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Forrest A. Sneva, ARS range scientist at
Squaw Butte Experiment Station from 1952 to 1982

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DEDICATION

The 1982 Range Field Day is dedicated to Forrest A. Sneva, range scientist, Agricultural Research Service, U.S. Department of Agriculture. Forry joined the Squaw Butte Experiment Station in 1952 and retires June 30, 1982.

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IMPROVEMENTS IN HERBICIDAL CONTROL OF SAGEBRUSH AND RABBITBRUSH[1/]

William C. Krueger and Thomas R. Bunch

Effective treatments have been developed for control of big sagebrush (Artemisia tridentata) and rabbitbrush (Chrysothamnus spp.) on rangelands of eastern Oregon. However, application of this technology has not always given consistent results. In the early 1970s we observed unsatisfactory results, particularly in control of sagebrush, when it appeared all guidelines had been observed carefully. We have not yet seen consistently good results in control of green rabbitbrush (Chrysothamnus visicidiflorus). In 1976, we began a series of field trials to reexamine herbicides that may be effective in brush control for eastern Oregon. We thank leaders of the Hampton Grazing Cooperative, the Les Schwab Ranch near Prineville and the J Spear Ranch near Paisley for making lands available for our studies.

METHODS

Sixty-two plots were established in Crook, Deschutes, and Lake counties on the ranches identified above. Herbicidal treatments included various combinations of herbicides at different rates (the basic treatments are identified in Table 1). These were combined in different combinations and with varying rates of the additives, X-77, Tronic, 5 percent diesel oil, M 4168 (an oil substitute), and niacin to give 51 different treatments. Eleven non-treated plots were established as controls. Plot size varied from one-eighth acre for sagebrush and green rabbitbrush to a maximum of 300 acres for gray rabbitbrush (C. nauseosus).

Herbicidal treatments were applied from 1976 to 1980 with both ground and aerial techniques. Each treatment was established in relation to phenological growth stage of each shrub species. These were: before development of ephemeral leaves, after development of ephemeral leaves in the spring, and also in the fall for Wyoming sagebrush (A. t. wyomingensis); before bud break and at the early leaf stage for green rabbitbrush; and in the early leaf stage for gray rabbitbrush. Plots were established in spring as early as late March and no later than mid-May. We recorded phenology of associated vegetation at the time of each treatment but none of these measurements were useful in interpreting results.

1/ The authors appreciate support given by Dow Chemical Company.

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Table 1. Herbicide treatments

Herbicides	Rate (lbs/A)
2,4-D	2, 3, 4
M 4021	1, 2
Picloram	1/4, 3/8, 1/2
2,4,5-T	1, 3
Dicamba	1

Effects of treatments were initially evaluated at the end of the first growing season after herbicidal treatment. However, it became apparent that responses were different after the second growing season so all results reported are from measurements made after the second full growing season. In each plot we randomly selected 25 to 50 plants and recorded if it was alive and estimated the percent of the canopy that had been defoliated. If any living tissue could be observed, the plant was recorded as alive.

Results were statistically analyzed using standard analysis of variance and Student's t test technique. In all cases, the level of significance accepted was 95 percent.

RESULTS AND DISCUSSION

Wyoming Sagebrush

When examined within a phenological stage all herbicidal and additive treatments produced similar results with no statistical differences. In 1976, addition of niacin appeared to strongly enhance control before development of ephemeral leaves but this advantage was not apparent in subsequent treatments applied in 1979. Most treatments included 2,4-D with another herbicide which did not yield additional benefits.

Comparison of results in different phenological stages indicated the value of presence of ephemeral leaves as an indicator for timing of herbicidal application. The treatments applied in fall were completely ineffective. After observation of the plots, no data were collected. Early spraying before development of ephemeral leaves did provide a significant kill and defoliation, but delaying spraying until ephemeral leaves developed significantly improved results (Table 2). Sagebrush in this area is usually sprayed a month or more after development of ephemeral leaves. It is clear that effective control is likely when herbicides are applied as soon as possible after development of ephemeral leaves. This varies according to annual weather patterns but occurs from early to mid-May in the study area.

Table 2. Percent kill and defoliation related to phenology for Wyoming sagebrush

Phenology	% Kill	% Defoliation
No ephemeral leaves present	42	71
Ephemeral leaves present	93	96
Control	1	22

As we observed responses of plants sprayed and compared them to responses from the general spray programs that commenced 2 to 3 weeks later, we noted the rate of defoliation and death varied considerably. The plants treated soon after ephemeral leaves developed defoliated slowly and often didn't appear substantially damaged until a year later. Plants treated later at the more normal time defoliated rapidly in the first summer after treatment but sometimes refoliated in the first fall or spring following treatment. The slower herbicidal action from the early spray appeared more efficient since it produced less variable responses. During the course of these studies, the general spray program in Crook County was adjusted to our results and substantial improvements were observed. We also noticed improved kills in the adjusted program for low sagebrush (*A. arbuscula*), mountain big sagebrush (*A. t. vaseyana*), and basin big sagebrush (*A. t. tridentata*).

