Shrub Reduction by Chemical Control – 1984

Dickinson Experiment Station

Llewellyn Manske and Phillip Sjursen

Some shrub species have become problems in localized areas for ranchers and other land managers in North Dakota. The shrub stands generally occupy areas of higher than normal available soil moisture or areas with a water table within range of the roots for at least part of the growing season. Because of the available water, many areas that support dense stands of shrubs have a high potential to produce high yields in graminoid herbage if the shrub plants were reduced in size and number. Shrubs tend to increase in size and density under light grazing or no grazing pressure and decrease under heavy grazing. Houston (1961) found this to be true in Montana. This has been shown to be true in western North Dakota by Brand (1980) and in eastern North Dakota under rotation grazing systems by Manske (1980 and 1981). With increasing emphasis on land managers to use rotation grazing systems to improve range condition, the increase in shrubs on localized areas of grasslands will be a growing problem. Because of this existing problem and the potential for the problem to increase, there is a need for information on simple, economic methods for reducing shrub densities on rangeland.

Many shrub species provide cover and fall and winter food for wildlife. Some shrubs are important in late summer, fall and winter diets of livestock. Wildlife and livestock do not require nor do they generally use large and very dense stands of shrubs. A harmonious level of shrub density on rangeland that is compatible with livestock grazing and wildlife needs should be the desired goal.

A study to test the effects of chemical treatment on a few selected shrub species was started at the Dickinson Experiment Station in 1983. The trial was established on 0.50 acres located on the SW¼, SW¼, NW¼ Sec. 12, T. 138 N., R. 101 W. at the Pyramid Park Experimental Area of the Dickinson Experiment Station. Each plot was 22 x 30 feet in size and arranged in a randomized block design. The chemical, Tebuthiuron (Graslan), was furnished by the Elanco products company in two concentrations, 20% and 40%, of active ingredient incorporated into dense clay pellets. Three rates, 0.25, 0.50 and 0.75 pounds of active ingredient per acre, for each concentration and a control of no herbicide were applied.

Each rate of each concentration was replicated at least twice with one rate, 0.50 lbs ai / acre and the control replicated four times. The size of the plots and the number of replications were limited by the available area of homogenious shrub densities. The herbicide was broadcast applied with a whirlybird hand spreader on 24 May 1983. No retreatment was made in 1984.

The soil was possibly Havrelon silt loam. Some additional work will be needed to confirm this preliminary soil classification. The range site was overflow. The site fits into the Sagebrush range type classification of Hanson and Whitman (1938). Silver sage (Artemisia cana) was the only shrub species that was included in this trial in 1983. Wolfberry (Symphoricarpos occidentalis) may be included at a future date.

Tebuthiuron is a herbicide designed to be effective on shrubs. The company claims that the chemical has very little effect on grass and grasslike plants at low rates. The grasses tend to increase on treated areas when the canopy cover of the shrubs is reduced. A simplified version of the theory on how the chemical works follows. The chemical is absorbed by the roots and translocated to the leaves. Photosynthesis is restricted. The leaves senesce prematurely and fall off and a new set of leaves develop. This process continues until the plant depletes its stored carbohydrates. This process may take one to four years before the plant dies completely depending on the species and the environmental conditions.

The data that were collected from these plots were: shrub density, plant height, crown diameter in two directions, north – south (N-S), and east – west (E-W) and plant species present list. Crown area and crown volume can be determined from the height and diameter measurements.

Shrub density, number of plants per unit area, was determined by counting every plant of silver sage in each plot which was 61.31 square meters. These data were converted to plants per meter square.

Each silver sagebrush plant of each plot was permanently identified by affixing a numbered tag. The individual plant height data were collected by measuring in centimeters from ground level to the apex of the tallest branch. The crown diameter data were collected by measuring the distance between the outside leaves in a north - south and an east – west direction. Two sets of height and crown diameter data were collected for each plant. One set of data included only living current years growth. The other set of data included the living portions plus the current years growth which had senesced. The difference between the two sets of data was the amount of senesced (dead) plant material. Crown area and crown volume was determined for the living portions and for the living plus dead portions of the plants. The formula used to determine crown area was:

$$\text{c.a.} = \left[\frac{D_1 + D_2}{4} \right]^2 \pi$$

The formula used to determine crown volume was:

$$\text{c.v.} = 4 \, / \, 3 \, \pi \, H \, D_1 \, D_2$$

A plant species present list was made for each plot. Each species was separated into four categories of relative abundance which were Dominant, Abundant, Frequent and Scarce.

A few silver sage plants that were located on or near the boundary between two plots were unintentionally placed in the wrong plot during field measurements in 1983. Since each plant had been tagged with identification numbers and measured individually, it was a simple matter to place the data with the correct plot. All of the 1983 data was recalculated and have been included in this report along with the 1984 data.

