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Nutritional Quality and Herbage Production of Intermediate Wheatgrass (*Agropyron intermedium* [Host] Beauv.) When Infested with Black Grass Bugs (*Labops hesperius* Uhler)

Alan M. Gray
Utah State University

NUTRITIONAL QUALITY AND HERBAGE PRODUCTION OF INTERMEDIATE WHEATGRASS (*Agropyron intermedium* [Host] Beauv.) WHEN INFESTED WITH BLACK GRASS BUGS (*Labops hesperius* Uhler)

by

Alan M. Gray

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Alan M. Gray

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Nutritional Quality and Herbage Production of Intermediate Wheatgrass (Agropyron intermedium [Host] Beauv.) When Infested with Black Grass Bugs (Labops hesperius Uhler)

by

Alan M. Gray, Master of Science

Utah State University, 1975

Major Professor: Dr. John C. Malechek
Department: Range Science

Two intermediate wheatgrass seedings with different levels of grass bug infestation were evaluated for herbage production, seedhead production, percent dry matter, crude protein, and cell contents. Study sites were located at different elevations on mountain summer ranges in northern (Site I) and central (Site II) Utah. Study plots at Site I and Site II were infested with 113 and 210 bugs per sweep, respectively. Herbage production appeared to be reduced in early spring on the site with the higher infestation; however, no effect on season-long herbage production could be detected on either site. Seedhead production on infested plots was reduced 45 percent at Site I and 56 percent at Site II. No important effect on dry matter content of infested plants was detected even though the leaves appeared to be dry and in a condition of moisture stress. Crude protein of infested plants was significantly higher (one to two percent) than control plants on the site with the higher infestation. The percentage of

cell contents of plants on the more highly infested plot was eight percent less than the percentage of cell contents of control plants in the early spring. This reduction coincided with the period of peak damage. Later in the season this difference diminished as plant growth continued after the bug population completed its life cycle.

(49 pages)

INTRODUCTION

In recent years the improvement and restoration of depleted rangelands has often been accomplished by establishing grass monocultures. Because exotic cool season grasses have been highly productive in arid regions of the western United States, they have been used extensively to bring thousands of acres of depleted rangeland into a more stable condition by reducing erosion and increasing forage production for livestock. However, as often happens with broad-scale vegetation type conversions, complications have resulted and unforseen side-effects of these practices have occurred.

Pure stands of introduced wheatgrass, primarily crested wheatgrass (Agropyron cristatum (L.) Gaertn.) and intermediate wheatgrass (A. intermedium (Host) Beauv.), provide prime habitat for the development of large populations of black grass bugs (Labops hesperius Uhler). Stockmen often become alarmed upon discovering a heavy infestation of grass bugs in critically-needed spring forage. Bug populations apparently require a number of growing seasons to build up to critical levels. Therefore, their presence is commonly discovered only after they have increased to levels that may inflict quite impressive visible damage.

This apparent threat to forage production on seeded ranges has generated considerable interest but only limited research. Various speculations about the actual effect of Labops have been the result of numerous observations by many concerned individuals.

The objective of this study was to investigate the effects of Labops hesperius on forage nutritional quality and herbage production of intermediate wheatgrass, an introduced species which has been commonly used in range improvement programs. Indicators of forage nutritional quality in this study were considered to be percentage of crude protein and the percentage of cellular contents. These nutritional attributes were thought important because they provide an indication of expected animal performance and are highly correlated to forage digestibility and intake by herbivores.

Since crude protein is significantly correlated to digestible protein content, determination of the crude protein level of a plant can give a reasonably reliable indication of its feed value (Sullivan, 1962). The portion of plant dry matter consisting of cellular contents provides a collective indication of the presence of sugars, starch, and protein.

LITERATURE REVIEW

Labops hesperius Uhler. (Figure 1) appears to be a native of the Intermountain Region. Labops is a true bug (Hemiptera:Miridae) and apparently causes only restricted or localized damage when present in climax native vegetation or floristically diverse communities. Prior to the introduction of new host species such as exotic wheatgrasses, Labops populations were probably restricted by native predators and other controls within the ecosystem.

Labops hesperius was first reported as a new species as a result of an expedition into Montana by Dr. F. V. Hayden in 1871 (Uhler, 1872). Further works on the taxonomy and distribution of Labops spp. (Knight, 1922; Slater, 1954, 1954a) restricted its distribution to the northern halves of the eastern and western hemispheres, principally northwestern North America and northeastern Siberia.