Green Rabbitbrush

Herbicidal treatments did result in significant kills of green rabbitbrush when compared to controls in the early leaf stage but results were not as good as for sagebrush. Addition of picloram, in the phenological stage after early leaves were formed, resulted in a 54 percent kill and 74 percent defoliation which was not significantly different than the 31 percent kill and 46 percent defoliation for the combination of other treatments. The experimental herbicide M 4021 killed 52 percent of the plants in the early leaf stage and resulted in 64 percent defoliation, which was not a significant improvement over the other herbicidal treatments.

Comparison of results based on phenological stage at time of treatment indicated treating in the bud stage was ineffective although the percent defoliation was significantly greater than for controls (Table 3). Deferment of spraying until the early leaf stage resulted in significantly higher kill and defoliation than for controls. However, the kill was not satisfactory to maintain long-term control. Observations in the first growing season after treatment suggested a high level of control but plants resprouted and grew in the second growing season.

Table 3. Percent kill and defoliation related to phenology for green rabbitbrush

Phenology	% Kill	% Defoliation
Bud	6	17
Early leaves	34	48
Control	0	3

Gray Rabbitbrush

Control was effective with both picloram combined with 2,4-D and 2,4-D alone. Treatments were only applied in the early leaf stage (Table 4). Addition of picloram improved efficacy of treatments but 3 pounds per acre of 2,4-D alone was satisfactory. Our studies of gray rabbitbrush are only beginning and we have examined results at only two locations on plots sprayed by ground equipment over about 150 acres and by aircraft on about 300 acres.

Table 4. Percent kill and defoliation related to phenology for gray rabbitbrush

	Picloram + 2,4-D		2,4-D only	
Phenology	% Kill	% Defoliation	% Kill	% Defoliation
Early leaves	99	99	90	95
Control	0	3	0	3

MANAGEMENT IMPLICATIONS

Wyoming big sagebrush can be effectively controlled when sprayed after ephemeral leaves have developed in the spring. We have sprayed brush much later than necessary in the past which can give erratic results. Earlier spraying allows a longer period of good growing conditions for the herbicide to act in the year of application and will give more consistent results.

Gray rabbitbrush can be controlled with early sprays, and when in mixed stands with Wyoming sagebrush both species should be effectively controlled.

Green rabbitbrush is resistant to herbicidal control and we expect risk of failure to remain high until a more effective treatment is developed.

SOIL-PLANT RELATIONSHIPS AMONG THREE BIG SAGEBRUSH SUBSPECIES

R. F. Miller, P. S. Doescher, S. R. Swanson, T. J. Svejcar, J. C. Buckhouse, F. A. Sneva, and A. H. Winward[1/]

Big sagebrush (*Artemisia tridentata*) dominates 90 million acres in the western United States. This species in its various forms is the most abundant and widespread of the woody species which characterize the extensive sagebrush-grass region. Numerous subspecies of big sagebrush have been reported by Beetle, Tisdale, Winward and Young. Subspecies of big sagebrush not only vary morphologically and phenologically but also have distinct ecologic and hydrologic requirements. These factors, having very important management implications, have led to numerous studies characterizing the ecological sites of big sagebrush subspecies. This paper will preview a portion of an overall effort to characterize soils, community structure, production, hydrology, water relations and volatile oils of three subspecies of big sagebrush occurring in eastern Oregon.

EXPERIMENTAL PROCEDURES

Wyoming big sagebrush (*A. tridentata* subsp. *wyomingensis*), basin big sagebrush (*A. tridentata* subsp. *tridentata*), and mountain big sagebrush (*A. tridentata* subsp. *vaseyana*) sites were studied. Four study locations were evaluated near Millican, Baker, Frenchglen, and Squaw Butte. These locations provided a wide range of soil types associated with the three subspecies. At each location, each of the three subspecies habitat types was delineated, and three replications of each measured. Sites selected were in poor to good condition. On each replication, shrub canopy cover was measured with a line intercept and herbage production was clipped, dried and weighed. Soil pits were dug on each replication where soils were characterized. Internal water stress and soil moisture were measured every two weeks in June and July, and monthly August through October on the Squaw Butte study sites only. Internal water stress was measured with a pressure chamber at three-hour intervals from predawn to 5 pm. Soil moisture was measured gravimetrically midday each day internal water stress was measured.

