SHRUB REDUCTION BY CHEMICAL CONTROL – 1983

Dickinson Experiment Station

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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 by Manske (1980 and 1981) under rotation grazing systems. 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 small plot pilot 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 of application for each concentration were: 0.25, 0.50 and 0.75 pounds of active ingredient per acre and a control of no herbicide 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 was limited by the available area of homogeneous shrub densities. The herbicide was Broadcast, applied with a whirlybird hand spreader on 24 May 1983.

The soil is possibly Havrelon silt loam. Some additional work is needed to confirm this preliminary soil classification. The range site is 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 an herbicide designed to be effective on shrubs. The company claims that the chemical has very little effect on grass and grass-like 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 year's growth. The other set of data included the living portions plus the current year's 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:

$$c.a. = (D_1 + D_2/4)^2 \pi$$

The formula used to determine crown volume was:

$$c.v. = 4/3 \pi H D_1 D_2$$

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

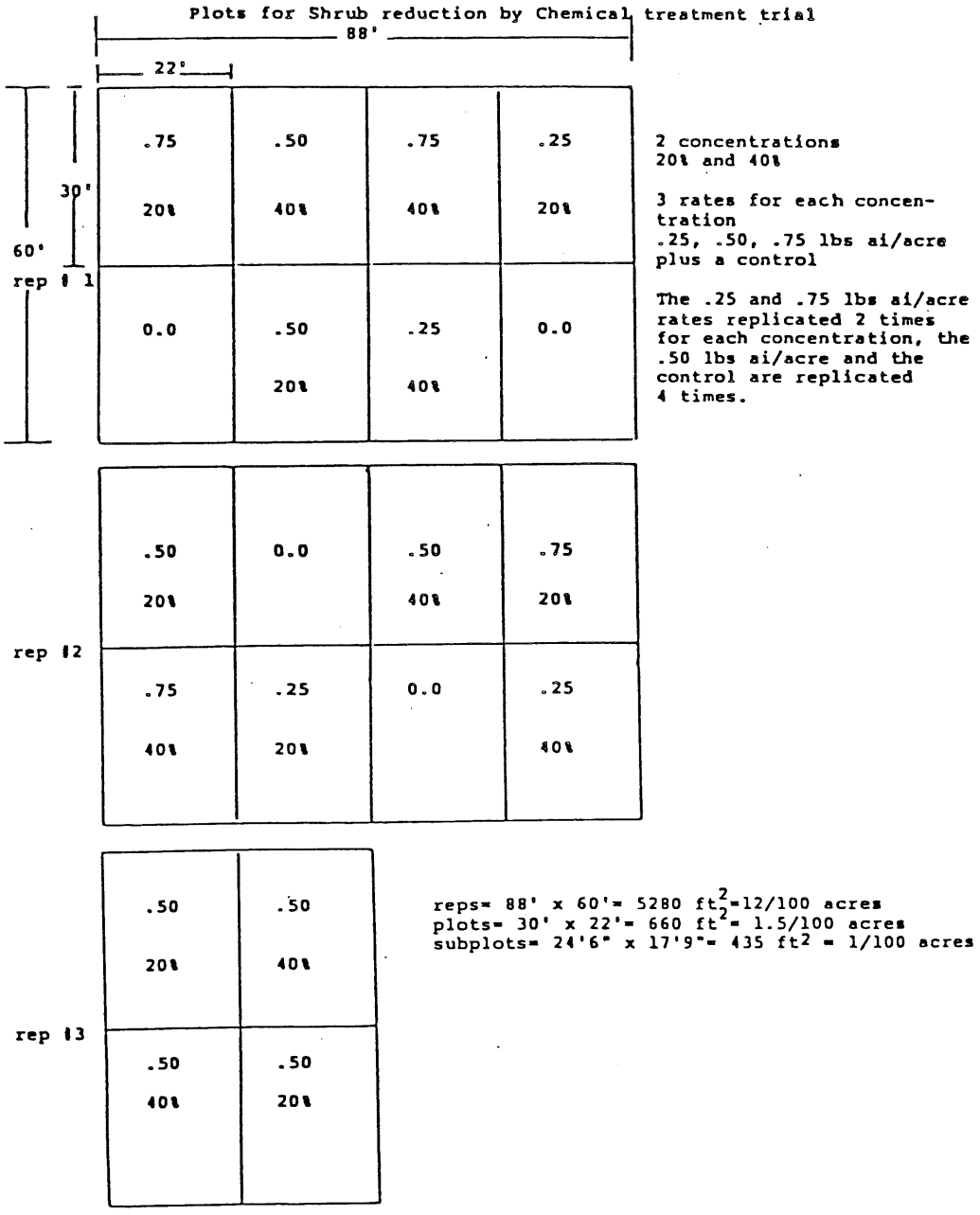

Figure 1. Shrub reduction trial plot location.

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

