Differential Preference of Wintering Mule Deer for Accessions of Big Sagebrush and for Black Sagebrush

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Abstract

Free-roaming mule deer showed significant differential preference for accessions of big sagebrush (*Artemisia tridentata*) grown in a uniform garden. Mule deer also selectively preferred certain accessions of black sagebrush (*A. nova*). The role of monoterpenoids (essential or volatile oils) in determining preference among accessions and taxa of *Artemisia*—the sagebrushes—and the role of sagebrush as a food of starvation is discussed.

Differential preference of mule deer for populations and individual plants of big sagebrush (*Artemisia tridentata*) has been noted by several workers (Smith 1950; Plummer et al. 1968; Winward 1970; Hanks et al. 1973; Stevens and McArthur 1974; Winward and Tisdale 1977; Willms et al. 1979; and McArthur et al. 1979). Few, however, have quantified their observations. Hanks et al. (1973), Sheehy (1975), and Scholl et al. (1977) did quantify their observed preferential differences. Of these workers, only Sheehy (1975) made statistical comparisons. He found that mule deer significantly preferred some sagebrush taxa over others. Preference of wintering mule deer for accessions of big sagebrush is one of several key characteristics being considered in our selecting and breeding program (Welch and McArthur 1979a). Therefore, we undertook this study to expand our knowledge base concerning mule deer preference for accessions of big sagebrush (*A. tridentata*) and for black sagebrush (*A. nova*) grown in a uniform garden.

Materials and Methods

From a uniform shrub¹ garden located at the Gordon Creek wildlife management area near Helper, Utah, 10 accessions of big sagebrush (*Artemisia tridentata*) and four accessions of black sagebrush (*Artemisia nova*) were chosen to determine differential preference by free-roaming, wintering mule deer. The accessions (plant material from a specific site) were transplanted onto the garden as seedlings from various Intermountain areas (Table 1). For each accession of big sagebrush, 10 plants were randomly selected. Plants were approximately the same age (planted 1968-1971). Twenty annual leaders per plant were measured to the nearest centimeter during mid-October 1977 and 1978. The leaders were selected at random over the entire crown of the plants. The 20 measurements per plant were used to arrive at a mean annual leader length (before browsing) for each plant. After the winter, and before spring growth, the plants were remeasured in the same manner as they were in October and a mean annual leader length

Table 1. Locations of 10 accessions of big sagebrush (*Artemisia tridentata*) and four accessions of black sagebrush (*Artemisia nova*) used to determine differences in preference of wintering wild mule deer. These accessions were grown on a uniform garden near Helper, Utah.

Species	Subspecies	Accessions	County and State
<i>tridentata</i>	<i>vaseyana</i>	Hobble Creek	Utah, Utah
		Spanish Valley	Grand, Utah
		Indian Peaks	Beaver, Utah
		Milford	Beaver, Utah
		Monticello	San Juan, Utah
<i>tridentata</i>	<i>tridentata</i>	Indianola	Sanpete, Utah
		Loa	Wayne, Utah
		Dove Creek	Dolores, Colorado
		Marysville	Piute, Utah
<i>tridentata</i> <i>nova</i>	<i>wyomingensis</i>	Trough Springs	Humboldt, Nevada
		Lund	Iron, Utah
		Manti	Sanpete, Utah
		Pioche	Lincoln, Nevada
		Pine Valley	Millard, Utah

(after browsing) was determined. Percent used was calculated by dividing the mean leader length after browsing by the mean leader length before browsing, and then multiplied by 100. This method of measuring leader length contained a precision error term of 4%. During the first year, we had the occasion to visit the shrub garden before the start of winter (December 12, 1977). Significant browsing of the big sagebrush was noted. We remeasured the big sagebrush in the manner described above so we could determine the amount of big sagebrush eaten before winter's onslaught.

For black sagebrush, 10 plants per accession were analyzed by the ocular method (National Academy of Sciences 1962) to estimate deer use. This was done only in the winter of 1978.

A completely random-designed analysis of variance was used to detect significant effects due to accessions. Hartley's multiple range test was used to compare accession means (Snedecor and Cochran 1967). A *t*-test with paired observations was used to compare winters (Snedecor and Cochran 1967).