Data to detect the effects of Tebuthiuron on silver sage was collected 94 days after treatment in 1983 and 413 days after treatment in 1984. Very little effect of the Tebuthiuron at the rates and concentrations tested was detected in 1983, 94 days after treatment. Very little difference was noticed between treatments.

In 1984, the effects of Tebuthiuron on silver sage were considerably greater than in 1983. The difference in the treatment effects were also greater in 1984. Based on percentage of reduction in total plant size per treatment the sequence from most effective to least effective rate and concentration was: .75, 20%; .50, 40%; .75, 40%; .50, 20%; .25, 40%; .25, 20%; and 0.0.

These plots will be monitored for two additional years to follow the effects of Tebuthiuron on silver sage at these rates.

Figure 1: Shrub Reduction Trial Plot Diagram.

Plots for Shrub reduction by Chemical treatment trial

2 concentrations
20% and 40%

3 rates for each concentration
.25, .50, .75 lbs ai/acre
plus a control

The .25 and .75 lbs ai/acre rates replicated 2 times for each concentration, the .50 lbs ai/acre and the control are replicated 4 times.

reps= 88' x 60'= 5280 ft^2=12/100 acres
plots= 30' x 22'= 660 ft^2= 1.5/100 acres
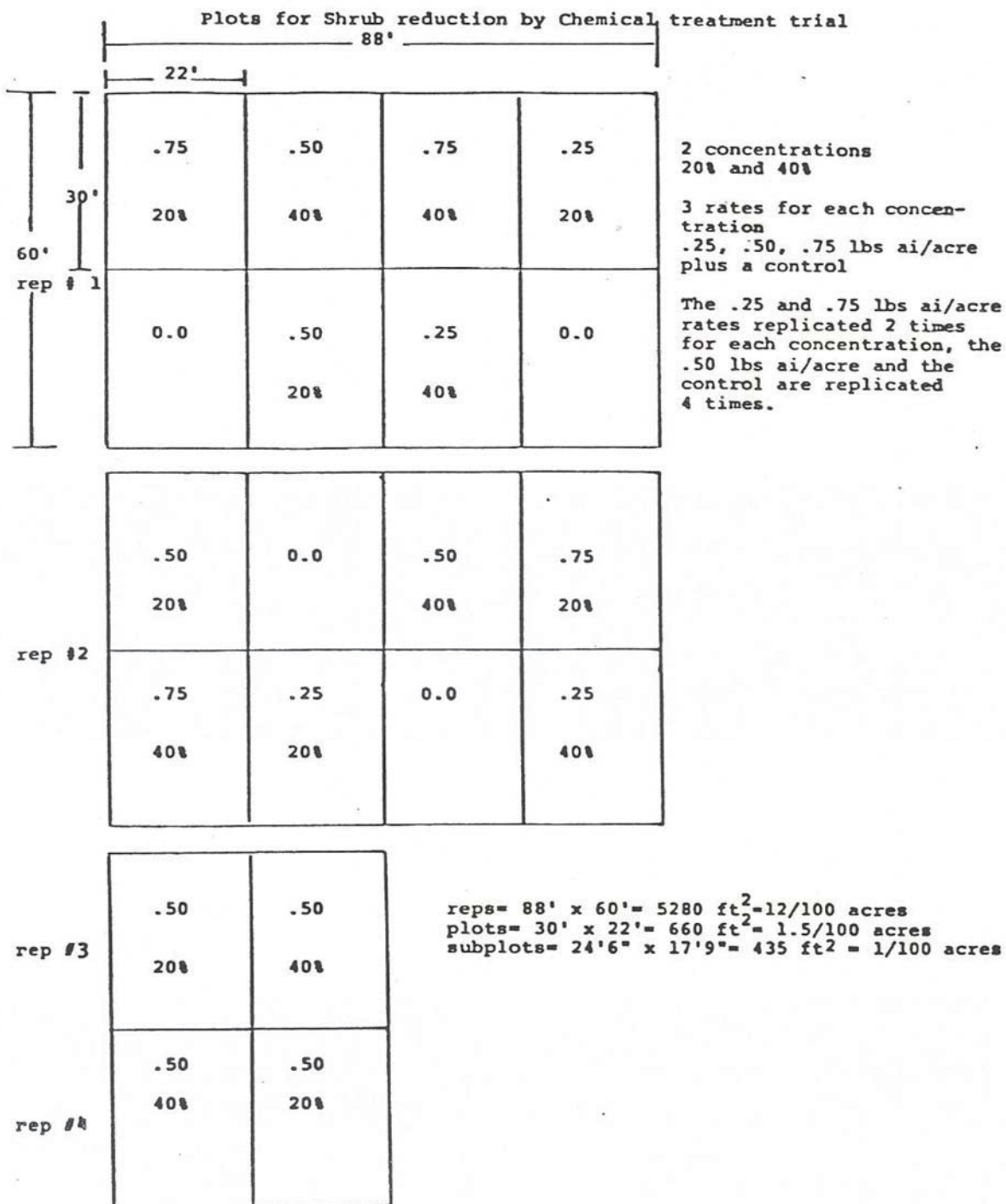subplots= 24'6" x 17'9"= 435 ft^2 = 1/100 acres

