beyond 15 years are increasingly uncertain and have little effect on net present value.

Results and Interpretation

Several mathematical forms were developed and evaluated for the annual herbage yield response relationship. The relationship selected was:

$$\underset{}{TFP} = -951 + \underset{(.0001)}{1786(TR)} - \underset{(.0001)}{975(TR)^2} - \underset{(.0094)}{504\,(TR/t)} + \underset{(.0142)}{63(R)}\quad(.0001)$$

where TFP = total annual forage yield with application of tebuthiuron (kg/ha),
TR = rate of tebuthiuron application (kg/ha),
R = May through August rainfall (cm), and
t = no. years after application of tebuthiuron.

Numbers in parentheses below estimated parameters are significance levels for the parameters. The model explained 61% of the total variation in herbage yields ($R^2 = .61$) with the 5 years of data. Parameters for sand depth and rainfall during other periods of the year were not significant.

Net present values of added herbage from 4 application rates of tebuthiuron were estimated at 4 discount rates and 3 calf prices (Table 1). May–August rainfall was held constant as its mean value, 18.2 cm, the treated range was deferred from grazing the year following treatment with no income derived that year, and the ranch incurred the full cost of treatment. If the government subsidized the treatment cost by, e.g., $5/ha, the net returns in Table 1 would increase by that amount.

Table 1 gives discounted net returns to treatment; positive values indicate a profit and negative values a loss. Discounted net returns are sensitive to treatment rate, cattle prices, and discount rate. The 0.84 and 1.12 kg/ha treatment rates were less profitable than lower rates in the area. The more profitable choice of the 0.28 or 0.56 kg/ha rates depend on expected cattle prices and the discount rate. In this study, no treatment with low cattle prices ($1.43/kg) and a 15% discount rate gave positive net returns. With moderate ($1.65/kg) and high ($1.87/kg) calf prices and a 10% discount rate, 0.56 kg/ha of tebuthiuron provided the greatest net returns (.28 kg/ha greatest returns with moderate prices and a 15% discount rate). While the approved application rate in the area is 0.56 kg/ha at the time of the study, ranchers can select the rate of tebuthiuron applied.

Tebuthiuron at 0.56 kg/ha costs $43/ha on land whose market value may not exceed $250/ha. This makes the economic feasibility sensitive to chemical cost, especially at low livestock prices and high discount rates. If the cost of tebuthiuron decreased from $66.14/kg to $55.12/kg, the net present values in Table 1 would increase by $3.08/ha to $12.34/ha, depending on treatment rate.

The optimum rate for tebuthiuron depends on calf prices, cost of treatment, discount rate, and precipitation after treatment. The optimum is where the change in net present value from a unit change in treatment rate becomes 0 (stop increasing the treatment rate when the income from the incremental addition of tebuthiuron just covers its cost). The first order condition for optimal application rate occurs where $\partial NPV/\partial TR = 0$. For the production, marketing, and cost conditions used here,

$$\begin{aligned}\partial NPV/\partial TR = {} & (30.86\,PB - 23.61)\left[\sum_{t=1}^{15} 1/(1+r)^t\right] \\ & -(8.71\,PB - 6.66)\left[\sum_{t=1}^{15} 1/t(1+r)^t\right] \\ & - 2TR(16.85 - 12.90)\left[\sum_{t=1}^{15} 1/(1+r)^t\right] - 72.8\end{aligned}$$

By equating to 0 and solving for TR, the optimum TR may be obtained for any combination of PB and r. If r = .10, the optimum TR for $1.43, $1.65, and $1.87/kg. calf prices is 0.41, 0.52, and 0.58 kg/ha, respectively. If r = .15, optima are 0.27, 0.41, and 0.49. Most of these rates are slightly below but relatively close to the commercially approved label 0.56 kg/ha rate in the area. This is consistent with the analysis by Neal (1983), which examined treatment rate but not economic feasibility.

Conclusions

Returns from treating sand shinnery oak with tebuthiuron in the Southern High Plains of Texas vary with many factors, including treatment rate, livestock prices, discount rates, rainfall, and cost of tebuthiuron. In all cases analyzed, tebuthiuron at 0.56 kg/ha or less was more profitable than higher rates. The 0.56 kg/ha treatment is a reasonable approximation of the optimum application rate escept when (1) calf prices are low ($1.43/kg and less) and discount rates are 10% and greater and (2) calf prices are moderate ($1.65/kg) and discount rates are 12.5% or more. The 0.56 kg/ha treatment rate gave positive net returns with discount rates 10% and less and calf prices $1.43/kg and greater. With calf prices $1.65/kg or more, treatment with 0.56 kg/ha was profitable at a discount rate of 15%.

Several ranchers in the area have been interviewed concerning the use of tebuthiuron to control sand shinnery oak. Most estimated that the treatment has a payback period of 3 to 6 years. On-going research suggests that stocking rates in the area can be doubled or tripled after the oak is killed.

The estimated returns represent general conditions for the region and the environmental conditions specified, but not necessarily for individual ranchers. The analysis applies only to sandy soils; higher tebuthiuron application rates may be required on finer-textured soils for effective kill of the oak. Additionally, economic returns will also have year-to-year variation in growing season rainfall, and differences in cattle enterprise costs will affect the economics of treatment.

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