Extensive damage to introduced grasses by black grass bugs (Labops spp.) has been reported throughout the western United States (Bohning and Currier, 1967; Denning, 1948; Haws, Dwyer and Anderson, 1973; Knowlton, 1966; Pepper et al., 1953; Todd and Kamm, 1974). During the 1930's occasional field collections of Labops spp. were reported in Utah. Their presence in Utah was definitely established in the 1940's (Knowlton, 1945), when unexplained losses in forage productivity were eventually attributed to black grass bugs.

Infested stands of grass were often bleached to a whitish-yellow color and the foliage appeared to be quite dry and wilted. Hence, ranchers often concluded that losses of early spring forage were due

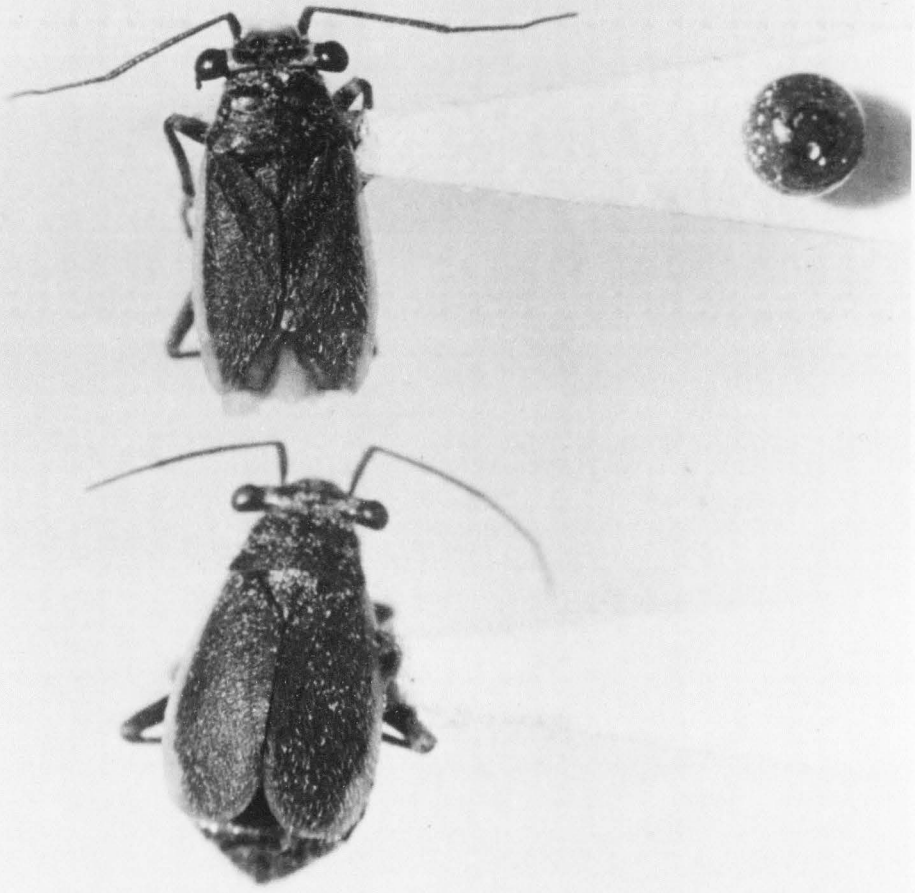

Figure 1. L. hesperius: male (top), female (bttom) actual size 4 mm.

to either frost or drought. Further investigation revealed that these puzzling occurrences were often the result of grass bug infestations. Since then, numerous reports from across the western United States have indicated that the problem is widespread on seeded ranges.

Grass bug feeding activity is characterized by a mottling of yellow or white, irregular spots on leaves. An entire grass stand, in cases of severe infestation, will take on a discolored appearance ranging from a brown to yellow color.

Grass bug activity begins in late winter and early spring and continues for about six to seven weeks. The exact dates of activity are dependent upon latitude and elevation. Nymphs hatch immediately after snow melt and progress through five instars, reaching the adult stage in about four weeks according to Todd and Kamm (1974). In the subsequent two to three weeks the adults mate and oviposition is completed. The bugs die rapidly after the eggs are deposited in early maturing grasses or litter remaining from the previous year. The eggs overwinter and the entire cycle begins again in early spring.