1/ This work was sponsored and funded by the Agricultural Research Service and Oregon State University Agricultural Experiment Station

RESULTS AND DISCUSSION

As shown in Figure 1, potential herbage production increased from Wyoming to mountain big sagebrush sites. Production potential will vary within a subspecies, depending on soils, range condition, and climate. Temperatures and precipitation were often comparable between adjacent Wyoming and basin big sagebrush sites. Soil depth is probably the important factor influencing the difference in potential production between the two subspecies. Soil depth on Wyoming big sagebrush sites studied averaged 32 inches and averaged 53 inches on basin big sagebrush sites. The deeper soils allow for greater soil water storage capacity. Soil depths (49 inches) on the mountain big sagebrush and basin big sagebrush sites were similar but temperatures were usually cooler and precipitation amounts similar or higher on the mountain big sagebrush sites. This means evapotranspiration levels will be lower and more total moisture available on mountain big sagebrush sites when compared with the other two sagebrush species.

Sagebrush canopy cover can attain higher levels on mountain and basin big sagebrush sites than Wyoming big sagebrush (Figure 1). Wyoming big sagebrush canopy cover rarely exceeds 20 percent. However, on basin and mountain big sagebrush sites, maximum shrub canopy cover frequently nears 30 percent, with mountain big sagebrush occasionally approaching 50 percent on higher elevation sites with deep soils. This is supported by work of other researchers in Oregon and Idaho.

Diurnal water potentials in big sagebrush range from -5 to -20 bars early in the growing season to -30 to -60 bars during summer droughts. In June and July, mountain big sagebrush was significantly less water stressed than the other two subspecies (Figure 2). There was no significant difference between basin and Wyoming big sagebrush. Similar internal plant water potentials between Wyoming and basin big sagebrush during the growing season were probably caused by a higher Leaf Area Index and, thus, higher transpiration potentials on the basin big sagebrush site. In August, mountain big sagebrush was the most stressed and Wyoming big sagebrush the least (differences significant for all three subspecies). Although all three subspecies were at high levels of drought stress in August, Wyoming big sagebrush appeared to better cope with the arid conditions.

Seasonal patterns of soil water availability were similar on the basin and Wyoming big sagebrush sites (Figure 2). Adequate moisture levels were available in June during rapid stem and leaf growth. By early to mid-July, soil water decreased to below -15 bars, which coincided with senescence of ephemeral leaves. On the mountain big sagebrush site soil moisture was available through July, and ephemeral leaf senescence occurred two weeks later compared to the other two subspecies. Winward, in Idaho, found similar soil water patterns with these three subspecies. Early depletion of water reserves on the basin big sagebrush site was probably caused by a higher demand for moisture than on the Wyoming big sagebrush sites.

