Yield and Nutritional Quality of Intermediate Wheatgrass Infested by Black Grass Bugs at Low Population Densities

JOHN C. MALECHEK, ALAN M. GRAY, AND B. AUSTIN HAWS

Highlight: Black grass bugs (*Labops hesperius*) at a population density of 156 bugs per square meter did not affect herbage yields of intermediate wheatgrass but depressed seedhead production 56%. They caused a small but significant increase in concentrations of crude protein and a slight decrease in cellular contents.

An important question in the management of wheatgrass monocultures during recent years has been the effect of the grass bug *Labops* spp. (*Hemiptera: Miridae*) on forage yields, forage quality, and stand longevity. Grass bugs occur throughout the Intermountain and adjacent areas (Bohning and Currier 1967; Denning 1948; Todd and Kamm 1974) and have been reported to cause extensive damage to crested wheatgrass (*Agropyron cristatum*) and intermediate wheatgrass (*A. intermedium*) stands in some areas (Knowlton 1967; Haws et al. 1973). Their effect on nutritional quality of forage has remained virtually unknown, although Todd and Kamm (1974) inferred significant short-term losses in a recent Oregon study.

The study reported here was initiated to determine the effects of relatively low population densities of black grass bugs (*Labops hesperius*) on yield and nutritional quality of intermediate wheatgrass.

Methods and Materials

Two intermediate wheatgrass seedings were selected as study areas in the spring of 1974. Major criteria used in selection of these areas included uniformity of soils, topography, and grass stands and presence of grass bug populations that were large enough to impart the characteristic yellowing of the grass leaves, commonly attributed to feeding activities.

At the time of the research, authors were associate professor and graduate student, Department of Range Science, and professor, Department of Biology, Utah State University, Logan 84322. At present Gray is range conservationist, Charles M. Russell National Wildlife Refuge, Fort Peck, Montana 59223.

The work is Contribution No. 2134, Utah Agricultural Experiment Station.

The authors wish to acknowledge the following Utah ranchers for providing study areas: Messrs. Gene Bertagnole, Bud Carter, Vernal Carter, and Howard Mattsson. They also wish to thank Dr. Dale Bartos for his critical review of the manuscript and Mr. Kim Marshall for his assistance with the statistical analysis of data.

Manuscript received September 24, 1975.

Site 1 was located approximately 0.5 km north of the East Canyon Reservoir, Morgan County, in northern Utah at an elevation of 1,750 meters. Site 2 was located 29 km east of Salina, Sevier County, in central Utah and at an elevation of 2,200 meters.

At each site, an infested plot and an uninfested control plot were established. Both plots at Site 1 were 0.1 ha in area. Ocular appraisal at the time the plots were selected indicated that the infested plot supported a larger population of grass bugs than did the control plot. At Site 2, the control plot (0.14 ha) was located on a part of the wheatgrass seeding that had been sprayed with Malathion at the rate of 0.56 kg active ingredient/ha the previous year, while the infested plot (0.40 ha) was located on a part of the seeding that had not been previously sprayed. Although the two plots were separated by a distance of roughly 300 m, both were similar in terms of the site and stand criteria mentioned above.

The control plot on Site 1 was hand-sprayed with Malathion in early spring at the rate of 0.56 kg active ingredient/ha. Preliminary examination of the control plot at Site 2 indicated that there were not enough grass bugs present in 1974 to warrant spraying.

Sampling of the grass stands for determinations of yield, forage quality, and grass bug population densities was begun in late May at Site 1 and early June at Site 2 and was continued at 3-week intervals through mid-September.

Two methods were used to determine bug densities. The sweep method (Southwood 1966), using a standard 0.38-m diameter insect net, was employed on the initial sampling date at Site 1. On all subsequent sampling dates at both sites a D-Vac® sampler was used, in addition to sweep sampling, to collect bugs from randomly located 1-m^2 circular quadrats immediately prior to clipping herbage for yield determinations (n=15 quadrats/treatment). The quadrat ring was constructed of 0.5-cm sheet steel with a depth of 20 cm and a beveled bottom edge. When the ring was positioned into the soil surface, bugs were prevented from moving into or out of the quadrat.

Grasses occurring in the quadrats were clipped at ground level and immediately bagged or labeled. These samples were later dried in the lab at 90°C for 48 hours, then allowed to equilibrate with ambient moisture conditions before weighing. Following initiation of reproduction in mid-July, all wheatgrass inflorescences within the quadrats were counted prior to clipping.