Grass bugs have piercing-sucking mouth parts. The resulting damage to plants appears to be restricted to the punctured area, but severe damage may result in the discoloration of entire leaves. The actual effect upon the physiology of injured plants is unknown. Haws, Dwyer, and Anderson (1973) and Knowlton (1966) have reported finding plants with dead leaves and stunted parts along with a low frequency of reproductive structures.

Considerable speculation has resulted concerning the impact of grass bug infestations. However, there has been only a limited amount

of research concerning the effects of grass bugs on forage production and quality. Todd and Kamm (1974) assessed the feeding injury and nutritional value of forage that was infested by Labops hesperius. Their field determinations were made during the period of peak bug damage and again in late summer after maturity of the host plants. Initially, they found that herbage yield was reduced 13 percent, crude protein was increased two percent, and cellular contents were decreased six percent. After the bugs had completed their life cycle and had disappeared, rain produced new plant growth and the same variables were again measured. The only detectable result was that infested plants contained approximately two percent less cell contents than did the control plants. It was concluded that adequate moisture after the stress period had allowed top-recovery of the host plant. At plant maturity no effect on herbage production could be measured as a result of earlier bug feeding.

Haws, Dwyer, and Anderson (1973) and Knowlton (1967) have reported various degrees of infestation, ranging from 200 to 1000 bugs on single grass plants. Damage due to a heavy grass bug infestation becomes quite apparent when the nymphs are rapidly approaching the adult stage. Because of the quick succession of mating and egg deposition, control measures should be taken prior to these activities.*

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* Personal communication by letter to J. R. Dutton, Regional Supervisor, Agricultural Research Service, written by H. F. Thornley, 1967.

There is some evidence that intensive early spring grazing of infested grasses may interfere with the grass bug life cycle and consequently reduce feeding injury. However, some stockmen have reported that livestock will avoid grazing injured grasses if given an alternative.

METHODS AND MATERIALS

Study areas

Two intermediate wheatgrass seedings were designated as study areas (Sites I and II) in the spring of 1974. Major criteria used in selection of these areas included uniformity of soils and grass stands and presence of comparatively light and heavy grass bug populations that were large enough to impart obvious effects on the grass.

Site I was located in Morgan County (T3E, R2N, Section 1) adjacent to East Canyon Reservoir in northern Utah. This study area was characterized by a south-easterly aspect and a five percent slope. The elevation is approximately 1750 meters and the annual precipitation is approximately 50 cm. The site was dominated by intermediate wheatgrass with scattered plants of alfalfa and negligible amounts of other forbs and grasses. The grass stand was established in 1958 and was grazed by sheep for one month each spring and one month each fall until 1973. Since then, the forage has been cut for hay in mid-July.

The property is currently owned by Goldfleck Corporation and is leased to a private rancher. As nearly as could be determined, the area had no previous history of a serious Labops infestation. Apparently, the bug population was just becoming established because the infestation was not spread uniformly throughout the entire seeding, but was generally restricted to the perimeter.

Site II was located 29 km east of Salina in Sevier County, Utah. This study area (T3E, R22S, Section 9, 10) was located on property

owned by Mr. Howard Mattsson and was situated at an elevation of approximately 2200 meters with a five percent slope and a south-easterly aspect. Annual precipitation in this area is approximately 50 cm. The stand was established in 1958 and the forage was neither grazed nor cut for hay for 10 years; however, cattle grazing was introduced in 1969. With few exceptions, the grazing season extended from about June 15 to October 15. The seeding was not grazed during the 1974 season. Grass bugs were first observed on the area in 1965 when the owner noticed that the grass appeared white in color during early spring.

Experimental procedures

At each study site, an infested and a control plot was located on the basis of uniformity of soil type, topography, and such features of the grass stand as density, plant height, and apparent productivity. Both plots at Site I were roughly 0.1 ha in area and were about 200 meters apart. The infested plot supported an obvious population of grass bugs at the time the plots were selected, whereas the control plot had no obvious grass bug infestation.

Part of the wheatgrass seeding at Site II had been sprayed with an insecticide (Malathion) for grass bug control in 1973. Therefore, location of the experimental plots was restricted so that the control plot occurred in the previously sprayed area of the seeding. This plot was roughly 0.14 ha in area and was somewhat restricted in size due to the limited homogeneous area available. The infested plot was located approximately 300 meters away from the previously sprayed

area of the seeding, but on a similar soil and slope. This plot was roughly 0.40 ha in area.

