



The response to western wheatgrass and needle- and thread grass to grasshopper defoliation
by Wayne Hunter Burleson

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Range Science

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Abstract:

A study of plant growth response to various intensities of defoliation by grasshoppers was conducted to determine the influence of herbage removal on vigor and growth patterns of two common range grasses, western wheatgrass (*Agropyron smithii*) and needle-and-thread (*Stipa comata*). Greenhouse and field data indicated that increased grazing intensities significantly decreased root growth, tillering, rhizome production and regrowth. It was also determined on a Montana rangeland site that the major portion of grasshopper defoliation occurred after cessation of active growth of the two grass species studied.

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Date July 26, 1976

THE RESPONSE OF WESTERN WHEATGRASS AND NEEDLE-AND-THREAD
GRASS TO GRASSHOPPER DEFOLIATION

by

WAYNE HUNTER BURLESON

A thesis submitted in partial fulfillment
of the requirements for the degree

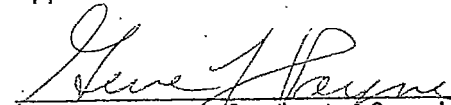
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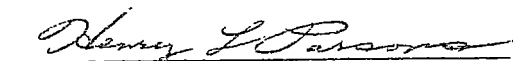
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ABSTRACT

A study of plant growth response to various intensities of defoliation by grasshoppers was conducted to determine the influence of herbage removal on vigor and growth patterns of two common range grasses, western wheatgrass (Agropyron smithii) and needle-and-thread (Stipa comata). Greenhouse and field data indicated that increased grazing intensities significantly decreased root growth, tillering, rhizome production and regrowth. It was also determined on a Montana rangeland site that the major portion of grasshopper defoliation occurred after cessation of active growth of the two grass species studied.

INTRODUCTION

The varied and pronounced effects of defoliation on grass plants should determine in part the basis for sound judgment in managing for the yield and quality of grassland productivity. There are detailed studies of the influence of hand clipping and grazing by livestock on rangeland forage species. Yet, little is known about the effects of insect defoliation, specifically grasshoppers on individual grass plants.

Rangeland grasshopper studies have dealt primarily with direct forage losses and not with the long-term effects of grasshopper defoliation. Research is needed on this latter component of the grassland ecosystem.

Studies reported herein were conducted under both greenhouse and field conditions to ascertain the influence of grasshopper grazing on western wheatgrass (Agropyron smithii) and needle-and-thread (Stipa comata).

LITERATURE REVIEW

Distribution and Importance

Western Wheatgrass

Western wheatgrass is an important perennial native rhizomatous grass distributed generally throughout the United States except in the humid southeastern states. It is most abundant in the northern and central parts of the Great Plains and is often the dominant grass over large areas (U. S. Forest Serv., 1937). Western wheatgrass is alkali-tolerant and grows in dense patches in well-drained bottom lands. It may also be found on open plains and in nearly pure stands on abandoned dryland farms in Montana (U. S. Dep. Agr., 1948).

Western wheatgrass is a valuable forage plant for all classes of livestock and is considered choice forage for elk and deer (U. S. Forest Serv., 1937). It cures well on the ground, thus making high quality winter forage and hay. Western wheatgrass has been used to some extent for revegetation; seed availability is adequate (Vallentine, 1974).

Needle-and-thread

Needle-and-thread is a deep-rooted, long-lived, native bunch-grass which occurs on western United States ranges and is most abundant on sandy soils of the Northern Great Plains (U. S. Dep.

Agr., 1948). It may be found in almost pure stands in an advanced stage of secondary succession on abandoned fields (Booth, 1950).

The forage value of needle-and-thread varies with regions, season of growth, and plant association. It is cut for hay in parts of Wyoming, North Dakota, South Dakota, and Nebraska where it rates as very good forage (U. S. Forest Serv., 1937). This grass provides early spring forage over much of eastern Montana but due to the stiff twisted awns, mechanical injury to livestock can occur at seed maturity (Booth, 1950).

Root Growth Characteristics

Both western wheatgrass and needle-and-thread are cool season grasses. Their principal growth period is in the cool, moist spring with decrease or cessation of growth during the summer. Optimum temperature for growth and net photosynthesis by temperate grass species ranges from 20^o to 25^o C (White, 1973).

Mueller (1941) indicated that root growth for western wheatgrass coincides with top growth. Active roots are white in color and vary from 0.2 to 1.0 mm in diameter. The thinner roots rarely exceed 30 cm in length and often grow horizontally while the thicker roots penetrate vertically but branch less densely. Depth of rooting varies considerably with climate, soil, and topography (Coupland and Johnson, 1965). Weaver (1942) determined the average root

growth rate of young western wheatgrass plants to be 8.4 mm/day for a three-month period. Its maximum rooting depth in Nebraska and Kansas ranged from 2.1 to 3.6 m while averaging 1.5 m in the more arid portions of the western United States (Weaver, 1958).