	Rate Lbs Ai/Acre	Conc. %	Total # Plants	Height		Diameter N-S		Diameter E-W	
				Dead Cm	Live Cm	Dead Cm	Live Cm	Dead Cm	Live Cm
Rep 1 E	0.0		75	84.02	83.29	71.72	69.37	67.59	65.83
Rep 1 W	0.0		59	74.49	73.84	62.65	60.14	60.58	59.89
Rep 2 E	0.0		53	76.10	75.26	75.11	73.05	72.52	70.00
Rep 2 W	0.0		94	72.73	72.32	58.03	54.65	56.12	52.67
Mean			281	76.75	76.12	65.88	63.20	63.21	60.97
Rep 1	.25	20	55	86.43	82.35	83.13	79.41	81.59	77.39
Rep 2	.25	20	51	83.34	82.62	88.78	83.08	86.37	85.21
Mean			106	84.95	82.48	85.85	81.18	83.89	81.15
Rep 1	.25	40	68	87.40	86.10	62.39	58.79	61.64	57.33
Rep 2	.25	40	66	69.48	69.21	64.79	61.24	60.66	56.94
Mean			134	78.57	77.78	63.57	60.00	61.16	57.13
Rep 1	.50	20	54	77.19	75.56	65.52	60.65	59.47	55.71
Rep 2	.50	20	66	88.57	88.37	85.26	82.90	78.19	74.17
Rep 3	.50	20	62	73.46	72.73	63.85	59.46	60.53	55.29
Rep 4	.50	20	49	73.99	73.79	58.94	55.92	55.94	50.14
Mean			231	78.76	78.08	69.31	65.69	64.35	59.69
Rep 1	.50	40	64	81.19	79.27	66.58	62.85	74.54	69.30
Rep 2	.50	40	56	87.47	86.23	86.31	80.80	81.62	77.79
Rep 3	.50	40	52	68.30	67.72	65.71	61.73	54.48	51.87
Rep 4	.50	40	49	82.34	81.30	84.63	82.47	72.24	67.31
Mean			221	80.00	78.76	75.38	71.48	71.11	66.91
Rep 1	.75	20	66	90.85	90.85	79.46	73.19	80.57	71.94
Rep 2	.75	20	62	97.52	97.52	75.41	72.46	76.52	70.92
Mean			128	94.08	94.08	77.50	72.83	78.61	71.45
Rep 1	.75	40	49	82.82	80.12	76.52	71.65	81.07	77.70
Rep 2	.75	40	55	83.61	83.51	85.29	82.04	73.96	70.65
Mean			104	83.23	81.93	81.16	77.14	77.31	73.98