Results

There was a significant difference in the use of big sagebrush between the winters of 1977 and 1978. This prevented the pooling of data for the two winters. In general, there was a reduction of about 10% in the use of the 10 accessions of big sagebrush for the winter of 1978 (Table 2). This reduction was not uniform among the accessions, i.e., Spanish Valley and Marysville accessions were down by 19%. The Dove Creek accession was browsed more in 1978 than in 1977 (Table 2). This accession was the tallest of all accessions in the garden.

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¹The uniform shrub garden at the Gordon Creek wildlife management area near Helper, Utah, is cooperatively maintained by the Utah State Division of Wildlife Resources (W-82-R) and the Intermountain Forest and Range Experiment Station.

Table 2. The winter preference of wild mule deer for 10 accessions of big sagebrush (*Artemisia tridentata*) grown on a uniform garden near Helper, Utah.

Winter of 1977		Winter of 1978	
Accession	% used	Accession	% used
Hobble Creek	84 ^{a*}	Hobble Creek	74 ^{a1}
Spanish Valley	73 ^a	Monticello	59 ^{ab}
Monticello	63 ^{ab}	Spanish Valley	54 ^{ab}
Indian Peaks	59 ^b	Dove Creek	50 ^b
Milford	58 ^b	Indian Peaks	47 ^b
Indianola	47 ^{bc}	Milford	45 ^{bc}
Dove Creek	46 ^{bcd}	Indianola	40 ^{bc}
Loa	33 ^{cd}	Loa	24 ^{cd}
Trough Springs	29 ^d	Marysville	12 ^d
Marysville	19 ^d	Trough Springs	10 ^d

*Values sharing the same letter superscript are not significantly different at the 5% level.

Some accessions of big sagebrush were preferred by mule deer over others (Table 2). The accessions were grouped similarly in both years despite the significant differences between winters. Hobble Creek accession was the most preferred accession of big sagebrush (84% and 74% used), although not significantly preferred over Spanish Valley and Monticello accessions. Accessions from Loa, Trough Springs, and Marysville were the least preferred by the wintering mule deer.

Our December 12, 1977, measurements showed considerable pre-winter mule deer use of several accessions of big sagebrush (Table 3). Better than 50% of the current year's growth of four accessions (Hobble Creek, Indian Peaks, Milford, and Monticello), had been eaten before the start of winter (Table 3).

Table 3. Amount of wild mule deer use on 10 accessions of big sagebrush (*Artemisia tridentata*) before the start of winter. Accessions were grown on a uniform garden located at Helper, Utah.

Accession	% used as of December 12, 1977
Hobble Creek	58.7
Indian Peaks	53.1
Milford	52.2
Monticello	51.8
Spanish Valley	39.5
Indianola	14.2
Dove Creek	10.3
Trough Springs	8.8
Marysville	6.6
Loa	0.0

As with big sagebrush, some accessions of black sagebrush were preferred over others by mule deer (Table 4). The accessions varied in use from zero (Lund accession) to 60% (Pine Valley). Deer removed 2.2% of the Manti accession current year's growth. The Pioche accession had 19.7% of the current-year growth removed.

Discussion

Winter effect on the differential preference of free-roaming wintering mule deer for 10 accessions of big sagebrush was nonsignificant for changing the array clusters of the accessions. Some movement within the arrays occurred between the winters, but for

Table 4. Preference of wintering wild mule deer for four accessions of black sagebrush (*Artemisia nova*) grown on a uniform garden near Helper, Utah, winter of 1978.

Accession	% used
Lund	0.0
Manti	2.2
Pioche	19.7
Pine Valley	60.0

the most part, these changes were of the magnitude of one position, except for the Dove Creek accession. None of the changes were from one group of significance to another. This differential preference of winter mule deer for big sagebrush has been observed in the field by a number of workers (Smith 1950; Plummer et al. 1968; Winward 1970; Brunner 1972; Hanks et al. 1973; Stevens and McArthur 1974; Sheehy 1975; Scholl et al. 1977; Winward and Tisdale 1977; Willms et al. 1979; McArthur et al. 1979; and Welch and McArthur 1979a). We will, in the near future, attempt to combine the high digestibility, high crude protein, and fast growth rate characteristics of the Dove Creek accession with the high preference of the Hobble Creek accession (Welch and McArthur 1979a; Welch and McArthur 1979b; Welch and Pederson 1982). Hopefully, this will result in a nutritionally superior strain of big sagebrush for use on mule deer winter ranges.