Hopkins (1953) found that the lower roots add little to the total weight of the root system. He indicated that in western wheatgrass only 15 percent of the total root weight occurred below the 30 cm level.

Weaver (1947) found that root decay was somewhat variable with species. Western wheatgrass had a tendency for less rapid decay than other species studied and a few roots retained tensile strength for three years. Weaver and Zink (1946) indicated root survival for western wheatgrass was 42 percent of tagged roots after the second summer.

Needle-and-thread is most extensively rooted in level, stabilized sand, where rooting depth reaches 150 cm with a lateral spread of 35 cm. Active roots are cream colored with two to seven main roots supporting each shoot of the bunch (Cupland and Johnson, 1965). In a study by Weaver (1958), needle-and-thread roots were more profusely branched and crisscrossed when compared to western wheatgrass roots.

Defoliation Studies

Past clipping studies (Aldous, 1930; Biswell and Weaver, 1933; Blaisdell and Pechanec, 1949; Wagner, 1952, Albertson et al, 1953; Heinrichs and Clark, 1960; Pond, 1961) have indicated that with increasing frequency and amount of plant tissue removed by clipping there is generally a decrease in grass productivity. Branson (1956) found that root production was affected more detrimentally than top production in relationship to top growth removal. In contrast to the above studies, Leopold (1949) found that clipping stimulated the production of tillers. In a Wyoming study by Baker and Hunt (1961), intermediate wheatgrass and pubescent wheatgrass clipped at 10 cm produced significantly more tillers than those clipped at 5 cm.

Changes in plant structure induced by prolonged heavy grazing of needle-and-thread appear to favor persistence (Peterson, 1962). Changes were as follows: (1) relatively rapid regrowth after clipping, (2) greener and more vigorous shoots, (3) maintenance of moderate carbohydrate reserve levels, (4) slower spring growth, (5) a shorter and more prostrate growth. Hanson et al (1931) found that western wheatgrass increased more under continuous grazing than under protection from grazing.

In a review, Jameson (1963) stated that, generally, root production was universally depressed when defoliation occurred,

while the yield of above ground parts was somewhat erratic. Crider (1955) reported that removal during the growing season of half or more of the foliage of both cool and warm season grass species (including bunch, rhizomatous, and stoloniferous types) caused root growth to stop for a period of time after each removal. Root growth stoppage usually occurred within 24 hours and continued until tops recovered. Crider (1955) presented the following data:

Percent Top Removal	Percent Root Stoppage	No. Days Complete Root Stoppage
90	100	17
80	100	12
70	78	0
60	50	0
50	2	0

No root stoppage was indicated in this study from a top reduction of 40 percent or less. A study by Parker and Sampson (1931) showed that a single harvest of foliage resulted in temporary cessation of root growth in soft chess (Bromus hordeaceus) and purple needlegrass (Stipa pulchra). This cessation was followed by an immediate increase in growth of the tops.

Branson (1953) listed two factors which affect the resistance of grasses to grazing: (1) the height to which the growing point (apical meristem) is raised, and (2) the ratio of fertile culms

to vegetative culms. His studies found that the vegetative culms of western wheatgrass raised their growing points from 16 cm in June to 40 cm in September. This would allow for their growing points to be removed by grazing so that no new leaves would be produced by those culms. He also noted that removal of the inflorescences has an effect similar to removal of elevated growing points.

Grasshopper Grazing

Grasshopper damage to rangeland has been an economic concern in the United States since the early 1800's (Parker and Connin, 1964). Cowan (1958) listed grasshoppers in the United States as being in the upper 10 most troublesome insect pests to agriculture. In an Arizona study, Nerney (1958) found grasshoppers to be in direct competition with livestock for available forage and were at least partly responsible for the decline in productivity of shortgrass rangelands. He found that preferred habitats of economic grasshopper species were associated with poor rangelands. These poor rangelands were generally dominated by low-growing weeds.

In the past, many published evaluations of grasshopper damage in relation to rangeland vegetation losses have been too generalized. Anderson (1972) indicated difficulties in interpreting data from damage studies as follows: changes in density of grasshopper populations, uneven feeding patterns, non-random distribution of

vegetation and grasshoppers, varied food-plant preference and food selectivity within plant species, and a lack of knowledge concerning plant growth phenomena as related to defoliation.

Newton and Esselbaugh (1952) stated that when grasshoppers feed on plant material near the ground they contribute to overgrazing, weakening of the root reserves, and may possibly be providing a way for later soil erosion. New Zealand grasshoppers are basically low-volume grazers but because of their selective feeding habits they can exert high grazing pressure on certain plant species (White, 1974).