Table 2. Mean Percent 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		75	0.87	3.28	2.60
Rep 1 W	0.0		59	0.87	4.01	1.14
Rep 2 E	0.0		53	1.10	2.74	3.47
Rep 2 W	0.0		94	0.56	5.82	6.15
Mean				0.82	4.07	3.54
Rep 1	.25	20	55	4.72	4.47	5.15
Rep 2	.25	20	51	0.86	6.42	1.34
Mean				2.91	5.44	3.27
Rep 1	.25	40	68	1.49	5.77	6.99
Rep 2	.25	40	66	0.39	5.48	6.13
Mean				1.01	5.62	6.59
Rep 1	.50	20	54	2.11	7.43	6.32
Rep 2	.50	20	66	0.23	2.77	5.14
Rep 3	.50	20	62	0.99	6.88	8.66
Rep 4	.50	20	49	0.27	5.12	10.37
Mean				0.86	5.22	7.24
Rep 1	.50	40	64	2.36	5.60	7.03
Rep 2	.50	40	56	1.42	6.38	4.69
Rep 3	.50	40	52	0.85	6.06	4.79
Rep 4	.50	40	49	1.26	2.55	6.82
Mean				1.55	5.17	5.91
Rep 1	.75	20	66	0.0	7.89	10.71
Rep 2	.75	20	62	0.0	3.91	7.32
Mean				0.0	6.03	9.11
Rep 1	.75	40	49	3.26	6.36	4.16
Rep 2	.75	40	55	0.12	3.81	4.48
Mean				1.56	4.95	4.31

Table 3. Plant Density of Silver Sage – 1983

	Rate Lbs Ai/Acre	Conc. %	Total # of Plants	# Plants With Dead	Plants % With Dead	Density #/m^2
Rep 1 E	0.0		75	22	29.33	1.22
Rep 1 W	0.0		59	13	22.03	0.96
Rep 2 E	0.0		53	14	26.42	0.86
Rep 2 W	0.0		94	28	29.79	1.53
Total			281	77	27.40	1.15
Rep 1	.25	20	55	17	30.91	0.90
Rep 2	.25	20	51	16	31.37	0.83
Total			106	33	31.13	0.86
Rep 1	.25	40	68	27	39.71	1.11
Rep 2	.25	40	66	13	19.70	1.08
Total			134	40	29.85	1.09
Rep 1	.50	20	54	16	29.63	0.88
Rep 2	.50	20	66	17	25.76	1.08
Rep 3	.50	20	62	20	32.26	1.01
Rep 4	.50	20	49	16	32.65	0.80
Total			231	69	29.87	0.94
Rep 1	.50	40	64	19	29.69	1.04
Rep 2	.50	40	56	26	46.43	0.91
Rep 3	.50	40	52	18	34.62	0.85
Rep 4	.50	40	49	16	32.65	0.80
Total			221	79	35.75	0.90
Rep 1	.75	20	66	23	34.85	1.08
Rep 2	.75	20	62	18	29.03	1.01
Total			128	41	32.03	1.04
Rep 1	.75	40	49	10	20.41	0.80
Rep 2	.75	40	55	13	23.64	0.90
Total			104	23	22.12	0.85

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		75	3810.61	3589.08	5.81
Rep 1 W	0.0		59	2981.69	2828.85	5.13
Rep 2 E	0.0		53	4279.36	4017.96	6.11
Rep 2 W	0.0		94	2558.48	2261.47	11.61
Mean			281	3272.01	3027.35	7.48
Rep 1	.25	20	55	5327.49	4827.50	9.39
Rep 2	.25	20	51	6023.52	5560.92	7.68
Mean			106	5657.16	5174.01	8.54
Rep 1	.25	40	68	3020.53	2647.55	12.35
Rep 2	.25	40	66	3090.09	2742.32	11.25
Mean			134	3054.72	2693.81	11.82
Rep 1	.50	20	54	3067.47	2658.50	13.33
Rep 2	.50	20	66	5245.66	4844.14	7.65
Rep 3	.50	20	62	3037.60	2585.44	14.89
Rep 4	.50	20	49	2591.31	2208.68	14.77
Mean			231	3507.78	3086.64	12.01
Rep 1	.50	40	64	3910.27	3428.97	12.31
Rep 2	.50	40	56	5537.15	4938.35	10.87
Rep 3	.50	40	52	2836.39	2533.88	10.67
Rep 4	.50	40	49	4831.81	4404.92	8.84
Mean			221	4213.53	3760.45	10.75
Rep 1	.75	20	66	5028.43	4135.65	17.75
Rep 2	.75	20	62	4532.28	4036.52	10.94
Mean			128	4785.10	4087.35	14.58
Rep 1	.75	40	49	4876.26	4379.66	10.18
Rep 2	.75	40	55	4979.53	4575.58	8.11
Mean			104	4930.88	4484.08	8.97