Table 1. **Mean Height and Two Diameters in Centimeters of Silver Sage – 1983**

	Rate Lbs. Ai / Acre	Conc. %	Total # Plants	Height Dead Cm	Height Live Cm	Diameter N-S Dead Cm	Diameter N-S Live Cm	Diameter E-W Dead Cm	Diameter E-W Live Cm
Rep 1 E	0.0		73	83.69	82.86	69.03	66.69	68.43	66.55
Rep 1 W	0.0		61	75.38	74.70	63.61	60.65	61.58	60.86
Rep 2 E	0.0		57	76.61	75.67	77.00	74.68	74.41	71.57
Rep 2 W	0.0		87	72.91	72.60	58.94	55.21	54.49	51.29
Mean			69.5	77.04	76.39	66.32	63.41	63.79	61.56
Rep 1	.25	20	55	86.17	82.09	84.09	80.37	82.23	78.03
Rep 2	.25	20	51	83.79	83.02	89.59	83.96	85.76	84.53
Mean			53.0	85.02	82.53	86.74	82.09	83.93	81.15
Rep 1	.25	40	69	74.07	72.80	62.39	58.68	63.28	58.22
Rep 2	.25	40	77	71.47	70.88	64.61	60.07	64.82	60.85
Mean			73.0	72.70	71.79	63.56	59.41	64.09	59.61
Rep 1	.50	20	61	78.05	76.42	66.06	61.21	58.03	54.71
Rep 2	.50	20	66	90.33	90.11	84.29	81.66	77.58	73.08
Rep 3	.50	20	71	72.81	71.95	61.50	57.32	58.64	53.41
Rep 4	.50	20	44	74.05	73.82	59.36	56.00	54.64	48.43
Mean			60.5	79.13	78.37	68.48	64.70	62.92	58.20
Rep 1	.50	40	67	79.40	77.20	65.13	60.58	72.99	66.19
Rep 2	.50	40	64	86.01	84.80	83.23	77.84	78.94	74.83
Rep 3	.50	40	49	68.68	68.30	66.14	62.20	55.51	52.90
Rep 4	.50	40	48	83.65	82.58	87.96	85.75	78.81	73.77
Mean			57.0	79.84	78.55	75.23	71.07	72.13	67.36
Rep 1	.75	20	66	90.93	90.93	80.95	74.29	82.41	72.99
Rep 2	.75	20	63	85.07	85.07	76.99	73.34	79.29	72.36
Mean			64.5	88.07	88.07	79.02	73.82	80.88	72.68
Rep 1	.75	40	51	82.00	79.15	74.72	69.57	79.74	76.19
Rep 2	.75	40	55	84.42	83.65	85.38	81.09	75.81	71.07
Mean			53.0	83.25	81.49	80.25	75.55	77.70	73.53

Table 2.   Mean Percentage of Dead Material – 1983

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Height % Dead	Diameter N-S % Dead	Diameter E-W % Dead
Rep 1 E	0.0		73	0.99	3.40	2.74
Rep 1 W	0.0		61	0.89	4.66	1.16
Rep 2 E	0.0		57	1.23	3.01	3.82
Rep 2 W	0.0		87	0.43	6.32	5.87
Mean			69.5	0.85	4.39	3.50
Rep 1	.25	20	55	4.74	4.43	5.11
Rep 2	.25	20	51	0.92	6.29	1.43
Mean			53.0	2.93	5.35	3.30
Rep 1	.25	40	69	1.71	5.95	7.99
Rep 2	.25	40	77	0.83	7.02	6.12
Mean			73.0	1.25	6.53	7.00
Rep 1	.50	20	61	2.09	7.34	5.71
Rep 2	.50	20	66	0.24	3.13	5.80
Rep 3	.50	20	71	1.18	6.80	8.91
Rep 4	.50	20	44	0.31	5.67	11.36
Mean			60.5	0.97	5.52	7.51
Rep 1	.50	40	67	2.77	6.99	9.31
Rep 2	.50	40	64	1.40	6.48	5.20
Rep 3	.50	40	49	0.56	5.96	4.71
Rep 4	.50	40	48	1.27	2.51	6.40
Mean			57.0	1.62	5.53	6.62
Rep 1	.75	20	66	0.00	8.23	11.43
Rep 2	.75	20	63	0.00	4.74	8.73
Mean			64.5	0.00	6.57	10.14
Rep 1	.75	40	51	3.47	6.90	4.46
Rep 2	.75	40	55	0.90	5.02	6.25
Mean			53.0	2.12	5.86	5.37