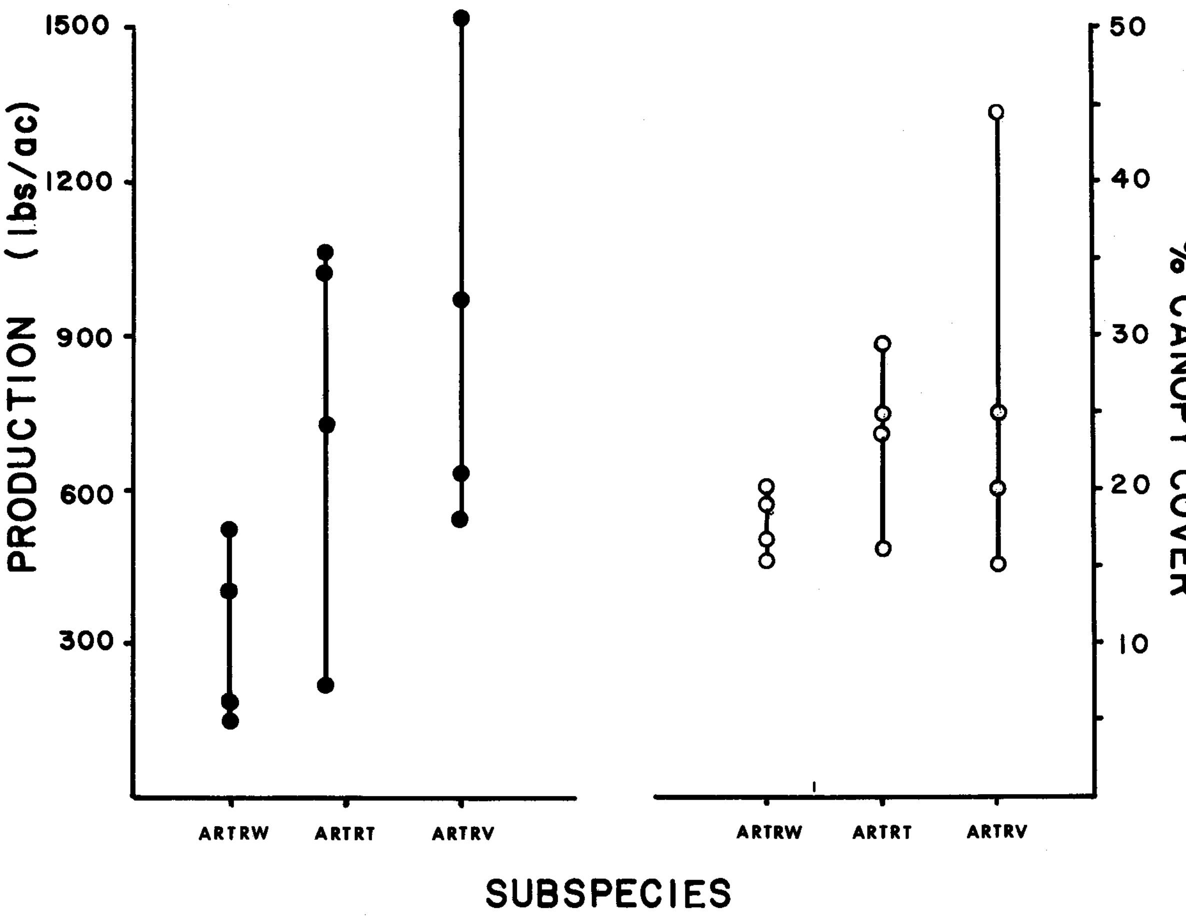

Figure 1. Average production and shrub canopy cover at each of the four locations for Wyoming big sagebrush (ARTRW), basin big sagebrush (ARTRT) and mountain big sagebrush (ARTRV).

