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EFFECTS OF BROWSING BY MULE DEER ON TREE GROWTH AND FRUIT PRODUCTION IN JUVENILE ORCHARDS

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ABSTRACT.—The effects of big game depredation on juvenile fruit trees were studied in northern Utah. Utilization of trees was determined by counts of nipped and intact buds in spring. Height, width, basal diameter, number of buds, and initial fruit production of peach and apple trees were determined from trees protected from or browsed by mule deer in winter. Results from the 10 orchards studied indicated that removal of buds at the observed browsing levels had no effect on tree growth or initial fruit production.

Key words: depredation, mule deer, orchards, fruit trees, deer damage evaluation, apple trees, peach trees, winter browsing.

Whenever depredation occurs in commercial orchards, potential crop losses due to big game browsing become a major concern to growers. Browsing of juvenile fruit trees has important economic consequences because the effects may limit future crop production and increase tree mortality. Research has clearly shown that browsing by big game on mature apple trees causes significant crop loss within the browsing zone (Katsma and Rusch 1979, 1980, Austin and Urness 1989). However, limited information on the effects of browsing on juvenile fruit trees is extant.

Westwood (1978) suggested deer browsing may be especially damaging to young trees, but rarely would browsing be expected to cause mortality. Harder (1970) reported no differences in trunk diameter growth between protected and unprotected apple trees with one winter of bud-removal browsing by mule deer. In this Colorado study of 160 trees, no mortality was attributed to bud-removal browsing, although 8 trees died as a result of bark damage caused by antler rubbing. Similarly, McAninch et al. (1985) in a New York study reported 9 of 10 growth parameters measured between protected and browsed trees showed no significant differences. One parameter, basal diameter, was smaller on browsed trees. However, this study with white-tailed deer also showed that average diameters of browsed limbs appeared greater than protected limbs, suggesting possible growth stimulation as a result of deer browsing.

In our project only bud-removal browsing was studied, and since browsing during summer was negligible, we considered only overwinter depredation. The purpose of this study conducted in northern Utah was to measure the degree of browsing in young fruit trees and to assess the browsing effects on tree growth and initial crop production.

METHODS

The percentage of buds browsed by mule deer was determined in March, during late dormancy, after deer switched diets from winter browse to herbaceous spring growth (Kufeld et al. 1973, Austin and Urness 1983). Percent bud removal was determined by counting all intact and nipped buds and then dividing nipped buds by the total nipped plus intact buds. Nipped buds are easily identified by the exposed and broken woody twigs (Katsma and Rusch 1979). Counted intact buds were restricted to terminal buds of the previous summer's annual growth, and all protruded buds along second-year and older stems >1 cm in length (Austin and Urness 1987). Protruded was defined by visualizing a perpendicular line from the twig to the tip of the bud, and an observable space was required between the line and the bud-twig intersection.

Tree growth measurements were taken after

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the end of the growing season but before winter browsing occurred. Tree height was measured to the nearest 1.0 cm from ground level, tree width to the nearest 1.0 cm at the height where maximum width occurred. Width was measured in north-south and east-west directions and the mean recorded. Basal trunk diameter was measured to the nearest 0.1 cm using dial calipers at 10 cm above the graft scion. Diameter was similarly measured on north-south and east-west directions and the mean recorded. The number of intact buds, using the same definition as that for bud-removal determinations, was counted using hand-tally registers. Where harvestable crops were produced, all fruits were hand-picked and counted. Specific methods are reported in the results for each orchard.

Data were analyzed between protected and browsed trees and between trees with various intensities of browsing, using the standard t test of the means. Confidence level was set at $P \leq .05$.

RESULTS

Orchard 1

A 4 × 6 block of 24 equal age and size Elberta peach trees, planted in spring 1986, was selected for study. Alternating trees, determined by coin toss, were fenced during three winters, 1986–89. During the fourth winter, 1989–90, all trees were fenced. Because within-year browsing effects decrease fruit production (Katsma and Rusch 1980, Austin and Urness 1989), trees were protected from browsing to compare production between previously browsed and protected trees. Tree measurements were taken, and peaches were hand-picked and counted in late summer 1990, the first year of commercial harvest.