Table 3.   **Plant Density of Silver Sage – 1983**

	Rate Lbs Ai / Acre	Conc. %	Total # of Plants	Density # / m²	# Plants With Dead	Plants % with Dead	# Plants Totally Dead	Plants % Totally Dead
Rep 1 E	0.0		73	1.19	22	30.14	0	0.0
Rep 1 W	0.0		61	0.99	15	24.59	0	0.0
Rep 2 E	0.0		57	0.93	17	29.82	0	0.0
Rep 2 W	0.0		87	1.42	28	32.18	0	0.0
Mean			69.5	1.13	20.5	29.50	0	0.0
Rep 1	.25	20	55	0.90	17	30.91	0	0.0
Rep 2	.25	20	51	0.83	17	33.33	0	0.0
Mean			53.0	0.87	17.0	32.08	0	0.0
Rep 1	.25	40	69	1.12	31	44.93	0	0.0
Rep 2	.25	40	77	1.26	20	25.97	0	0.0
Mean			73.0	1.19	25.5	34.93	0	0.0
Rep 1	.50	20	61	0.99	17	27.87	0	0.0
Rep 2	.50	20	66	1.08	19	28.79	0	0.0
Rep 3	.50	20	71	1.16	24	33.80	0	0.0
Rep 4	.50	20	44	0.72	15	34.09	0	0.0
Mean			60.5	0.99	18.8	30.99	0	0.0
Rep 1	.50	40.	67	1.09	24	35.82	0	0.0
Rep 2	.50	40	64	1.04	30	46.88	0	0.0
Rep 3	.50	40	49	0.80	16	32.65	0	0.0
Rep 4	.50	40	48	0.78	16	33.33	0	0.0
Mean			57.0	0.93	21.5	37.72	0	0.0
Rep 1	.75	20	66	1.08	24	36.36	0	0.0
Rep 2	.75	20	63	1.03	22	34.92	0	0.0
Mean			64.5	1.06	23.0	35.66	0	0.0
Rep 1	.75	40	51	0.83	11	21.57	0	0.0
Rep 2	.75	40	55	0.90	14	25.45	0	0.0
Mean			53.0	0.87	12.5	23.58	0	0.0

Table 4.   Mean Crown Area and Percent Dead Area – 1983

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Crown Area Dead Cm^2	Crown Area Live Cm^2	% Dead
Rep 1 E	0.0		73	3710.24	3485.69	6.05
Rep 1 W	0.0		61	3077.30	2899.03	5.79
Rep 2 E	0.0		57	4501.34	4199.58	6.70
Rep 2 W	0.0		87	2526.25	2227.24	11.84
Mean			69.5	3323.84	3066.28	7.75
Rep 1	.25	20	55	5431.13	4925.95	9.30
Rep 2	.25	20	51	6037.48	5574.03	7.68
Mean			53.0	5718.86	5232.77	8.50
Rep 1	.25	40	69	3100.99	2683.24	13.47
Rep 2	.25	40	77	3289.40	2871.18	12.71
Mean			73.0	3199.66	2781.56	13.07
Rep 1	.50	20	61	3023.30	2638.65	12.72
Rep 2	.50	20	66	5145.10	4701.63	8.62
Rep 3	.50	20	71	2834.01	2407.63	15.04
Rep 4	.50	20	44	2551.76	2141.39	16.08
Mean			60.5	3390.21	2965.68	12.52
Rep 1	.50	40	67	3745.67	3155.47	15.76
Rep 2	.50	40	64	5163.64	4576.56	11.37
Rep 3	.50	40	49	2905.77	2601.15	10.48
Rep 4	.50	40	48	5460.97	4996.49	8.51
Mean			57.0	4263.83	3762.44	11.76
Rep 1	.75	20	66	5239.82	4258.85	18.72
Rep 2	.75	20	63	4795.49	4168.39	13.08
Mean			64.5	5020.36	4214.55	16.05
Rep 1	.75	40	51	4684.89	4171.46	10.96
Rep 2	.75	40	55	5101.31	4545.91	10.89
Mean			53.0	4898.74	4363.74	10.92