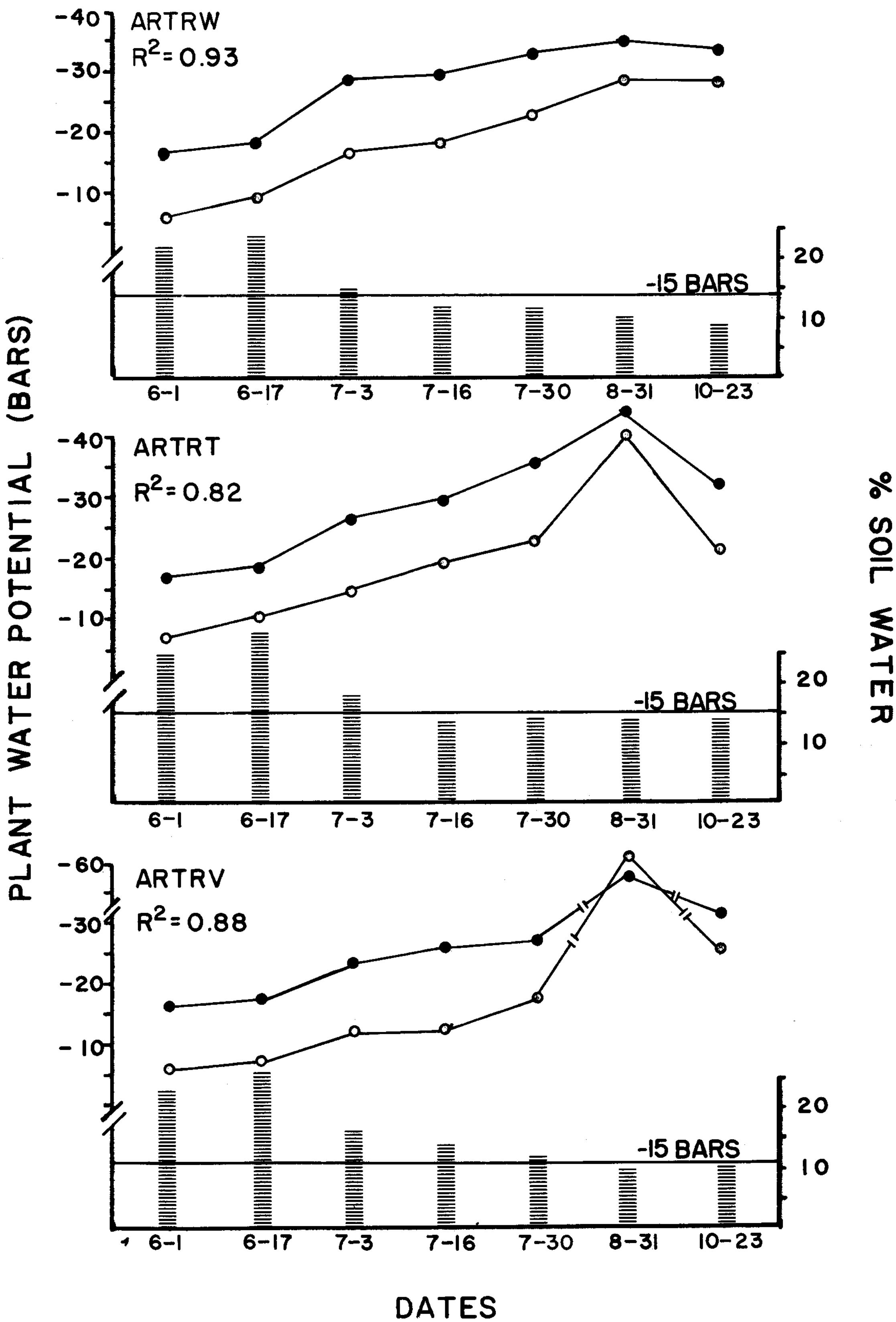

Figure 2. Predawn (o—o) and midday (●—●) plant water potentials from June through October for Wyoming big sagebrush (ARTRW), basin big sagebrush (ARTRT) and mountain big sagebrush (ARTRV). Vertical bars represent percent soil moisture measured in the deepest soil horizon. R^2 is the correlation between midday plant water potential and percent soil moisture in the deepest soil horizon.

Soil moisture in the deepest horizon correlated very strongly with plant water potentials throughout the spring and summer (Figure 2). The strongest correlation was a polynomial relationship:

$$Y = a + bX + cX^2$$

where Y is the estimated value for plant water potential, X is the measured percent soil moisture, and a, b, and c are computed values in the polynomial equation. Moisture in the deepest horizon correlated higher with plant water potentials than any of the other soil horizons.

CONCLUSION

As we go from a Wyoming to basin to a mountain big sagebrush site, we can expect soil depths, potential herbage production, and potential shrub canopy cover to increase. Wyoming and basin big sagebrush proved to have the lowest plant water potentials during the active growth period in June and July. Although basin big sagebrush sites with deeper soils have a greater water storage capacity than Wyoming big sagebrush sites, higher levels of leaf surface area on the basin big sagebrush site increased transpiration potentials. During this time, mountain big sagebrush was the least water stressed. During summer drought, plant water stress in the three subspecies was reversed with the more drought tolerant subspecies being the least stressed. Plant water potentials for all three subspecies correlated very strongly with soil water levels in the deepest horizon. A major difference separating mountain big sagebrush from the other two subspecies was the availability of soil moisture during July.

Other parameters to be reported soon on this study will be transpiration rates, litter fall, infiltration rates, sediment load potentials, soil morphology, soil chemical characteristics, and volatile oil contents.

HYDROLOGIC RESPONSE FOLLOWING RANGELAND IMPROVEMENT PRACTICES IN EASTERN OREGON[1/]

J. C. Buckhouse and D. A. Bolognani

It is of interest and importance to natural resource managers to understand the hydrologic response of various range improvement practices as they are commonly implemented in eastern Oregon. As a consequence, this study was conducted during the summer of 1980 to establish the changes in infiltration and potential sedimentation in the Oregon Range and Resource Evaluation Project work area of eastern Oregon (Bolognani, 1982).

METHODS

A modified Rocky Mountain infiltrometer was used to simulate 28-minute high intensity rainfall events of about five inches per hour. This rate of rainfall was chosen since it approximates the kind of high intensity, summer thunderstorms which hit the area occasionally. It is estimated that a storm of this magnitude would have a return frequency of about 75 years.

The simulated storms were programmed to last 28 minutes, with rainfall and runoff being collected after an initial three minutes and thereafter at five-minute intervals. A composite sample of the runoff was also collected to determine the potential rate of sediment production associated with the storm.

Sixteen natural resource units sampled by Gaither (1981) and subjected to various improvement practices (seeding, herbicide spraying, mechanical brush control, and certain combinations of two or more practices) were studied.

1/ This work was sponsored and funded by the U.S. Forest Service Range Evaluation Project. Particular thanks are given to Jon Skovlin and Reed Sanderson of the USFS Range Evaluation Team.

RESULTS AND DISCUSSION

On six of nine mountain grassland ecosystems which had been reseeded, the control (untreated) area was either not different or had significantly higher infiltration rates for the entire rainfall period than did the treated areas. Interestingly, the controls also generally had higher potential sediment losses. The controls lost significantly more sediment in all cases except three, and in two of these there were no significant differences. Thus, only one treated site exhibited significantly higher potential sediment loss than did the controls. Average potential sediment loss on the control area was .50 T/A compared to .28 T/A on the treated areas.

On the sagebrush ecosystem sampled, where sagebrush had been mechanically removed and the area seeded, the treated area had significantly lower infiltration rates. Nevertheless, the potential sediment loss was lower on the treated areas (.65 T/A in the treated area compared to 1.74 T/A in the control).

On a ponderosa pine overstory with elk sedge understory, higher infiltration rates and lower potential sediment rates were noted in one treatment case (0.02 T/A treatment site vs. 0.06 T/A untreated site) and with lower infiltration rates and higher sediment rates in another. In the latter case, two subsamples were taken. On the subsample where no seed catch occurred, phenomenally high (5.67 T/A) sediment production was noted. On the area where some revegetation had occurred (27 percent cover), the sediment production rate was 0.09 T/A.

