Contrasting Responses of Squirreltail and Needleandthread to Herbage Removal

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Highlight

Clipping squirreltail and needleandthread from preseed formation to postseed formation affected herbage yields least at seed cast. After seed cast during summer months, clipping damaged squirreltail mildly, but damaged needleandthread seriously. Squirreltail became dormant in July, so it resisted serious damage by clipping after that time. By contrast, needleandthread did not become dormant at any time in summer so it did not resist serious damage. If plants are dormant, grazing may not be very harmful to them regardless of the stage of plant development. On the other hand, if the plants are not dormant, rest from grazing when temperatures are high might be more desirable than rest from grazing during seed formation.

Recent study by Wright and Klemmedson (1965) shows that squirreltail *(Sitanion hystrix)* (also known as "bottlebrush squirreltail") is damaged only slightly by fire as compared with needleandthread *(Stipa comata)*. The contrasting yields of these species after burning are unusual and difficult to explain by heat damage alone. Thus, the objective of this study was to determine whether these species differed in susceptibility to damage by herbage removal. The results pointed out pronounced physiological differences between squirreltail and needleandthread.

Most of the literature on clipping studies indicates that herbage removal is most harmful to plants either at the early stage of plant growth or at the time of seed formation (Cook et al., 1958; Jameson, 1963). For example, clipping harms mountain brome *(Bromus marginatus)* and slender wheatgrass *(Agropyron trachycaulum)* more during the period of active reproduction than at any other stage of growth (McCarty and Price, 1942). Similarly, clipping damages bluebunch wheatgrass *(Agropyron spicatum)* most severely immediately after seed heads are out of boot (Blaisdell and Pechanec, 1949). In northeastern Idaho, clipping damages needleandthread most severely from boot stage to complete maturation of the fruit (Pearson, 1964).

Despite a decline in carbohydrate concentrations at flowering time for crested wheatgrass *(Agropyron desertorum)*, Hyder and Sneva (1959) concluded that flowering was not the direct cause for this decline. Their conclusion was based on a deheading experiment, which did not affect carbohydrate trends. In a literature review, Jameson (1963) reported similar data by a few other researchers.

Two studies suggest that summer dormancy influences the response of plants to herbage removal. In areas of little or no summer growth, Stoddart (1946) found that we must give spring-grazed plants an opportunity to regrow before the dormant period if we wish to prevent serious physiological disturbance. His view was later supported by Blaisdell and Pechanec (1949) who concluded that complete herbage removal can seriously impair plant vigor after the date when substantial regrowth is impossible, and before maturity.

Summer dormancy in herbaceous perennials is defined by Laude (1953) as a phenological period when ". . . plant growth may become greatly limited or completely cease." By definition, growth is the progressive development of an organism and is usually defined by quantitative expressions, such as increase in size or number of cells, weight, volume, etc. (Curtis and Clark, 1950). In my opinion, even though growth has ceased in a plant, the plant should not be considered dormant unless photosynthesis becomes greatly limited or completely ceases. This will be the definition of summer dormancy in this paper.

The beginning of dormancy for different species within one genus may vary with moisture stress, temperature, day length, and other factors. Laude (1953) shows that *Poa secunda* and *P. nevadensis* begin dormancy only when moisture becomes limited. *Poa scabrella*, however, begins dormancy in early June, no matter how much moisture is available; long days and temperatures above 75 F induce dormancy.

Inherent dormancy in one ecotype but not in another characterizes some species. "Summer dormancy occurs in many Mediterranean populations of *Dactylis glomerata* (Knight, 1960) . . . some forms are capable of responding to added water, while others remain dormant even under irrigation." (Cooper, 1963). Cooper suggests that "... such obligatory summer dormancy may have been selected in regions with occasional but unreliable rains."

Methods

Stands of squirreltail and needleandthread grow on adjacent sites at the study area 0.5 mi north of Boise, Idaho. Elevation is 2,750 ft and average annual precipitation is 11.43 inches. The soil dominated by needleandthread is sandy and shows weak profile development. The soil dominated by squirreltail is high in clay and shows strong profile development.

Sixty plants (2 to 6 inches in diameter) of each species were randomly divided into five groups. Each month from May 19 to September 21, 1962, one group of plants of each species was clipped 1 cm above the soil surface. Concurrently, percentage of plant moisture (ovendry basis) and phenological data were recorded.

In September 1962, numbers of culms (regrowth) produced within the year of treatment were counted. One growing season after clipping, herbage of squirreltail and needleandthread was harvested on July 5 and June 5, 1963, respectively. These dates correlated with the mature stage of seed of the two species. Ovendry weights of the herbage were analyzed.

Results

Damage to plants by clipping, as reflected in subsequent herbage yield, was moderately severe for squirreltail and needleandthread on May 19 and June 10 (Fig. 1). On July 21 and August 20, clipping severely affected needleandthread, while it only mildly affected squirreltail. During September, squirreltail continued to withstand more

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damage than needleandthread, but the tolerance of both species approached a common mean.

Contrary to previous data on needleandthread and other species, this study shows that the last stages of seed formation (seed heads fully out of boot to seed maturity) were not the most critical stage of plant growth for either squirreltail or needleandthread. Both species were most tolerant to clipping at the time of seed maturity. After seed maturity, needleandthread became extremely susceptible to clipping; by contrast, the tolerance of squirreltail to clipping declined only slightly.