Table 5.   Mean Plant Volume and Percent Dead Volume – 1983

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Plant Volume Dead M³	Plant Volume Live M³	% Dead
Rep 1 E	0.0		73	0.207	0.193	6.98
Rep 1 W	0.0		61	0.155	0.144	6.61
Rep 2 E	0.0		57	0.230	0.212	7.87
Rep 2 W	0.0		87	0.123	0.108	12.20
Mean			69.5	0.171	0.156	8.52
Rep 1	.25	20	55	0.312	0.270	13.61
Rep 2	.25	20	51	0.337	0.308	8.48
Mean			53.0	0.324	0.288	11.16
Rep 1	.25	40	69	0.153	0.130	14.95
Rep 2	.25	40	77	0.156	0.136	13.44
Mean			73.0	0.155	0.133	14.15
Rep 1	.50	20	61	0.157	0.134	14.46
Rep 2	.50	20	66	0.309	0.282	8.97
Rep 3	.50	20	71	0.137	0.115	16.10
Rep 4	.50	20	44	0.126	0.105	16.64
Mean			60.5	0.179	0.155	13.45
Rep 1	.50	40	67	0.198	0.162	17.99
Rep 2	.50	40	64	0.296	0.259	12.59
Rep 3	.50	40	49	0.132	0.118	10.89
Rep 4	.50	40	48	0.304	0.274	9.91
Mean			57.0	0.227	0.197	13.21
Rep 1	.75	20	66	0.318	0.258	18.72
Rep 2	.75	20	63	0.272	0.236	13.06
Mean			64.5	0.295	0.247	16.04
Rep 1	.75	40	51	0.256	0.220	14.14
Rep 2	.75	40	55	0.286	0.252	11.77
Mean			53.0	0.272	0.237	12.80

Table 6. **Mean Percent Dead, Summary – 1983**

Rate Lbs Ai / Acre	Conc. %	Height % Dead	Diameter N-S % Dead	Diameter E-W % Dead	Total Height Diameter N-S E-W	Area % Dead	Volume % Dead
0.0		0.85	4.39	3.50	8.74	7.75	8.52
.25	20	2.93	5.35	3.30	11.58	8.50	11.16
.25	40	1.25	6.53	7.00	14.78	13.07	14.15
.50	20	0.97	5.52	7.51	14.00	12.52	13.45
.50	40	1.62	5.53	6.62	13.77	11.76	13.21
.75	20	0.00	6.57	10.14	16.71	16.05	16.04
.75	40	2.12	5.86	5.37	13.35	10.92	12.80

Table 7.   **Mean Height and Two Diameters in Centimeters of Silver Sage – 1984**

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Height Dead cm	Height Live cm	Diameter N-S Dead cm	Diameter N-S Live cm	Diameter E-W Dead cm	Diameter E-W Live cm
Rep 1 E	0.0		73	68.96	66.03	58.17	55.22	53.76	51.08
Rep 1 W	0.0		66	64.77	59.68	56.39	47.52	56.81	48.83
Rep 2 E	0.0		59	74.14	72.22	66.38	61.99	60.42	55.74
Rep 2 W	0.0		77	68.87	60.82	54.71	49.35	51.26	45.32
Mean			68.8	69.04	64.37	58.53	53.18	55.22	49.93
Rep 1	.25	20	37	87.06	78.68	87.78	74.50	82.04	70.56
Rep 2	.25	20	49	81.58	72.11	71.41	58.34	68.25	53.61
Mean			43.0	83.93	74.93	78.45	65.29	74.18	60.90
Rep 1	.25	40	65	66.42	58.19	56.09	47.36	55.62	45.14
Rep 2	.25	40	78	64.50	57.88	56.03	45.47	51.43	41.17
Mean			71.5	65.37	58.02	56.06	46.33	53.33	42.97
Rep 1	.50	20	58	74.94	52.28	60.60	34.97	61.22	37.63
Rep 2	.50	20	59	91.45	75.43	78.84	56.39	74.55	53.92
Rep 3	.50	20	62	73.40	56.37	65.74	41.30	66.34	41.29
Rep 4	.50	20	50	69.97	58.40	59.14	43.25	52.32	36.00
Mean			57.3	77.69	60.69	66.37	44.01	64.10	42.55
Rep 1	.50	40	56	82.18	68.42	71.51	61.02	68.92	58.13
Rep 2	.50	40	62	81.55	66.57	80.59	54.81	79.89	56.36
Rep 3	.50	40	68	61.74	29.61	50.43	24.03	46.13	22.29
Rep 4	.50	40	64	78.08	42.28	63.39	32.49	51.71	23.36
Mean			62.5	75.42	50.71	65.95	42.11	61.04	39.04
Rep 1	.75	20	52	94.93	78.51	81.71	77.40	79.99	64.93
Rep 2	.75	20	61	76.39	49.77	68.12	40.07	67.68	38.67
Mean			56.5	84.92	62.99	74.37	57.25	73.35	50.75
Rep 1	.75	40	40	79.95	59.89	80.54	64.01	72.87	59.13
Rep 2	.75	40	43	72.53	60.05	71.42	54.77	63.06	46.10
Mean			41.5	76.10	59.97	75.82	59.23	67.78	52.38