A ponderosa pine - bunchgrass ecosystem demonstrated significantly higher infiltration under the treatment conditions. Potential sediment was not significantly different in either case (0.03 T/A under the control and 0.02 T/A under the treatment).

Untreated larch ecosystems had significantly higher infiltration rates than did the treated areas. This was coupled with correspondingly lower potential sediment rates in the control areas ($<$0.01 T/A) compared to the treated areas (0.13 T/A).

SUMMARY AND CONCLUSIONS

A complex interaction of factors influences the infiltration and potential sediment production values which are associated with any particular wildland site. The factors of soil compaction, standing vegetation, and litter seem to be of particular importance. Although interactions among these factors affect both infiltration and sediment production, it appears that sediment production is the more sensitive of the two end products.

Any disturbance which compacts the soil, either through the direct traffic of machinery or through the forces of raindrops, reduces infiltration. Conversely, any practice which increases the standing vegetation and litter decreases sediment production. Therefore, the relative hydrologic balance of a rangeland improvement technique depends on several factors:

(1) How severe was the soil disturbance as a result of this practice? (The more severe, the greater the compaction and the less the infiltration).

(2) How successful was the "catch" of planted or released vegetation following the practice? (The more successful, the lower the sediment production).

(3) How long ago was the practice implemented? (The effects of compaction ameliorate over several years--established vegetation may thicken or thin as the years pass, depending on the adaptability of the species and subsequent management).

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EFFECT OF DEFOLIATION FREQUENCY ON GROWTH OF IMPROVED PASTURE IN WESTERN OREGON

I. Motazedian and S. H. Sharrow

A primary objective of pasture management is to maximize the production of protein and other digestible nutrients for grazing animals without deterioration of pasture condition. To reach this goal, pasture plants must be managed to use the available resources efficiently.

One of the basic resources which supports plant life is energy from the sun. Plants use their leaves and, to some extent, green stems to capture solar energy which is converted into carbohydrates for plant growth. Agriculturalists generally measure the amount of leaf area that a plant possesses relative to the soil surface under the plant. This measure, called Leaf Area Index (LAI), roughly corresponds to the number of leaves which a ray of sunlight must pass through to reach the soil surface.

In general, as the LAI of a pasture increases, its growth rate also increases until there is enough leaf area to capture all the incoming solar energy. The LAI at which greater than 95% of the usable solar radiation is absorbed is called the "optimum LAI." Optimum LAI for pastures in temperate areas during the spring-summer is believed to be about 4.5 to 5. Grazing, mowing, or other forms of defoliation often reduce LAI and, therefore, plant growth.

The objective of this study is to document the effects of frequency of defoliation on pasture yield and species composition. It is hoped that this information will aid in devising systems of pasture management which will minimize any detrimental impacts of grazing on plant growth rate.

EXPERIMENTAL PROCEDURE

The study was conducted on a typical perennial ryegrass (*Lolium perenne* L.) - subterranean clover (*Trifolium subterraneum* L.) hill pasture in western Oregon. The pasture is about one mile northwest of Corvallis. Elevation is 333 feet above sea level. Average annual precipitation is 40 inches. Canopy cover in the early spring of 1980 was 60 percent ryegrass, 20 percent subclover, 10 percent tall fescue, 5 percent annual grasses and forbs, and 5 percent other perennial grasses.

Four defoliation frequencies (mowed every 1, 3, 5, or 7 weeks) and three defoliation intensities (1.6, 2.2, or 2.8 inches stubble height after defoliation) were applied in 1980 and 1981. Study plots were 44.5 $foot^2$ in area. A rear-bagging rotary lawn mower was used to harvest forage from appropriate plots. The contents of the mower bag were weighed and a grab sample obtained for dry-matter determination.

A .89-foot^2 quadrat was hand clipped from each plot before each mowing. This material was separated into two components--grass and clover. Leaf Area Index was determined for each treatment by feeding these samples through an electronic planimeter. Data from the 1980 and 1981 growing seasons were analyzed as a factorial arrangement of treatments in a randomized complete block design with three replications. Information on defoliation frequency presented here was calculated by averaging the three defoliation heights.

RESULTS AND DISCUSSION

All the defoliation treatments applied reduced competition for light between ryegrass and subclover. As a result, canopy cover of subclover increased from 20 percent in 1980 to 50 percent in 1981 in all treated plots. During this same period, the canopy cover of clover in the unmowed control plots was reduced to almost zero; cover of annual grasses increased to 30 percent. These observations point out the importance of timely defoliation in maintaining clover in grass-clover pastures.