Following clipping, the quadrats were again vacuumed with the D-Vac® sampler. Bugs that escaped the second vacuuming were collected with aspirator bottles. Vacuum samples were thoroughly examined in the laboratory and all bugs were counted. Tyler® standard screens of 9-, 14-, and 60-mesh were used to separate bugs from debris.

Herbage samples for chemical determinations were collected along a line transect in each plot. Entire plants were clipped at ground level, placed on ice in a cold storage chest, and transported to the laboratory where they were freeze-dried and milled to pass a 40-mesh screen. Approximately 20 plants were collected and aggregated into one sample for each treatment on each sampling date. Crude protein was then determined by the macrokjeldahl method described by Harris (1970). Cell contents and cell walls were partitioned by the neutral detergent method (Van Soest 1967).

Additional assessments of effects of grass bugs on forage nutritional quality were made in a digestion-balance trial with sheep. Approximately 115 kg (air dry) of herbage were mown from each of two areas, one immediately adjacent to the control plot and one adjacent to the infested plot, at Site 2 on July 2. Plants from these two areas exhibited similar characteristics as those within the two respective adjacent experimental plots.

After air drying, the herbage was chopped to approximately 5-cm lengths in a forage chopper and was fed in a standard digestion-balance trial (Harris 1970), utilizing two 35-kg Targhee × Columbia yearling ewes per treatment in a completely random design. Variables measured included daily dry matter consumption and apparent dry-matter digestibility.

The field data on herbage production, seedhead production, and percentage dry matter were evaluated statistically by analysis of variance. Comparisons of treatment means at each sampling date were accomplished by the least significant difference (LSD) test (Steel and Torrie 1960). Data on percentage crude protein and percentage cellular contents were analyzed by a paired *t*-test (Steel and Torrie 1960). Results from the digestion-balance trial were compared by simple analysis of variance procedures.

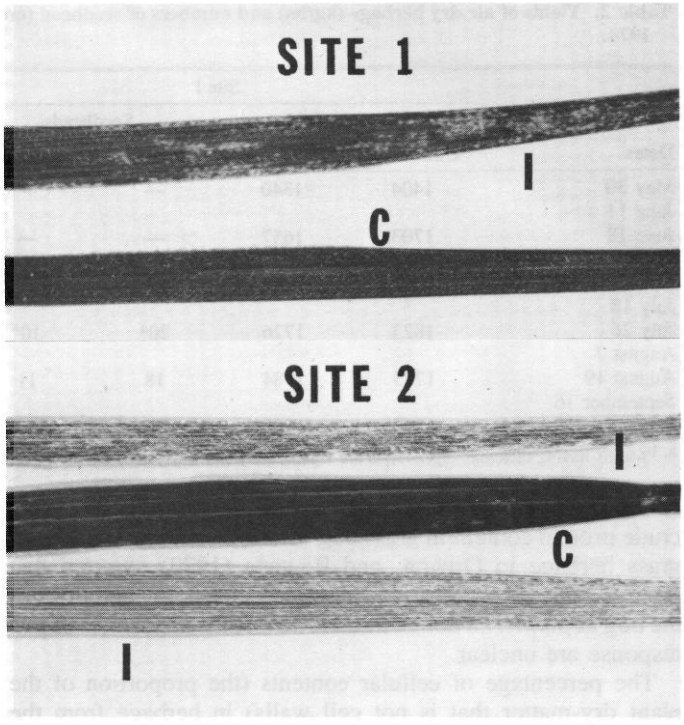

Fig. 1. Agropyron intermedium *leaves from infested (I) and uninfested (C) plots on two sites.*

Results and Discussion

Population Densities of Grass Bugs

Peak population densities of bugs were recorded on May 30 at Site 1 and on June 11 at Site 2 (Table 1). By July 1, bugs at both sites had completed their life cycle.

Population numbers, even on the more heavily infested Site 2 (Table 1) were considerably smaller than those reported by Todd and Kamm (1974) and Haws et al. (1973). However, there were sufficient numbers of bugs present on the lightly infested Site 1 to impart the characteristic yellow mottled appearance of grass leaves (Fig. 1). Visual effects of bugs were even more obvious at Site 2 (Fig. 1), where the infested part of the grass stand appeared uniformly yellow in color when viewed from a distance.