Table 8.   Mean Percentage of Dead Material – 1984

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Height % Dead	Diameter N-S % Dead	Diameter E-W % Dead
Rep 1 E	0.0		73	4.25	5.07	4.98
Rep 1 W	0.0		66	7.86	15.73	14.05
Rep 2 E	0.0		59	2.60	6.61	7.75
Rep 2 W	0.0		77	11.70	9.80	11.58
Mean			68.8	6.76	9.15	9.59
Rep 1	.25	20	37	9.63	15.13	13.99
Rep 2	.25	20	49	11.61	18.30	21.45
Mean			43.0	10.73	16.77	17.90
Rep 1	.25	40	65	12.40	15.56	18.84
Rep 2	.25	40	78	10.26	18.84	19.95
Mean			71.5	11.25	17.35	19.43
Rep 1	.50	20	58	30.24	42.29	38.53
Rep 2	.50	20	59	17.51	28.48	27.68
Rep 3	.50	20	62	23.20	37.19	37.75
Rep 4	.50	20	50	16.54	26.86	30.43
Mean			57.3	21.89	33.70	33.62
Rep 1	.50	40	56	16.75	14.67	15.66
Rep 2	.50	40	62	18.37	31.99	29.46
Rep 3	.50	40	68	52.04	52.35	51.68
Rep 4	.50	40	64	45.86	48.75	54.83
Mean			62.5	32.76	36.14	36.04
Rep 1	.75	20	52	17.30	5.27	18.83
Rep 2	.75	20	61	34.85	41.17	42.87
Mean			56.5	25.82	23.02	30.80
Rep 1	.75	40	40	25.10	20.52	18.85
Rep 2	.75	40	43	17.20	23.31	26.89
Mean			41.5	21.20	21.88	22.72

Table 9.   Plant Density of Silver Sage – 1984

	Rate Lbs Ai / Acre	Conc. %	Total # of Plants	Density # / m²	# Plants With Dead	Plants % With Dead	# Plants Totally Dead	Plants % Totally Dead
Rep 1 E	0.0		73	1.19	24	32.88	2	2.74
Rep 1 W	0.0		66	1.08	27	40.91	1	1.52
Rep 2 E	0.0		59	0.96	19	32.20	0	0.00
Rep 2 W	0.0		77	1.26	37	48.05	6	7.79
Mean			68.8	1.12	26.8	38.91	2.3	3.27
Rep 1	.25	20	37	0.60	29	78.38	1	2.70
Rep 2	.25	20	49	0.80	22	44.90	3	6.12
Mean			43.0	0.70	25.5	59.30	2.0	4.65
Rep 1	.25	40	65	1.06	34	52.31	3	4.62
Rep 2	.25	40	78	1.27	39	50.00	5	6.41
Mean			71.5	1.17	36.5	51.05	4.0	5.59
Rep 1	.50	20	58	0.95	34	58.62	16	27.59
Rep 2	.50	20	59	0.96	55	93.22	5	8.47
Rep 3	.50	20	62	1.01	51	82.26	13	20.97
Rep 4	.50	20	50	0.82	32	64.00	7	14.00
Mean			57.3	0.94	43.0	75.11	10.3	17.90
Rep 1	.50	40	56	0.91	40	71.43	7	12.50
Rep 2	.50	40	62	1.01	50	80.65	4	6.45
Rep 3	.50	40	68	1.11	42	61.76	30	44.12
Rep 4	.50	40	64	1.04	46	71.88	28	43.75
Mean			62.5	1.02	44.5	71.20	17.3	27.60
Rep 1	.75	20	52	0.85	49	94.23	2	3.85
Rep 2	.75	20	61	0.99	54	88.52	17	27.87
Mean			56.5	0.92	51.5	91.15	9.5	16.81
Rep 1	.75	40	40	0.65	19	47.50	7	17.50
Rep 2	.75	40	43	0.70	20	46.51	5	11.63
Mean			41.5	0.68	19.5	46.99	6.0	14.46

Table 10.   Mean Crown Area and Percent Dead Area – 1984

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Crown Area Dead Cm²	Crown Area Live Cm²	% Dead
Rep 1 E	0.0		73	2460.00	2218.80	9.80
Rep 1 W	0.0		66	2516.00	1822.60	27.56
Rep 2 E	0.0		59	3156.79	2721.26	13.80
Rep 2 W	0.0		77	2204.72	1759.72	20.18
Mean			68.8	2540.77	2087.37	17.84
Rep 1	.25	20	37	5662.24	4131.64	27.03
Rep 2	.25	20	49	3829.62	2460.85	35.74
Mean			43.0	4574.30	3126.92	31.64
Rep 1	.25	40	65	2450.17	1680.02	31.43
Rep 2	.25	40	78	2267.28	1473.93	34.99
Mean			71.5	2349.53	1565.93	33.35
Rep 1	.50	20	58	2913.88	1035.01	64.48
Rep 2	.50	20	59	4620.31	2388.95	48.29
Rep 3	.50	20	62	3425.38	1339.23	60.90
Rep 4	.50	20	50	2439.32	1245.79	48.93
Mean			57.3	3342.45	1471.14	55.99
Rep 1	.50	40	56	3872.15	2787.19	28.02
Rep 2	.50	40	62	5057.00	2426.47	52.02
Rep 3	.50	40	68	1830.80	421.26	76.99
Rep 4	.50	40	64	2601.03	612.36	76.46
Mean			62.5	3166.20	1293.10	59.16
Rep 1	.75	20	52	5134.05	3977.98	22.52
Rep 2	.75	20	61	3621.01	1217.34	66.38
Mean			56.5	4284.55	2290.45	46.54
Rep 1	.75	40	40	4620.71	2977.34	35.57
Rep 2	.75	40	43	3550.78	1997.98	43.73
Mean			41.5	4048.85	2445.66	39.60