Increased forage production requires increased utilization of solar energy, other environmental factors being favorable. The higher LAI of less frequently mowed plots allowed a greater utilization of incident sunlight. As a result, total dry matter production increased as the interval between defoliations increased during both 1980 and 1981 (Table 1). Plants which were frequently mowed reacted by becoming leafier and more prostrate. This tendency, which can be seen in their lower leaf area to dry weight ratio, may have implications for forage quality. Since leaves are frequently more digestible than stems, leafiness is often a good indicator of forage quality.

Table 1. Average dry matter yield (lbs/acre), Leaf Area Index (LAI and Leaf Area/dry weight ratio (LA/dry wt) of plots under different defoliation treatments

Defoliation Intervals (week)	Components			
	Yield 1980	Yield 1981	1981 LAI	1981 LA/dry weight
1	5658.19[a1]	4576.66[a]	.52[a]	225[a]
3	5843.54[b]	5775.91[b]	2.57[b]	212[b]
5	7216.77[c]	6126.98[c]	3.77[c]	138[c]
7	9466.52[d]	9239.91[d]	7.60[d]	134[d]

1 Means within a column not sharing a common letter differ ($P<.05$).

CONCLUSIONS

These data suggest that pasture production may be increased by increasing the period of non-use between defoliations. This is an especially useful concept in intensive management systems such as rotational grazing where pastures are intensively grazed for short periods, then allowed to recover. Although a seven-week recovery period produced the most forage on this trial, LAI reached levels well above optimum. Optimum Leaf Area Index (presumably highest pasture growth rate) was reached at about six weeks after defoliation. It is recommended, therefore, that intensively grazed pastures in western Oregon be allowed a six-week recovery period before being grazed again to maximize forage production.

EFFECT OF GRAZING MANAGEMENT ON DIET AND WEIGHT GAINS OF SHEEP GRAZING ANNUAL GRASS - CLOVER PASTURE

S. H. Sharrow

Rotational grazing systems have been successfully applied to perennial grass pastures in the maritime climatic regions of Great Britain, Ireland, and New Zealand for many years. Observations from more arid areas, such as South Africa, Zimbabwe, and Australia have also demonstrated the superiority of rotational grazing over continuous grazing where stocking rates are high. A great deal of interest in rotational grazing has been generated recently in the United States by Allan Savory and his students who claim that stocking rates of western rangelands may be doubled by switching from continuous grazing to an intensive rotational grazing system.

In rotational grazing, pastures are subdivided into smaller parcels called paddocks. Animals are concentrated into a single herd which is periodically moved from one paddock to the next during the green-feed period with a period of non-use between grazings. The resulting pattern of intense utilization followed by a recovery period is designed to achieve more uniform forage utilization by forcing animals to consume most of the forage in a paddock before they are moved to a fresh paddock.

Plants regrow rapidly during the non-use period because they are able to accumulate more leaf tissue than is possible under continuous grazing where animals are present to consume the new leaves as they appear. Rotational grazing has been credited with increasing pasture production, increasing livestock production, and maintaining high condition of range and pasture lands.

A study was conducted in 1977 and 1978 to compare forage on offer, dry matter intake and diets selected by sheep under rotational grazing to those under continuous grazing on annual grass - subclover pastures.

EXPERIMENTAL PROCEDURE

The study was conducted on five acres of hill pasture approximately eight miles north of Corvallis, Oregon. Species composition of the pasture before grazing in 1977 was 56 percent rattail fescue (*Vulpia myuros*), 12 percent soft chess (*Bromus mollis*), 25 percent subclover (*Trifolium subteraneum*), and 3 percent perennial ryegrass (*Lolium perenne*). The original pasture was divided in half. One 2.5-acre portion was continuously grazed throughout the grazing season (approximately April - December). The other half was subdivided into five half-acre paddocks. Sheep consecutively grazed each paddock for four days before being moved to the next paddock. Each paddock was grazed four days and then allowed 16 days to recover before being grazed again. Both rotational and continuous grazing treatments were stocked with five ewes and their lambs per acre.

Sheep were weighed every two weeks while they were on pasture. Forage on offer to sheep, amount of forage consumed (intake), and diets selected by sheep were determined for each two-week period by comparing the amount of forage present in the pasture to the amount of forage inside 10 small ungrazed exclosures, per treatment.

RESULTS AND DISCUSSION

Liveweight gains of both ewes and their lambs tended to be higher under rotational than under continuous grazing in mid- and late spring 1977. Summer weight gains, however, were lower under rotational than under continuous grazing. In 1978, no differences were apparent in weight gains between grazing management systems during any season.

The rotationally grazed pasture consistently had more total forage on offer to livestock during the midspring and late spring periods than did the continuously grazed pasture (Table 1). Herbage consumption by sheep, however, did not reflect these differences in herbage on offer. Sheep tended to consume the same amount of forage under both grazing management systems. Since no meaningful differences were detected in herbage consumption, treatment differences in lamb and ewe weight gains likely are caused by differences in the quality rather than quantity of the diet selected under rotational vs. continuous grazing.