Percent bud removal as measured in spring 1987, 1988, and 1989 was 35.6, 76.6 and 73.5%, respectively. Even with this high degree of browsing by deer, trees fully recovered during the summer growing seasons. No differences between protected and browsed trees were found for any tree measurements or fruit production (Table 1).

Orchard 2

A small commercial orchard comprising 210 Elberta peach trees was planted in spring 1986. Percent overwinter bud removal was determined in early spring 1987. Since 9 trees showed bark scraping damage, they were deleted from the sample. Trees were placed into three equal groups of 67 by the percentage of bud-removal browsing damage: heavy 61–100%, moderate 34–60%, and light 0–33%. Tree measurements were made following the 1987 summer growing period. No differences in tree measurements were found among the three intensities of browsing by mule deer (Table 1).

Orchard 3

Twelve pairs of equal age and size Yellow Delicious apple trees were carefully selected by ocular observation within a commercial orchard planted during spring 1984. One tree of each pair, determined by coin toss, was protected from browsing by fencing during five winters, 1984–89. During the sixth winter, 1989–90, for the same reason as described for orchard 1, all trees were fenced.

Percent bud removal from browsing was 76.4, 60.5, 41.7, 23.6, and 63.2% for years 1985–89, respectively. No differences between protected and browsed trees were found for any tree measurements or fruit production (Table 1)

Orchard 4

Twelve pairs of equal age and size Red Delicious apple trees were carefully selected by ocular observation within a commercial orchard planted in spring 1983. One tree of each pair, determined by coin toss, was protected from browsing by fencing during three winters, 1984–87. During winter 1986–87 a deer-proof fence was constructed around the orchard, and, consequently, deer use was close to zero (0.4%). During the two previous winters (1984–86) percent bud removal was 71.0 and 17.0%, respectively. No differences between protected and browsed trees were found for either tree measurements or number of fruits (Table 1). Also, flower cluster counts, which were collected in spring 1987 as part of an ongoing parallel study (Austin and Urness 1987), showed no difference between protected ($\bar{x}$ = 166) and browsed ($\bar{x}$ = 169) trees.

Orchard 5

Twelve pairs of equal age and size Red Delicious apple trees were selected within a commercial orchard planted in spring 1985. One tree of each pair, determined by coin toss, was protected from browsing during four winters, 1985–1989. During the fifth winter, 1989–90, all trees were fenced.

TABLE 1. Mean growth measurements and initial fruit production from juvenile peach and apple trees protected from or browsed by mule deer in winter.

Orchard No.	Fruit tree	Treatment	N	Years	Mean tree measurements: % buds removed	Height (cm)	Width (cm)	Basal diameter (mm)	No. of buds	No. of fruits
1	Elberta peach	Browsed	12	1986–90	62	225	257	5.6	—	104
		Protected	12			230	247	5.7	—	103
2	Elberta peach	Heavily browsed	67	1986–87	61–100	120	88	2.6	61	—
		Moderately browsed	67		34–60	124	92	2.7	67	—
		Lightly browsed	67		0–33	122	91	2.7	65	—
3	Yellow Delicious apple	Browsed	12	1984–90	53	192	136	5.1	250	72
		Protected	12			193	149	5.2	238	70
4	Red Delicious apple	Browsed	12	1984–87	44	569	248	4.4	349	75
		Protected	12			588	262	4.4	375	59
5	Red Delicious apple	Browsed	12	1985–90	24	259	163	5.4	577	3
		Protected	12			250	158	5.4	570	3
6	Golden Delicous apple	Heavily browsed	20	1987	65–92	198[a]	93[a]	3.5	96	—
		Moderately browsed	20		28–64	192[a]	88	3.5	93	—
		Lightly browsed	20		0–27	175[b]	80[b]	3.5	92	—
7	Red Delicious apple	Heavily browsed	8	1985–86	49	88	22	1.7	11	—
		Moderately browsed	8		21	98	30	1.8	10	—
		Protected	8			92	21	1.6	7	—
8	McIntosh apple	Heavily browsed	8	1985–86	50	132	62	2.4	31	—
		Moderately browsed	8		35	126	47	2.1	22	—
		Protected	8			129	44	2.6	17	—
9	Jonathan apple	Heavily browsed	8	1985–86	28	147	69	2.4	26	—
		Moderately browsed	8		22	123	48	2.0	22	—
		Protected	8			131	69	2.0	45	—
10	Red Delicious apple	Browsed	12	1985–87	39.4	167	67	5.1	90	—
		Protected	12			159	63	5.0	107	—