Table 11.   Mean Plant Volume and Percent Dead Volume – 1984

	Rate Lbs Ai / Acre	Conc. %	Total # Plants	Plant Volume Dead M³	Plant Volume Live M³	% Dead
Rep 1 E	0.0		73	0.113	0.098	13.64
Rep 1 W	0.0		66	0.109	0.073	33.26
Rep 2 E	0.0		59	0.156	0.131	16.09
Rep 2 W	0.0		77	0.101	0.071	29.57
Mean			68.8	0.117	0.089	23.41
Rep 1	.25	20	37	0.328	0.217	34.03
Rep 2	.25	20	49	0.208	0.118	43.27
Mean			43.0	0.226	0.156	39.00
Rep 1	.25	40	65	0.108	0.065	39.97
Rep 2	.25	40	78	0.097	0.057	41.70
Mean			71.5	0.102	0.060	40.90
Rep 1	.50	20	58	0.146	0.036	75.25
Rep 2	.50	20	59	0.281	0.120	57.34
Rep 3	.50	20	62	0.168	0.050	69.97
Rep 4	.50	20	50	0.113	0.048	57.53
Mean			57.3	0.173	0.060	65.62
Rep 1	.50	40	56	0.212	0.127	40.09
Rep 2	.50	40	62	0.275	0.108	60.84
Rep 3	.50	40	68	0.075	0.008	88.96
Rep 4	.50	40	64	0.134	0.017	87.47
Mean			62.5	0.159	0.044	72.54
Rep 1	.75	20	52	0.325	0.207	36.40
Rep 2	.75	20	61	0.184	0.040	78.10
Mean			56.5	0.243	0.096	60.49
Rep 1	.75	40	40	0.246	0.119	51.69
Rep 2	.75	40	43	0.171	0.079	53.57
Mean			41.5	0.205	0.097	52.43

Table 12.   **Mean Percent Dead, Summary – 1984**

Rate Lbs Ai / Acre	Conc. %	Height % Dead	Diameter N-S % Dead	Diameter E-W % Dead	Total Height Diameter N-S E-W	Area % Dead	Volume % Dead
0.0		6.76	9.15	9.59	25.50	17.84	23.41
.25	20	10.73	16.77	17.90	45.40	31.64	39.00
.25	40	11.25	17.35	19.43	48.03	33.35	40.90
.50	20	21.89	33.70	33.62	89.21	55.99	65.62
.50	40	32.76	36.14	36.04	104.94	59.16	72.54
.75	20	25.82	23.02	30.80	79.64	46.54	60.49
.75	40	21.20	21.88	22.72	65.80	39.60	52.43

Table 13.   **Percentage of Reduction in Mean Plant Size per Plot and Total Plant Size per Plot 94 and 413 Days after Treatment of Tebuthiuron**

| | | Treatment | | | | | | |
| | | .25 lbs Ai / Acre | | .50 lbs Ai / Acre | | .75 lbs Ai / Acre | |
	0.0	20%	40%	20%	40%	20%	40%
MEAN PLANT SIZE PER PLOT:							
Mean Height cm	77.0	85.0	72.7	79.1	79.8	88.1	83.3
% Reduction in 94 Days	0.8	2.9	1.3	1.0	1.6	0.0	2.1
% Reduction in 413 Days	16.5	11.9	20.2	23.3	36.5	28.5	28.0
Mean Diameter N-S cm	66.3	86.7	63.6	68.5	75.2	79.0	80.3
% Reduction in 94 Days	4.4	5.4	6.5	5.5	5.5	6.6	5.9
% Reduction in 413 Days	19.8	24.7	27.1	35.7	44.0	27.6	26.2
Mean Diameter E-W cm	63.8	83.9	64.1	62.9	72.1	80.9	77.7
% Reduction in 94 Days	3.5	3.3	7.0	7.5	6.6	10.1	5.4
% Reduction in 413 Days	21.7	27.4	33.0	32.4	45.9	37.3	32.6
Mean Crown Area m^2	0.332	0.572	0.320	0.339	0.426	0.502	0.485
% Reduction in 94 Days	7.8	8.5	13.1	12.5	11.8	16.1	10.9
% Reduction in 413 Days	37.2	45.3	51.1	56.6	69.7	54.4	50.1
Mean Volume m^3	0.171	0.324	0.155	0.179	0.227	0.295	0.272
% Reduction in 94 Days	8.8	11.1	14.2	13.4	13.2	16.3	12.9
% Reduction in 413 Days	48.0	51.9	61.3	66.5	80.6	67.5	64.3
TOTAL PLANT SIZE PER PLOT:							
Total Crown Area m^2	23.1	30.3	23.4	20.5	24.3	32.4	26.0
% Reduction in 94 Days	7.8	8.5	13.1	12.5	11.7	16.1	10.9
% Reduction in 413 Days	37.9	55.6	52.1	59.0	66.8	60.0	60.9
Total Volume m^3	11.9	17.2	11.3	10.8	12.9	19.0	14.4
% Reduction in 94 Days	8.5	11.2	14.1	13.4	13.2	16.0	12.8
% Reduction in 413 Days	48.2	60.9	61.8	68.4	78.9	71.5	72.0

