Growth Characteristics of Squirreltail Seedlings in Competition with Medusahead

M. HIRONAKA AND BRIAN W. SINDELAR

Highlight: A competition study between several densities of medusahead (*Taeniatherum asperum* (Sim) Nevski) and a constant number of squirreltail (*Sitanion hystrix* Scribn.) seedlings was conducted over an 85-day period in the greenhouse. At the end of experiment the average root weight of squirreltail was greater than that of medusahead even though the average shoot weight of medusahead was greater in all treatments where the two species were grown together. Squirreltail contributed only a small proportion of the total leaf length produced in containers with high densities of medusahead, but the proportion remained relatively constant throughout the experiment. In treatments where medusahead densities were low to moderate, the proportion of total leaf length produced by squirreltail decreased steadily over time.

Attempts to establish introduced perennial grass species by direct seeding into natural stands of cheatgrass (*Bromus tectorum* L.) or medusahead (*Taeniatherum asperum* (Sim) Nevski) have repeatedly failed (Hull and Pechanec, 1947; Stewart and Hull, 1949; Torell et al., 1961; Harris, 1967). However, instances of replacement of cheatgrass and medusahead by natural establishment of native squirreltail grass (*Sitanion hystrix* Scribn.) have been reported in Idaho (Hironaka and Tisdale, 1963; Tisdale et al., 1969). Successful establishment of squirreltail when broadcast seeded in natural stands of medusahead with densities in excess of 100 plants per square foot has been reported (Sindelar, 1968; Hironaka and Sindelar, 1973).

The behavior of squirreltail seedlings under the stresses of competition has not been closely observed. This knowledge would allow better understanding of how squirreltail is able to successfully invade established stands of medusahead or cheatgrass. The performance of squirreltail seedlings in competition with medusahead is herein reported.

Procedure

Squirreltail seedlings were grown alone, and with various numbers of medusahead seedlings, in 8" X 36" galvanized steel containers in the greenhouse. Loam soil from an area where medusahead is the dominant species was used. The soil was screened and autoclaved for 24 hours before being placed in the containers. This killed extraneous seeds already present in

the soil. The filled containers were watered for 6 days prior to seeding to ensure soil saturation at the beginning of the experiment.

Three replications of 0, 4, 12, 36, 108, and 324 medusahead seedlings were uniformly established with 10 squirreltail seedlings. These densities correspond to 0, 9, 27, 81, 243, and 729 medusahead and 22 squirreltail plants per square foot. Germination occurred 4 days after planting. No water was added after germination until the end of the experiment. Natural daylight was supplemented by fluorescent "grolux" lights to achieve a 14-hour photoperiod. Day temperatures ranged from 25 to 30°C and night temperatures did not fall below 10°C. The containers were periodically rotated within randomized blocks.

Shoot growth was measured daily during the initial 2 weeks and weekly thereafter. Measurement consisted of total length of leaves (TLL) per individual plant. Measurement on medusahead was from 10 randomly selected individuals in each container except those with only four plants, in which case, all four were measured. The number of medusahead

Fig. 1. Average total green leaf length (TLL) of squirreltail at different medusahead densities.

Authors are professor and former graduate assistant, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow. Sindelar is at present at Montana State University, Bozeman.

This study was supported in part by funds received from the Bureau of Land Management, U.S. Department of the Interior.

Manuscript received July 26, 1974.

Fig. 2. Average total green leaf length (TLL) of medusahead at different medusahead densities.

plants measured per container was reduced to five when sampling time became excessive. All squirreltail plants were measured. Only green leaves or portions thereof were involved in the measurement.

After 85 days all plants were clipped, oven-dried at 68°C for 24 hours, and weighed. Roots from two replications of each density level were recovered, separated, oven-dried (68°C for 24 hours), and weighed.

Results

The TLL (total green leaf length) of individual squirreltail plants decreased with increased medusahead density. The effect of medusahead competition on squirreltail growth was not detected until the plants were 5 weeks old, as reflected by a slowdown in rate of growth, and then only in those containers with 108 and 324 medusahead plants. There was little difference in growth rate of squirreltail growing with 0, 4, 12, and 36 medusahead plants until the 7th week. Differences in growth of squirreltail increased rapidly with time thereafter.

Cessation of leaf growth of squirreltail varied among treatments (Fig. 1). With 324 medusahead plants, reduction in TLL of squirreltail began during the 6th week. Two and a half weeks later, reduction was noted in treatments with 108 and 36 medusahead plants. At 10 weeks, the remaining two treatments showed declines in TLL. Squirreltail grown alone continued to increase its TLL during the entire period.

The effect of intraspecific competition among medusahead plants became evident by the 4th week as expressed by reduced rate of increase in TLL (Fig. 2) in containers with 108 and 324 medusahead plants. Actual reduction in TLL of medusahead was not detected until the 7th week in containers with 324 medusahead plants. A week later reduction was noted in those containers with 108 medusahead plants. Reduction in TLL occurred after the 10th week for the remaining containers with medusahead.

Fig. 3. Percent squirreltail of total green leaf length per box at different medusahead densities.

Squirreltail contributed only a small portion of the total leaf length in containers with 324 medusahead plants. This small proportion remained relatively uniform throughout the study with high density of medusahead. In the low density containers, the proportion of squirreltail to medusahead's TLL decreased steadily as time progressed (Fig. 3).