[a,b]Figures with different superscripted numbers within columns were significantly different, $P \leq .05$.

Percent bud removal from browsing was 16.7, 0.0, 16.7, and 61.0 for years 1985–89, respectively. No differences between protected and browsed trees were found for any tree measurements or fruit production, which was greatly reduced in 1990 due to cold temperatures in spring (Table 1).

Orchard 6

A 2 × 30 block of 60 two-year-old Golden Delicious apple trees was measured for overwinter bud-removal browsing use in spring 1987. Utilization during the previous winter was unknown, but was probably similar to the use

measured in 1987. Percent bud removal ranged from 0 to 92%, with a mean of 46.7% (Table 1). Trees were placed into three groups of 20 by bud-removal classes: 0–27, 28–64, and 64–92%. Surprisingly, heavily and moderately browsed trees had significantly greater height at the end of the growing season than lightly browsed trees, and heavily browsed trees also had greater width than lightly browsed trees (Table 1). Although other factors, such as pruning, could have accounted for these increases, height and width may have been increased by browsing. No differences were found in basal diameters or number of buds.

Orchards 7, 8, 9

Twenty-four equal age and size trees of Red Delicious, McIntosh, and Jonathan apples were planted in spring 1985 for this study. In winter 1985–86, one-third (8 of each species) of the trees, randomly selected, were protected; one-third received moderate browsing by tame mule deer as modified by temporary fencing; and one-third received heavy browsing. Mean bud removal varied from 21 to 35% under moderate browsing, and 28 to 50% under heavy browsing (Table 1). Following the summer growing season in 1986, no significant growth differences in tree measurements were found between protected, moderately browsed, or heavily browsed trees (Table 1).

Orchard 10

Twelve pairs of equal age and size Red Delicious apple trees were selected within a commercial orchard planted in spring 1983. One tree of each pair, determined by coin toss, was protected from browsing during winters 1985–87. Percent bud removal from browsing was 76.6, 37.4, and 4.1%, respectively. No differences between protected and browsed trees were found (Table 1).

DISCUSSION

Percentages of bud removal measured from these 10 orchards were mostly less than 65%. Browsing by mule deer during winter dormancy at this level of use was not sufficient to cause a decrease in tree growth parameters measured. From the view of carbohydrate reserves, decreased productivity would not be expected if the total number of intact buds available for spring growth were sufficient to maintain balance with the root system. This was the observed case.

In this study trees were not browsed severely. As a suggested definition, severely browsed trees would include browsing of >90% of the available protruded buds, removal of >70% of the current annual growth, scraped bark on the central leader and/or scraped bark on two or more primary branches, or limb breakage. Certainly, as the level of browsing increases toward severe levels, the potential for permanent damage and reduced growth also increases. The level of browsing intensity needed to damage juvenile fruit trees is unknown, but it is apparently higher than that which occurs in most depredation situations in northern Utah and elsewhere (Harder 1970, McAninch et al. 1985).

The intensity of browsing needed to cause measurable damage would also be expected to vary with the quality of the horticultural practices involved in managing the orchard. In this study all orchards received high-intensity care, including adequate irrigation, periodic spraying, weed control, etc. Orchard trees receiving lower intensities of care and increased environmental stress from pests, or competition from weeds, may respond negatively to similar levels of deer browsing.

In conclusion, the results from this study of juvenile apple and peach fruit trees were consistent with previous research (Harder 1970, McAninch et al. 1985). Browsing by mule deer at the intensities observed had no negative effects on tree height, width, basal diameter, number of buds, or initial fruit production.

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