Cowan (1958) stated that damage to rangeland vegetation is governed by the grasshopper species, the vegetation complex, the number of grasshoppers, and the weather. Three types of damage are possible: (1) removal of forage in direct competition with livestock, (2) permanent damage to plants due to continued feeding by grasshoppers beyond percent use factors, and (3) destruction of seed heads. However, not all grasshopper damage studies have indicated that a loss of vegetation results from grasshopper grazing. Harris (1974) explained how sometimes no loss, or even an increase in plant yield, may come about due to insect feeding. He stated that defoliated plants may redirect limiting nutrient resources to undamaged tissue and develop a surplus. Also, early removal of apical dominance of growing plants may stimulate tillering.

In a grasshopper damage study on Montana rangelands, Anderson (1961) found little correlation between numbers of grasshoppers per unit area and loss of vegetation. In a summary by Anderson (1972), clipping effects on vegetation suggested that grasshoppers may be responsible for permanent damage to rangeland vegetation, but he also indicated that grasshoppers under certain circumstances may be responsible for increases in forage production over a period of years.

DESCRIPTION OF FIELD STUDY AREA

A study area was selected 12.8 km northeast of Three Forks, Montana in Broadwater County. A 16 ha experimental site was exclosed from livestock grazing in 1973. This site had previously been plowed, approximately 30 years earlier, and later abandoned. The area is located on an upland bench with a two percent slope and a southeast exposure. A small water run-in area traverses the enclosure.

The soil type is classified as a Brocko series in the mixed family Borollic Calciorthid (SCS, National Cooperation Soil Survey, 1972). The texture throughout the profile ranges from very fine sandy loam to silt loam with 8 to 18 percent noncarbonate clay and 1 to 14 percent fine sand to coarser particles. Brocko soils are formed from eolian material which has been deposited over older river terraces.

The climate is cool, semiarid with an annual average precipitation of 30.5 cm in which most of the precipitation occurs during the spring months. Three years of precipitation and temperature data are summarized on Tables 1 and 2 respectively. These data were recorded at Trident, Montana approximately 8 km southeast of the actual study site.

TABLE 1. Three year summary of monthly precipitation (centimeters) near the Three Forks Study Site. Data were taken at Trident, Montana.^{1/}

YEAR	MONTH													
	JA	FE	MA	AP	MY	JU	JL	AG	SE	OC	NO	DE	TOTAL/YEAR	
1973	Total Precipitation	.53	.76	.84	1.85	E ^{2/} 1.85	9.17	E .91	2.71	E4.70	E4.93	E2.30	.84	E 29.57
1974	Total Precipitation	.03	.05	1.55	.38	3.81	1.02	1.09	4.42	.48	1.98	.89	.61	16.31
	Deviation from Mean	-.94	-.61	.03	-2.26	-1.14	-5.54	-1.57	1.47	-2.69	.20	-.36	-.22	-13.64
1975	Total Precipitation	1.45	1.30	1.14	3.40	9.30	7.70	7.01	3.12	.99	5.74	.33	.58	42.06
	Deviation from Mean	.48	.64	-.38	.76	4.34	1.14	4.34	.18	-2.18	3.96	-.91	-.25	12.12

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^{1/} U. S. Dept. of Commerce Administration, National Oceanic and Atmospheric Administration, Environmental Data Service, Vol: 76,77,78

^{2/} Amount is partially estimated

TABLE 2. Three year summary of monthly temperatures (degrees Celsius) near the Three Forks Study Site. Data were taken at Trident, Montana.^{1/}

YEAR		MONTH											
		JA	FE	MA	AP	MY	JU	JL	AG	SE	OC	NO	DE
1973	Mean/Mo.	- 6.1	- 4.7	3.1	5.9	12.2	17.0	21.4	20.9	13.3	9.2	-0.1	0.2
	Max. Mean	- 0.3	-92.3	9.1	12.8	21.3	25.6	31.5	30.8	20.9	17.2	4.7	5.7
	Min. Mean	-11.9	-11.9	-3.0	- 0.9	2.7	8.3	11.3	11.1	5.6	1.3	-4.8	-6.2
1974	Mean/Mo.	- 6.4	0.1	1.6	8.6	9.9	18.6	21.8	17.0	12.4	8.5	1.6	-3.2
	Max. Mean	- 1.4	5.8	7.6	14.9	16.2	27.8	31.6	25.0	22.6	18.2	7.8	2.2
	Min. Mean	-11.4	- 5.8	-4.6	2.2	3.7	9.4	12.0	8.9	2.3	-1.2	-4.7	-8.6
1975	Mean/Mo.	- 5.3	- 5.9	-9.7	1.6	10.0	14.8	21.7	18.2	13.8	7.9	-0.1	-1.3
	Max. Mean	0.4	0.2	4.3	7.3	17.2	22.8	30.4	26.8	24.1	14.5	6.6	4.3
	Min. Mean	-11.1	-11.9	-5.7	- 4.2	2.8	6.2	12.9	9.4	3.5	1.3	-6.8	-6.9

^{1/} U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Vol: 76, 77, 78

