Physiological Responses of Big Sagebrush to Different Types of Herbage Removal

C. WAYNE COOK AND L. A. STODDART

Research Professor and Head, Department of Range Management, Utah State University, Logan, Utah

Studies dealing with various intensities of artificial removal of herbage from browse plants always bring up the problem of how to select the material to be harvested. Should it be a prescribed percentage of each twig, based upon total length or weight; or should it be a prescribed percentage of the total current growth present on the plant. In the latter case, it would not matter how much of each twig was harvested or where the twig was located on the plant as long as the approximate predetermined percentage of the whole was harvested.

During the spring of 1956, on desert sagebrush types of central Utah, a study was initiated to determine how big sagebrush *(Artemisia tridentata)* responded to two different types of herbage removal. At each of two locations, ten pairs of plants were permanently marked for study. One plant of each pair was harvested by removing one-half of the current growth of each twig over the entire plant; the other was harvested by removing all of the current year's growth from only one-half of the plant. Thus, to begin with, approximately equal weight of herbage was removed from each plant under each treatment. The plants were harvested each spring for three years, about March 1, just before active spring growth was apparent.

Results

Herbage Responses

Plants that were harvested by removing all of the current growth on one-half of the plant displayed considerably more dead material at the end of the three years of treatment than the plants harvested by clipping one-half of each twig over the entire plant (figure 1).

In the first case there was an average of 272 square inches of dead material per plant at the end of three years of treatment, compared to only 75 square inches of dead material for the plants in the second case (table 1). There were no completely dead plants in either group, but in most cases where all of one-half the plant was harvested—that half of the plant was dead by the end of three years. However, the half of the plant that was unclipped grew more vigorously than plants receiving no treatment (table 2). The current twig growth on control plants averaged 32.8 millimeters in length, compared to 57 millimeters on the unharvested portion of treated plants. In spite of death of half of the plant treated, the remaining half produced as many seedheads as untreated plants (table 2).

FIGURE 1. The top picture shows the right side of the plant dead as a result of defoliation for 3 years, but the other half more vigorous than the control plants. The lower picture shows general loss of vigor in the plant to the right as a result of harvesting one-half of the current growth over all of the plant, compared to the unclipped plant on the left.

Chemical Responses

Plants that were harvested by clipping all of the current growth from one-half of the plant produced somewhat higher percentages of lignin and cellulose, whereas plants harvested by clipping one-half of each twig over the entire plant produced higher percentages of ether extract, protein, and other carbohydrates. In both types of harvesting, the ether extract, protein, cellulose, and phosphorus increased from 1956 to 1958; and ash, lignin, other carbohydrates, and gross energy decreased (table 3).

Root Responses

On plants which had all of the foliage removed from half of the plant, most of the roots on the harvested side of the plant were dead or almost so; however, they were rapidly being replaced by roots from the other side of the plant. No major roots had grown from the living side to the dead side, but numerous small tertiary roots were growing into that side. This indicates that manufactured food is not translocated laterally from the leaves on one side to the roots on the other.

Discussion

McMurtrey (1937) stated that radial transfer of solutes from xylem to phloem or vice versa appears to occur along the vascular rays, but translocation from one side of the plant to the other is not understood.

Most findings strongly support

Table 1. Average vigor and yield measurements on 20 paired sagebrush plants harvested by two different methods for three years. Measurements were taken in the fall over the entire plant, regardless of treatment.

Harvesting treatment	Year	Length of vegetative twig	Length of seed-stalk	Number of seed-stalks	Cover		Herbage yield per plant
					Live	Dead	
		(mm)	(mm)		(sq. inches)		(gms)
All of half of the plant	1956	22.4	82.7	232.3	199.8	17.3	56.53
	1957	53.4	158.0	217.6	205.2	189.4	21.03
	1958	32.1	72.3	106.9	208.1	272.2	25.57
Half of all of the plant	1956	24.6	85.1	245.2	225.0	10.8	51.26
	1957	57.9	118.1	196.6	211.7	44.3	29.02
	1958	24.7	37.6	41.8	220.7	74.9	92.40
Differences	1956	-2.2	-2.4	-12.9	-25.2	6.5	1.16
	1957	-4.5	39.9	21.0*	-31.7	145.1**	-7.99
	1958	7.4*	34.7	65.1**	-12.6	197.3**	-66.83**

*Significant at the .05 level
**Significant at the .01 level

the theory that little or no cross-transfer of food occurs in tissue already formed. There is, however, some evidence that new secondary tissue may develop from one side of the plant to the other (MacDaniels and Curtis, 1930).