Summer dormancy appears to greatly influence the opposing cyclic responses of these species to herbage removal. Observations and measurements indicate that summer dormancy occurs in squirreltail, but not in needleandthread. Needleandthread regrew after clipping on June 10, while squirreltail did not. This is shown in the following tabulation, which compares the number of culms per plant in September 1962 on plants clipped in May and June 1962.

Species	May 19	June 10
Squirreltail	72	1
Needleandthread	62	68

This response of regrowth is unusual since needleandthread casts most seed from June 10 to 15, and bottlebrush squirreltail does not cast seed until July 15. After seed cast, needleandthread remains green and relatively high in moisture content, while squirreltail becomes gray and relatively low in moisture content (Table 1).

Two factors substantiate that needleandthread was photosynthetically active all summer: (1) increasing tolerance to clipping from August to September (Fig. 1), and (2) the presence of green leaves throughout the summer. By contrast, the declining tolerance to clipping and the dry leaves of squirreltail after July 21 indicate that it was photosynthetically inactive, or nearly so, during the latter half of the summer. From this I conclude that summer dormancy occurs in squirreltail but not in needleandthread.

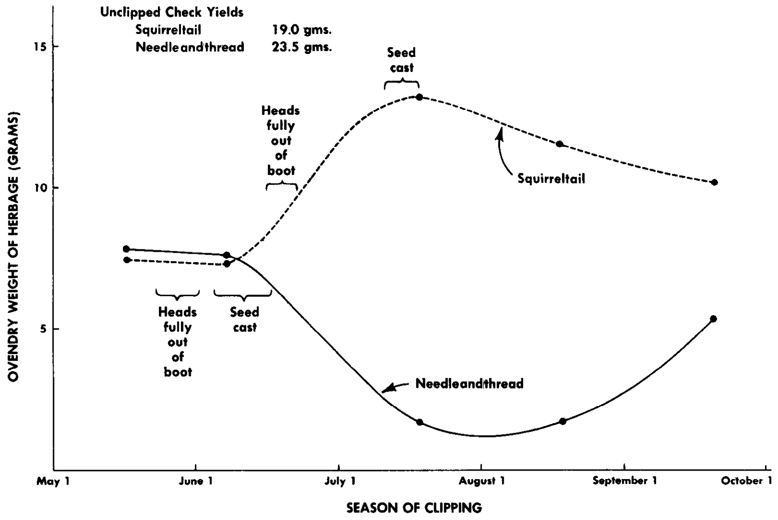

FIG. 1. Average herbage yield per plant for squirreltail and needleandthread in relation to time of clipping in the previous growth year.

Table 1. Moisture content (percent based on ovendry weight) of living tissue of squirreltail and needleandthread at time of clipping.[1]

Treatment date	Squirreltail	Needleandthread
May 19	165.5	157.8
June 10	126.6	129.4
July 21	53.0	82.1
Aug. 20	38.0	65.8
Sept. 21	27.5	61.3

[1] Differences between species are statistically significant (P.=0.01) in July, August, and September.

Table 2. Total precipitation (inches) and average air temperatures (°F) for time intervals between clipping dates.

Time interval (1962)	Precipitation	Ave. air temp.
May 1-May 19	0.95	57
May 20-June 10	2.04	56
June 11-July 21	0.03	69
July 22-Aug. 20	0.16	75
Aug. 21-Sept. 21	0.05	66

Discussion

The different responses of squirreltail and needleandthread to clipping relate to dormancy. After July 15, squirreltail seems to have photosynthetically inactive leaf tissue, to form few or no carbohydrates, and to have low respiratory rates. During this same time, needleandthread seems to have photosynthetically active leaf tissue, to form carbohydrates, to have high respiratory rates, and possibly to have a breakdown and translocation of starches and sugars from the leaves and stems. The attributes of squirreltail are those of a dormant plant, while the attributes of needleandthread are those of a nondormant plant.

High air temperatures during July and August (Table 2) perhaps cause high respiratory rates in active leaf tissue of needleandthread. Such high respiratory rates could result in negative photosynthetic rates and could reduce stored carbohydrates in July and August. Support for this deduction comes from Rappe (1951). He found that, in Sweden, high air temperatures depress midsummer pasture yields. During September, however, lower air temperatures possibly allow photosynthesis to exceed respiration. This may allow accumulation of carbohydrates and explain the increased tolerance of needleandthread during September. Kido and Yanatori (1959) mention that carbohydrate accumulations of *Oryza sativa* in autumn correlate with low respiratory rates in roots.

Despite high air temperatures, it is my opinion that respiratory rates in squirreltail were low after July 15, since this species is dormant during the summer. Respiration in the green stem bases may account for squirreltail's slight but steady decline (significant at P. 0.10) in tolerance to herbage removal in August and September. Before herbage is removed during these months, the stem bases apparently use stored food from the roots.

Fruit development is an unlikely cause for the depressed herbage yield of needleandthread during July and August, since seed were cast in June. Fruit development obviously did not depress the yield of squirreltail. Several researchers have shown that developing fruits account for only a small part of the carbohydrates lost during fruiting (Jameson, 1963). Possibly the plants referred to in Jameson's review lost large quantities of carbohydrates because of high respiratory rates. This also might have been the cause for the depressed herbage yields of needleandthread in this study.

In other studies needleandthread responded to treatment earlier in the season when it was clipped (Pearson, 1964) and when it was burned (Wright and Klemmedson, 1965). The difference in response relates to moisture. The earlier work was done in 1960, a dry year, whereas this work was done in 1962, a wet year. Wet years seem to delay the time of extreme susceptibility to damage.

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