Table 14. **Plant Species Present on Shrub Reduction Treatments – 1984**

Dominant (D), Abundant (A), Frequent (F), and Scarce (S)

	Treatments						
	0.0	**.25 lbs Ai / Acre**		**.50 lbs Ai / Acre**		**.75 lbs Ai / Acre**	
		20%	**40%**	**20%**	**40%**	**20%**	**40%**
GRAMINOIDS:							
Agropyron desertorum 　Crested wheatgrass		S		F	A		
Agropyron smithii 　Western wheatgrass	D	D	D	D	D	D	D
Agropyron trachycaulum 　Slender wheatgrass	F	F	S	F	F	F	F
Bouteloua gracilis 　Blue grama	F	F	F	S	S	S	
Bromus inermis 　Smooth bromegrass			S				
Bromus japonicus 　Japanese chess		S		S			S
Calamagrostis montanensis 　Plains reedgrass				S			
Distichlis stricta 　Saltgrass	S						
Koeleria pyramidata 　Prairie junegrass			S				
Poa pratensis 　Kentucky bluegrass	D	D	D	A	A	A	A
Stipa comata 　Needleandthread	S		F				
Stipa viridula 　Green needlegrass	D	D	D	D	D	D	D
Carex heliophila 　Sun sedge						S	
FORBS:							
Achillea millefolium							

Yarrow	F	A	F	F	A	A	A
Artemisia dracunculus Green sage	S						

Table 14 (Cont.)   Plant Species Present on Shrub Reduction Treatments – 1984
Dominant (D), Abundant (A), Frequent (F) and Scarce (S)

		Treatment					
	0.0	**.25 lbs Ai / Acre**		**.50 lbs Ai / Acre**		**.75 lbs Ai / Acre**	
		20%	**40%**	**20%**	**40%**	**20%**	**40%**
FORBS (Cont.):							
Artemisia frigida Fringed sage		S					
Artemisia ludoviciana White sage	F	F	F	F	F	F	F
Aster ericoides White prairie aster	F	S	S	F	S	S	S
Aster laevis Smooth blue aster							
Astragalus canadensis Little rattlepod				S	S		S
Conyza canadensis Horseweed							
Descurainia sophia Flixweed		S					
Galium boreale Northern bedstraw				S			
Lactuca oblongifolia Blue wild lettuce	F	F	F	F	F	F	F
Lepidium densiflorum Peppergrass							
Linum rigidum Stiffstem flax	S		S	S	S		
Melilotus officinalis Yellow sweet clover							
Polygala alba White milkwort							

Psoralea argophylla Silverleaf scurfpea					S		
Ratibida columnifera Long headed coneflower	F	S	F	F	S	S	S

Table 14 (Cont.)   Plant Species Present on Shrub Reduction Treatments – 1984
Dominant (D), Abundant (A), Frequent (F), and Scarce (S)

		Treatments					
	0.0	**.25 lbs Ai / Acre**		**.50 lbs Ai / Acre**		**.75 lbs Ai / Acre**	
		20%	**40%**	**20%**	**40%**	**20%**	**40%**
FORBS (Cont.):							
Solidago rigida Stiff goldenrod				S			
Sphaeralcea coccinea Scarlet globemallow		S	S			F	
Taraxacum officinale Dandelion	S	S	S				
Vicia americana Wild vetch	A	F	A	F	F	A	F
SHRUBS:							
Artemisia cana Silver sagebrush	D	D	D	D	D	D	D
Ribes americanum Wild black current		S		S			S
Prunus virginiana Chokecherry							
Rosa woodsii Western wildrose		F		S		S	
Symphoricarpos occidentalis Wolfberry	F	F	S	F	F		F

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