During spring 1977, sheep on the rotationally grazed pasture ate substantially more subclover and forbs, both high quality items, than did sheep on the continuously grazed pasture. In addition, soft chess contributed more to the late spring and less to the early summer diet of rotationally grazing animals than to that of sheep under continuous grazing. Even though the greater quantity of forage on offer to ewes and lambs under rotational grazing did not affect total herbage consumption, it apparently allowed rotation animals to exercise more selectivity, thus aiding them in choosing a high quality diet from the larger bulk of forage available on rotational compared to continuously grazed pasture.

By the start of the summer dry-feed period of 1977, selective grazing by livestock had removed most of the clover and other forbs from both pastures. Higher consumption of soft chess during the late spring resulted in fewer seedheads, a preferred summer feed, being available to sheep on the rotational than on the continuously grazed pasture. Summer diets of sheep reflected differences in the amount of each plant species on offer. Approximately 97 percent of the forage consumed on both pastures was rattail fescue and soft chess. Forbs contributed little to summer diets of rotationally grazing sheep. The summer diet of sheep on the continuously grazed pasture contained approximately 3 percent forbs.

The major difference in summer sheep diets attributable to grazing management was a higher proportion of soft chess, principally seedheads, in the diets of sheep on the continuously grazed pasture.

Table 1. Continuous (C) Vs. Rotational (R) Grazing

Factor	Season 1977			
	Midspring		Late Spring	
	C	R	C	R
Ewe Liveweight Change (lbs/day)	-0.26	-0.20	-0.18	-0.04†
Lamb Liveweight Change (lbs/day)	0.20	0.37†	0.20	0.15†
Herbage on Offer (lbs/acre)	1780	2170†	1650	2500*
Herbage Consumption (lbs/lb body wt/day)	.28	.27	.39	.37

	Season 1978			
	Midspring		Late Spring	
	C	R	C	R
Ewe Liveweight Change (lbs/day)	0.57	0.51	-0.18	-0.09
Lamb Liveweight Change (lbs/day)	0.93	0.86	0.37	0.42
Herbage on Offer (lbs/acre)	1420	2280*	2630	3230*
Herbage Consumption (lbs/lb body wt/day)	.27	.31	.32	.30

	Summer Season			
	1977		1978	
	C	R	C	R
Ewe Liveweight Change (lbs/day)	-0.33	-0.66*	-0.22	-0.22
Herbage on Offer (lbs/acre)	1300	1280	2670	1940*
Herbage Consumption (lbs/lb body wt/day)	.23	.23	.32	.30

*,† Rotational differs from continuous grazing, $P<.05$ and $P<.10$, respectively).

The spring of 1978 was relatively cool and moist. This favored the growth of cool season forbs such as subclover. Subclover was the highest single element in both forage on offer and in sheep diets during midspring 1978. Diets of animals on both rotational and continuously grazed pastures were approximately 11 percent rattail fescue, 12 percent soft chess, and 75 percent subclover in midspring. By late spring, however, the rotation pasture had more than twice as much subclover on offer than was present on the continuously grazed pasture. Sheep diets during this period were also twice as high in subclover under rotational as under continuous grazing. As in 1977, summer diets were predominately rattail fescue and soft chess.

Sheep in the rotationally grazed pasture tended to eat more rattail fescue and less soft chess during the summer than sheep on the continuously grazed pasture.

MANAGEMENT IMPLICATIONS

These data suggest that animal performance during the spring green-feed period was largely determined by the amount of subclover in sheep diets under the two treatments examined. Rotational grazing resulted in more subclover on offer to sheep than occurred under continuous grazing. When subclover was plentiful, such as in 1978, little difference in animal performance could be attributed to grazing management. When subclover was scarce, as occurred in 1977, the additional clover on offer under rotational compared to continuous grazing allowed selection of a diet higher in clover, thus increasing liveweight gains of sheep on rotationally grazed, relative to continuously grazed pasture. Subclover and other annual forbs were largely consumed on both pastures by early summer. Diets of ewes and live-stock performance during this period reflected the higher contribution of soft chess, the preferred summer feed, to forage on offer under continuous compared to rotational grazing.

The observations suggest that rotational grazing can be effective in increasing forage on offer to livestock and improving animal performance during the green-feed period, when plants are actively growing. During the dry-feed period, however, rotational grazing should be avoided as it tends to suppress dietary selectivity and to reduce animal performance.

PREVIOUS RANGELAND MANAGEMENT
PROGRESS REPORTS

These progress reports are available upon request from the Squaw Butte Experiment Station, P. O. Box 833, Burns, Oregon 97720.

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