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

	Rate Lbs Ai/Acre	Conc. %	Total # Plants	Plant Volume Dead M^3	Plant Volume Live M^3	% Dead
Rep 1 E	0.0		75	0.213	0.199	6.57
Rep 1 W	0.0		59	0.148	0.139	6.08
Rep 2 E	0.0		53	0.217	0.202	6.91
Rep 2 W	0.0		94	0.124	0.109	12.10
Mean				0.167	0.154	8.24
Rep 1	.25	20	55	0.307	0.265	13.68
Rep 2	.25	20	51	0.335	0.306	8.66
Mean				0.320	0.285	11.21
Rep 1	.25	40	68	0.176	0.152	13.64
Rep 2	.25	40	66	0.143	0.126	11.89
Mean				0.160	0.140	12.73
Rep 1	.50	20	54	0.158	0.134	15.19
Rep 2	.50	20	66	0.309	0.285	7.77
Rep 3	.50	20	62	0.149	0.125	16.11
Rep 4	.50	20	49	0.128	0.108	15.63
Mean				0.184	0.160	12.84
Rep 1	.50	40	64	0.211	0.181	14.22
Rep 2	.50	40	56	0.323	0.284	12.07
Rep 3	.50	40	52	0.128	0.114	10.94
Rep 4	.50	40	49	0.264	0.236	10.61
Mean				0.225	0.197	12.16
Rep 1	.75	20	66	0.305	0.251	17.70
Rep 2	.75	20	62	0.295	0.262	11.19
Mean				0.300	0.256	14.57
Rep 1	.75	40	49	0.269	0.234	13.01
Rep 2	.75	40	55	0.276	0.254	7.97
Mean				0.274	0.245	10.48

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		0.82	4.07	3.54	8.43	7.48	8.24
.25	20	2.91	5.44	3.27	11.62	8.54	11.21
.25	40	1.01	5.62	6.59	13.22	11.82	12.73
.50	20	0.86	5.22	7.24	13.32	12.01	12.84
.50	40	1.55	5.17	5.91	12.63	10.75	12.16
.75	20	0.0	6.03	9.11	15.14	14.58	14.57
.75	40	1.56	4.95	4.31	10.82	8.97	10.48

Table 7. Plant Species Present on Shrub Reduction Treatments – 1983

Dominant (D), Abundant (A), Present (P), and Rare (R)

	Treatments									
	0.0	**.25 20%**	**.25 40%**	**.50 20%**	**.50 40%**	**.75 20%**	**.75 40%**
Graminoids:							
Agropyron desertorum Crested wheatgrass				P	P		
Agropyron smithii Western wheatgrass	D	D	D	D	D	D	D
Bouteloua gracilis Blue grama	P	P	P	D	D	P	P
Bromus japonicas Japanese chess		P					P
Calamagrostis montanensis Plains reedgrass		P		R			
Distichlis stricta Saltgrass	R						
Poa pratensis Kentucky bluegrass	D	D	D	A	A	P	P
Stipa viridula Green needlegrass	D	D	D	D	D	D	D
Carex heliophila Sun sedge					P		
Forbs:							
Achillea millefolium Yarrow	A	A	A	A	A	A	A
Artemisia dracunculus Green sage	P		P				
Artemisia frigida Fringed sage			P		P		
Artemisia ludoviciana White sage	P	P		P	P	P	P
Aster ericoides White prairie aster	P	P	P	P	P	P	P
Aster laevis Smooth blue aster						P	

Table 7 (Continued):