After 85 days, weight of individual medusahead plants was greater than squirreltail in all treatments where both species were grown together. Differences between the average individual shoot weights of the two species decreased as medusahead density increased (Fig. 4). There was good correlation between the average shoot weight of the two species. Containers with the highest density of medusahead produced the smallest individuals of both species (Fig. 5).

Average root weight of squirreltail was greater than that of medusahead in all containers (Table 1). Shoot-root ratios of squirreltail were significantly lower than for medusahead. As medusahead density increased, the shoot-root ratios of both species decreased, indicating that shoot weight was more affected than root weight. Diminished root development of squirreltail was evidenced by fewer roots penetrating to the

Fig. 4. Average shoot weight (g) of squirreltail and medusahead grown 85 days at different medusahead densities.

Table 1. Squirreltail and medusahead shoot and root weights (g) at different medusahead densities, after 85 days.

Density	Species	Avg shoot wt*	Avg root wt**	Total	Shoot: root
0	Squirreltail	1.00	.40	1.40	2.57
4	Squirreltail	.45	.24	.69	1.96
	Medusahead	1.82	.18	2.00	11.95
12	Squirreltail	.26	.14	.40	2.26
	Medusahead	.88	.04	.92	18.81
36	Squirreltail	.14	.08	.22	1.95
	Medusahead	.34	.03	.37	11.25
108	Squirreltail	.06	.03	.09	2.00
	Medusahead	.14	.02	.16	8.75
324	Squirreltail	.02	.02	.04	0.95
	Medusahead	.05	.02	.07	3.25

* Average shoot weight per individual of all seedlings in three replications of each treatment.

**Average root weight per individual of all seedlings in two replications of each treatment.

bottom of containers, reduced number of roots per individual, and reduced branching with increase in medusahead density.

At the time of clipping, all squirreltail seedlings were alive; but the number of live medusahead in the highest density containers had decreased. Only 155 of the 324 medusahead plants recovered when rewatered after clipping, whereas all squirreltail seedlings produced new growth.

Discussion

It was significant that no mortality of squirreltail seedlings occurred. In a similarly designed experiment by Evans (1961) with crested wheatgrass (*Agropyron desertorum* (Fisch.) Schult.) and cheatgrass, mortality of crested wheatgrass was reported, presumably in the high cheatgrass density treatment (256 cheatgrass plants per square foot). There is evidence that the evapo-transpiration rate for cheatgrass is higher than for medusahead (Dahl, 1966). This would result in a higher soil moisture depletion rate and may explain the mortality of crested wheatgrass in Evans' study, whereas none was observed in this experiment. A relative performance study of squirreltail and crested wheatgrass under similar conditions of competition stress is unknown to the authors.

If we consider squirreltail to be a successful invader of annual grass stands, and crested wheatgrass as an unsuccessful species, the difference between the two species may be related to their rate of root development as compared to root development rate of annual grass. On an individual basis, root biomass of squirreltail surpassed that of medusahead in all treatments, whereas cheatgrass produced more root material per individual than did crested wheatgrass (Evans, 1961). Shoot biomass was greater for annual grasses in both studies.

The ability of a perennial grass seedling to become established in the Intermountain region depends on whether

SQUIRRELTAIL SHOOT WT IN GRAMS

Fig. 5. Regression of squirreltail shoot weight (g) on medusahead shoot weight (g) on medusahead shoot weight (g) in density study.

the seedling is able to survive the semidormant or dormant stage during the summer, when temperature and moisture stresses are high. This ability is probably related to the amount of root reserves the seedling root system is able to store. With sufficient root reserves, the seedling is able to withstand the summer drought period and resume growth when conditions again become favorable. Squirreltail seedlings appear better able to store sufficient root reserves under conditions of competition with annuals than most other perennial grass species in the Intermountain region.

Literature Cited

- Dahl, B. E. 1966. Environmental factors related to medusahead distribution. PhD Diss., Univ. of Idaho, Moscow. 122 p.
- Evans, R. A. 1961. Effects of different densities of downy brome (*Bromus tectorum*) in growth and survival of crested wheatgrass (*Agropyron desertorum*) in the green house. Weeds. 9:216-223.
- Harris, G. 1967. Some competitive relationships between *Agropyron spicatum* and *Bromus tectorum*. Ecol. Monog. 37:89-111.
- Hironaka, M., and E. W. Tisdale. 1963. Secondary succession in annual grass vegetation in southern Idaho. Ecology. 44:810-812.
- Hironaka, M., and B. W. Sindelar. 1973. Reproductive success of squirreltail in medusahead infested ranges. J. Range Manage. 26:219-221.
- Hull, A. C., Jr., and J. F. Pechanec. 1947. Cheatgrass—a challenge to range research. J. Forest. 45:555-564.
- Sindelar, B. W. 1968. An investigation of the competitive ability of *Sitanion hystris*. MS Thesis. Univ. of Idaho, Moscow. 59 p.
- Stewart, G., and A. C. Hull, Jr. 1949. Cheatgrass (*Bromus tectorum* L.)—An ecological intruder in southern Idaho. Ecology. 30:58-73.
- Tisdale, E. W., M. Hironaka, and M. A. Fosberg. 1969. The sagebrush region in Idaho—a problem in range resource management. Univ. of Idaho Agr. Exp. Sta. Bull. 512. 15 p.
- Torell, P. J., L. C. Erickson, and R. H. Haas. 1961. The medusahead problem in Idaho. Weeds. 9:124-131.