Herbage Yield

No statistically significant ($P \leq 0.5$) differences in herbage yield were noted between infested and uninfested plots on Site 1 (Table 2). Further, the failure of the analysis to show a treatment by date interaction indicated that the rate of herbage growth was comparable on the two treatments. Peak yields of approximately 1,800 kg/ha probably occurred in late July or early August, and a sharp decline followed (Table 2).

On Site 2, herbage growth rates were similar on both treatments until early August, when we noted that biomass on the uninfested plot had decreased since the preceding sampling date (Table 2). This trend continued to the termination of sampling in mid-September, when the infested plot yielded 215 kg/ha more ($P \leq 0.5$) herbage than did the uninfested plot. The divergence in production between the two treatments late in the growing season was verified by a significant treatment by date interaction in the analysis of variance, but an explanation is not apparent. Grasshopper feeding damage or loss to the litter component probably accounted for the declines in yields from late August through mid-September on Site 1, but there, the effects were similar on both infested and uninfested plots.

Table 1. Mean population numbers (±95% confidence limits) of *Labops hesperius* on infested and uninfested plots at two study sites, 1974.

	Site 1		Site 2	
Date	Infested	Uninfested	Infested	Uninfested
May 30	113±13[a]	0[a]		
June 11			210±18 (156±30)	14±3 (5±5)
June 18	9±2 (32±14)[b]	0 (0)[b]		
July 1			0 (0)	0 (0)

[a]Numbers of bugs per sweep (n = 33 on May 30, but n = 50 on all subsequent dates).
[b]Data in parenthesis indicate numbers of bugs/m² (n = 15 on each sampling date).

Seedhead Production

Grass bugs significantly reduced the number of seedheads of intermediate wheatgrass produced on both sites (Table 2). On the average, infested plots produced 39% and 56% fewer seedheads than did uninfested plots at Sites 1 and 2, respectively. The disappearance of seedheads from August 19 to September 18 on the uninfested plot at Site 1 (Table 2) is thought to have been caused by grasshoppers feeding on the flowering culms.

Seed production probably does not play a major role in maintenance of intermediate wheatgrass stands in the Intermountain area. Thus, the direct effects of grass bugs in this regard may not be great. However, production of seedheads by grasses has long been regarded as indicator of plant vigor (Hanson and Stoddart 1940). The impacts of grass bugs on the health and longevity of plants remain to be seen.

Forage Quality

Crude protein content of grass bug-infested herbage was slightly but significantly higher than that of grass bug-free herbage (Table 3). Treatment differences were slightly larger at Site 2, where the bug infestation was considerably heavier

Table 2. Yields of air dry herbage (kg/ha) and numbers of seedhead (no./m²) on infested and uninfested plots of intermediate wheatgrass at two locations, 1974.

	Site 1				Site 2			
	Herbage yield		Seedheads		Herbage yield		Seedheads	
Dates	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested	Uninfested	Infested
May 30	1404	1340	—	—				
June 11					1115	1232	—	—
June 18	1703	1657	—	—				
July 1					1361	1249	3	2
July 8	1790	1674	21[a]	9[b]				
July 18					1496	1485	10	5
July 26	1823	1726	20[a]	10[b]				
August 7					1412	1570	9	2
August 19	1775	1784	18	11				
September 16					1391[a]	1606[b]	15[a]	7[b]
September 18	1510	1666	7	10				

a, bMeans having different superscripts are significantly ($P \leq 0.05$) different for a particular sampling date and plant attribute.

(Table 1). Todd and Kamm (1974) also noted a slightly higher crude protein content in grass bug-infested intermediate wheatgrass herbage in Oregon, and Rautapa (1970) reported that protein content of wheat was increased by feeding activities of the bug *Leptopterna dolobrata*. However, the mechanics of this response are unclear.

The percentage of cellular contents (the proportion of the plant dry-matter that is not cell walls) in herbage from the infested plots on both sites was significantly lower than that from uninfested plots, but as with crude protein, the magnitude of the differences was not great (Table 3). Again, these findings generally agree with those of Todd and Kamm (1974), who found a 6% reduction in cellular contents. They stated that the reduction was directly attributable to removal by the grass bugs. However, this aspect of grass bug feeding injury is not well understood.