	Treatments											
	0.0	**.25**	**20%**	**.25**	**40%**	**.50**	**20%**	**.50**	**40%**	**.75**	**20%**	**.75**	**40%**
Forbs (Continued):													
Conyza canadensis Horseweed	P												
Galium boreale Northern bedstraw							P						
Lactuca oblongifolia Blue wild lettuce			P						P		P		P
Lepidium densiflorum Peppergrass													P
Linum rigidum Stiffstem flax					R		P						
Melilotus officinalis Yellow sweetclover	P		P				P		P		P		P
Polygala alba White milkwort	P												
Psoralea argophylla Silverleaf scurfpea									P				
Ratibida columnifera Long headed coneflower	A		P		P		P		P		R		
Solidago rigida Stiff goldenrod							P						
Sphaeralcea coccinea Scarlet globemallow							P				P		
Vicia americana Wild vetch	A		A		A		A		A		A		
Shrubs:													
Artemisia cana Silver sagebrush	D		D		D		D		D		D		D
Ribes americanum Wild black current			P				P						P
Prunus virginiana Choke cherry							P						

Table 7 (Continued):

	Treatments											
	0.0	**.25**	**20%**	**.25**	**40%**	**.50**	**20%**	**.50**	**40%**	**.75**	**20%**	**.75**	**40%**
Shrubs (Continued):													
Rosa woodsii Western wild rose	P						P				P		P
Symphoricarpos occidentalis Wolfberry	P		P				P		P				P

Table 1 gives the Mean Heights and Diameters for Living and Living plus Dead Measurements of Silver Sage. The mean heights and diameters were very similar between treatments. The maximum difference between the high and low means was 24 centimeters, which was from the East – West diameter measurements.

The Mean Percent Dead Material is given on Table 2. These values reflect the amount of senesced material that could be visually observed. The range of the mean percent dead material was from 0% to 9%.

Silver Sage Plant Densities are shown on Table 3. The mean densities ranged from 0.85 to 1.15 plants per square meter. This site was the most uniform patch of Silver Sage available for this study.

The Crown Area is a factor of the two diameter measurements. The Mean Crown Area Per Plant (Table 4) for each treatment ranged from 3055 cm^2 to 5657 cm^2 for the living plus dead portions. The Crown Area for the living portions ranged from 2694 cm^2 to 5174 cm^2. The Mean Percent of Area of each treatment covered by shrub crown ranged from 33% to 50%.

The Mean Plant Volume is a factor of the height and the two diameter measurements. The Range of the Mean Plant Volumes (Table 5) ranged from 0.16m^3 to 0.32m^3 for the living plus dead portions. The living portions ranged in mean plant volume from 0.14m^3 to 0.29m^3.

The Mean Percent Dead for the height, the two diameters, the height – diameter totals, the crown area and the crown volume are summarized on Table 6. The percent dead are very similar for the different measurement methods. The sequence of herbicide rates and percent concentrations from greatest effect (highest percent dead) to least effect is: .75, 20%; .50, 20%; .25, 40%; .50, 40%; .25, 20%; .75, 40%; and 0.0 for the plant volume data and the total height – diameter data. The sequence for the crown area data is the same except the .25, 20% and .75, 40% rates exchange order.

The Plant Species Present List with Relative Abundance is shown on Table 7. All of the treatments had very similar species composition.

No definitive conclusions can be made from these first year data. The visual percent dead attributed to the herbicide treatments above natural senescence was generally small for all of the rates used. All of the rates did have a slightly greater percent dead material than the untreated control in all of the various measurement methods used.

The rate and amount of senescence on these plots should be followed for a few years to determine the total effect that the herbicide has on Silver Sage at these various rates.

LITERATURE CITED

Brand, Michael D. 1980. Secondary Succession in the Mixed Grass Prairie of Southwestern North Dakota. Ph.D. Dissertation. North Dakota State University, Fargo. 77pp.

Hanson, H.C. and W. Whitman. 1938. Characteristics of Major Grassland Types in Western North Dakota. Ecological Monographs 8: 57-114.

Houston, Walter R. 1961. Some Interrelations of Sagebrush, Soils, and Grazing Intensity in the Northern Great Plains. Ecology 42(1): 31-38.

Manske, Llewellyn L. 1980. Habitat, Phenology and Growth of Selected Sandhills Range Plants. Ph.D. Dissertation. North Dakota State University, Fargo. 154pp.

Manske, Llewellyn L. and William T. Barker. 1981. The Prairie Grouse on the Sheyenne National Grasslands, North Dakota. North Dakota State University, Fargo. 238pp.