McMurtrey (1937) found that when mineral elements were withheld from the roots, mineral deficiencies appeared on that side of the plant only. Caldwell (1930) found, by shading leaves on one side of a turnip, that the sugar content of that side of the root was considerably less.

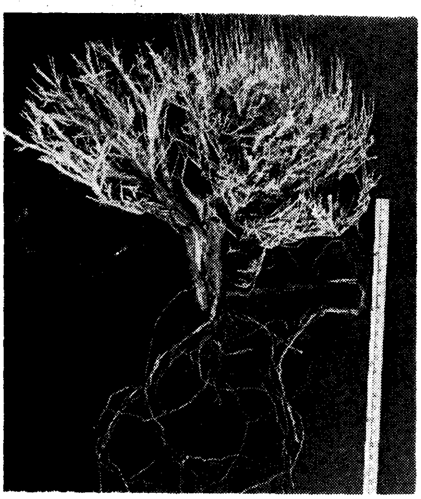

FIGURE 2. A sagebrush plant with the left side dead as a result of a single harvesting of all of one-half of the plant for 3 successive years.

Auchter (1923) concluded that in straight-grained trees the carbohydrates from leaves are translocated to the roots directly below them, but not to the roots on the other side of the tree. However, he found that water was readily transferred from roots on one side of the tree to leaves on the other side. Crane (1922) observed that trees with one side dwarfed as a result of pruning had roots on that side that were likewise small compared to the other side.

In the present study it is indicated that sagebrush reacts in the same manner as a straight-grained tree. From close observation it is indicated that vessels run up and down one side of the plant from the tip of the twigs to the roots. However, branches of the plant may be distorted to the extent that the foliage does not always appear directly over the roots fastened to them.

As shown in figures 2 and 3, the sagebrush plant separates rather easily into a number of apparently self-supporting units, including branches and roots.

Summary and Conclusions

It was found that clipping all of the current year's growth from one side of the plant during late winter or early spring caused death of that one-half of the plant after three years of treatment; whereas clipping one-half of all the current year's growth over the entire plant re-

Table 2. Average vigor measurements for the unharvested half of sagebrush plants where the other half was completely removed compared to untreated plants.

	Year	Length of vegetative twig	Length of seed-stalk	Number of seed-stalks
		(mm)	(mm)	
Unharvested part of plant treated	1956	51.7	82.7	232.3
	1957	68.4	158.0	217.6
	1958	51.0	72.3	106.9
Control plants untreated	1956	34.6	91.5	254.0
	1957	30.0	140.7	185.1
	1958	33.1	72.8	109.1
Difference	1956	17.1*	-8.8	-11.7
	1957	38.4**	17.3**	32.5**
	1958	17.9*	-0.5	-2.2

*Significant at the .05 level
**Significant at the .01 level

Table 3. Chemical composition of material harvested from twenty paired sagebrush plants harvested by two different methods during March before active spring growth was evident.

Harvesting treatment	Year	Ether extract	Total protein	Ash	Lignin	Cellulose	Other carbohydrates	Calcium	Phosphorus	Gross energy
All of half					(percent)					(Cal/kg)
of the plant	1956	5.9	11.6	9.0	13.0	13.1	46.5	0.97	.16	5035
	1958	9.0	12.2	8.3	10.8	20.1	39.6	....	.17	4680
Half of all										
of the plant	1956	7.2	12.8	8.8	12.2	12.0	47.1	1.08	.16	5162
	1958	9.0	13.5	8.4	10.6	17.2	41.3	....	.21	4495

duced vigor of the entire plant substantially, but only small isolated twigs or branches were killed.

At the end of three years of treatment, the unharvested one-half of plants in the first group had grown so vigorously that the increased production about compensated for the loss of the other one-half of the plant.

The study indicates that there is little or no translocation of manufactured food from one side of the plant to the other. Harvested material from clipping all of the herbage from one side of the plant was higher in lignin and cellulose, whereas herbage from clipping one-half of each twig over the entire plant was higher in ether extract, protein, and other carbohydrates.

FIGURE 3. A plant half dead and half alive, separated into recognizable self-supporting units including roots and branches.

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