Results of the digestion-balance trial on mown herbage from Site 2 did not reflect any statistical differences in either digestibility or intake between bug-infested and noninfested herbage. Mean dry matter digestibility (±95% confidence limits) for infested and noninfested herbage was 59.1 ± 3.8% and 60.6 ± 2.6%, respectively. Stockmen have suggested that grass bugs decrease the palatability of herbage, and forage consumption by grazing animals is thereby depressed. However, we did not detect a significant depression of intake in our digestion-balance trial. Rates of daily dry-matter intake (±95% confidence limits) for bug-infested and noninfested herbage were 65.9 ± 22.8 and 68.3 ± 14.8 g/kg$^{0.75}$ body weight.

Todd and Kamm (1974) inferred that forage digestibility would be reduced 5% as the result of a 6% decrease in cellular contents attributable to grass bug feeding injury. This loss combined with a 13% reduction in herbage yield at mid-season was said to result in an 18% reduction of "forage value" of intermediate wheatgrass. Considering that our highest population density of grass bugs was only about 12% as large as theirs (156 vs 1,345 bugs/m²), it is not surprising that we detected no important deficiencies in forage quality due to grass bug feeding injury.

Table 3. Mean crude protein (%) and cellular contents (%) concentrations in intermediate wheatgrass herbage from uninfested and grass bug infested plots at two locations.

	Crude protein		Cellular contents	
Locations	Uninfested	Infested	Uninfested	Infested
Site 1	5.6[a]	6.1[b]	40.9[a]	38.7[b]
Site 2	5.5[a]	6.6[b]	42.4[a]	40.1[b]

a, bMeans having different superscripts are significantly ($P \leq 0.05$) different for a particular site and nutritional constituent.

The general similarity of our findings on crude protein and cellular contents to those of Todd and Kamm (1974), but under conditions of greatly different bug population densities, leads us to suspect that these commonly used chemical measures of nutritive value may not provide a sensitive index to overall forage quality where feeding injury by bugs is concerned. There is also the possibility that above some unknown population level, additional bug numbers contribute relatively little to diminutions in forage quality. However, the ultimate evaluation of grass bugs' integrated impacts on forage value yet remains to be conducted in controlled grazing studies where animal production is measured.

Summary and Conclusions

Herbage yield, seedhead production, and forage quality of intermediate wheatgrass infested by black grass bugs were studied at two locations in Utah. A heavily infested site supported a bug population of 156 bugs/m². This was considered a comparatively light level of infestation in relation to another studies reported in the literature, but in our study, this was considered a heavy infestation relative to another site that supported only half as many bugs.

Even though plants at the heavily infested site exhibited signs of extensive feeding damage, forage yields were not significantly depressed. Production of seedheads was reduced by grass bugs on both sites.

In terms of forage quality, crude protein content of infested plants was increased on the heavily infested site and the concentration of cellular contents in herbage was reduced by grass bugs on both sites. However, all differences were relatively small. Neither digestibility nor forage intake was affected. animals. Neither digestibility nor forage intake was affected.

The question of grass bugs' impact on livestock production from seeded wheatgrass ranges still remains. Controlled grazing studies would be an appropriate next step.

Literature Cited

Bohning, J. W., and W. F. Currier. 1967. Does your range have wheatgrass bugs? J. Range Manage. 20:265-267.

Denning, D. G. 1948. The crested wheatgrass bug. Wyoming Agr. Exp. Sta. Circ. 33. May. (Mimeographed).

Hanson, W. R., and L. A. Stoddart. 1940. Effects of grazing upon bunch wheatgrass. Amer. Soc. Agron. J. 32:278-289.

Harris, L. E. 1970. Nutrition research techniques for domestic and wild animals. Vol. I. Dep. Anim. Sci., Utah State Univ., Logan. 243 p.

Haws, B. A., D. Dwyer, and M. G. Anderson. 1973. Problems with range grasses? Look for black grass bugs! Utah Sci. 34:3-9.

Knowlton, G. F. 1967. Grassbugs: A serious range problem in 1966. Utah Acad. of Sci. Arts and Letters 43:20-21.

Rautapaa, J. 1970. Effects of meadow capsid bug, *Leptopterna dolobrata* (L.) (Herts., Captridae), on the yield and quality of wheat. Annales Entomol. Fennici 36:142-152.

Southwood, T. R. E. 1966. Ecological methods, with particular reference to insect populations. Chapman and Hall, London. 391 p.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., New York. 481 p.

Todd, J. G., and J. A. Kamm. 1974. Biology and impact of grass bug *Labops hesperius* Uhler in Oregon rangeland. J. Range Manage. 27:453-458.

Van Soest, P. J. 1967. Development of a comprehensive system of feed analysis and its application to forages. J. Anim. Sci. 26:119-128.