Some workers believe that big sagebrush is consumed by mule deer in the late winter or "very" early spring (Nagy et al. 1964; Nagy and Tengerdy 1968; Dietz and Nagy 1976; and Nagy 1979). The implication given is that big sagebrush is a starvation food, that is, big sagebrush is eaten only when nothing else is available. Our results show that mule deer consumed 58.7% of the current year's growth of the Hobble Creek accession, 53.1% for Indian Peaks, 52.2% for Milford, and 51.8% for Monticello—before the onset of winter, December 12, 1977 (Table 3). These results agree with the observations made by Welch and Andrus (1977). They found that 2 days after mule deer arrived on a winter range near Richmond, Utah, the only shrubs heavily browsed were vasey big sagebrush (*A. tridentata* ssp. *vaseyana*), the hips of woods rose (*Rosa woodsi*), and sweetbrier rose (*R. eglanteria*). Black chokecherry (*Prunus virginiana melanocarpa*) and antelope bitterbrush (*Purshia tridentata*) were not heavily browsed until a month later. Also, Medin (1980) found during a 5-year dietary study of wintering mule deer in north central Colorado that big sagebrush made up 5% of the fall diet (max. 27%), 31% of the winter diet (max. 75%), and 14% of the spring diet (max. 56%). It was noted by Medin and Anderson (1979) that during this 5-year period, a wide variety of forages was almost continuously available. The deer did not have to eat the big sagebrush. Others also have reported non-starvation use of big sagebrush by mule deer (Julander 1955; Mackie 1970; Constan 1972). Kufeld et al. (1973 summary), indicates some year-round use of big sagebrush by mule deer with heaviest use occurring during the winter.

It has been hypothesized that black sagebrush (*A. nova*) is preferred by mule deer over big sagebrush (Nagy and Tengerdy 1968; Dietz and Nagy 1976; and Nagy and Regelin 1977). The idea behind this hypothesis is that black sagebrush contains lower concentrations of monoterpenoids (essential or volatile oils) which are less inhibitory to microorganisms than big sagebrush. This would in theory cause the deer to select black sagebrush over big sagebrush. This hypothesis, however, does not take into account the observations made by Smith (1950) and Sheehy (1975) that mule deer did not prefer black sagebrush over big sagebrush, even though Sheehy (1975) found monoterpenoid content to be lower in black sagebrush than in big sagebrush. Our results somewhat support the observations of Smith (1950) and Sheehy (1975) (Table 4). From our study of mule deer preference for accessions of black sagebrush and that of Scholl et al. (1977) and Stevens and McArthur (1974), there appears, however, to be enough variation that some accessions of black sagebrush could be preferred over some accessions of big sagebrush and vis-a-vis. The proposed role of monoterpenoids in determining differential preference among species of *Artemisia* or accessions of *Artemisia* is questionable. Sheehy (1975) reported that the relative concentration of eight monoterpenoids could account for 90% of the variation of mule deer utilization among seven sagebrush taxa. Scholl et al. (1977), however, using the relative concentration of eight monoterpenoids, could only account for 20.7% of the variation of mule deer utilization among 12 sagebrush taxa. Radwan and Crouch (1978) found that the "families of Douglas-fir" varied significantly in yield

and composition of essential oils, but differences were not related to preference (as determined by black-tailed deer). Welch and McArthur (1981) have reported significance in yield and composition of monoterpenoids among 21 accessions of big sagebrush, grown on the Ephraim, Utah, uniform garden. Unfortunately, wild mule deer do not move in this garden in high enough numbers to allow us to rank the accession according to preference. The 21 accessions, mentioned above, have been established on field plots on mule deer winter ranges. When the plants are ready, we will conduct preference tests and determine monoterpenoid levels. These two measurements will be related together as an aid in determining any adjustment we may need to make on our breeding and selecting program.

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