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

Sampling for herbage production and nutritional parameters was begun in late May at Site I and early June at Site II and was continued at three-week intervals until mid-September. Biomass of current annual growth of intermediate wheatgrass was determined by randomly locating circular 1.0 m^2 quadrats in both control and infested plots. Grasses occurring in the quadrats were clipped at ground (crown) level, immediately weighed in the field, and dried in the lab at 90°C for 48 hours to determine percentage dry matter. On each sampling date, the number of quadrats clipped per plot varied due to predetermination of sample size but averaged about 10.

As the plants initiated reproduction in mid-July, all seedheads within the quadrats were counted prior to clipping.

Samples for nutritional determinations were collected along a 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 ground through a 40-mesh screen. Approximately 20 plants were collected and aggregated for each treatment on each sampling date. Crude protein was then deter-

mined by the Kjeldahl method described by Harris (1970). Cell contents and cell walls were partitioned by the neutral detergent method (Van Soest, 1967).

Two methods were used to determine the relative levels of bug infestation. The sweep method (Southwood, 1966), using a standard .38-meter diameter bug net (Figure 2), was employed on the initial sampling date at Site I. On all subsequent sampling dates at both sites a D-Vac (Figure 3) sampler was also used to quantitatively remove bugs from the 1.0 m^2 quadrats immediately prior to clipping. A sampling ring was constructed of .50 cm sheet metal with a depth of 20 cm and a beveled edge on the bottom. When the ring was positioned into the soil surface, bugs were prevented from moving in or out of the quadrat. Following clipping, the quadrats were again swept with the D-Vac sampler. Bugs that escaped this second vacuuming were collected with aspirator bottles. Vacuum samples removed before and after clipping 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.

The field data on herbage production, seedhead production, percent dry matter, and numbers of insects were evaluated statistically by analysis of variance according to the least squares procedure. Protein and cellular content data were derived from aggregate means for each collection date and were evaluated according to an analysis of covariance with date being the covariate.

Figure 2. Sweep method of sampling bug numbers.

Figure 3. D-Vac method of sampling bug numbers.

RESULTS AND DISCUSSION

Grass bug numbers

Grass bug population data for infested and control plots on both study sites are compiled in Table 1. The table provides an estimate of the relative bug numbers for each site according to each sampling method and date.

Table 1. Grass bug population numbers (mean ± 95% C.I.) on two study sites.

	Site I		Site II	
Date	Infested	Control	Infested	Control
30 May	113±13[a]	<0[a]		
11 June			210±18 (156±30)	14±3 (5±5)
18 June	9±2 (32±14)[b]	<0 (0)[b]		
1 July			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 per m^2 (n = 10 on each sampling date).

An attempt was made to sample bugs during the period of peak numbers at each site. The bugs were thought to have been at near maximum numbers on May 30 at Site I and on June 11 at Site II. It should be stated that the comparative light and heavy infestations at

Site I and II, respectively, were relative only to the study. They were probably both representative of a light infestation in comparison to those reported by Todd and Kamm (1974) and Haws, Dwyer, and Anderson (1973).

No D-Vac data are available to provide quantitative estimates of bugs per unit area of ground on the May 30 sampling date because the procedure was not perfected until later. Both methods were employed on all subsequent bug sampling dates. The bug population at both sites had disappeared by July 1.

The sweep technique was employed in the evenings when the bugs appeared to be feeding on the upper leaves of the grasses. This method has several limitations. Generally, only those individuals that remained on the tops of the grasses during the sampling period could be easily caught. Observations of bug behavior during sampling suggested that the bugs were sensitive to disturbance and tended to move from the upper grass leaves to the plant bases and litter. Weather conditions, as well as height of the vegetation, appeared to influence the vertical distribution of grass bugs. These environmental factors, combined with a lack of consistency by the individual taking the samples, could all contribute to sampling errors associated with the sweep method.

In contrast, the D-Vac technique appears to provide an accurate quantitative estimate of bug population numbers. Bug populations on both sites were sampled with the D-Vac during the late spring over a moist, sandy loam soil. Therefore, the absence of cracks in the soil provided no avenues of escape for the bugs.

Herbage production

Production curves for bug-infested and control plots on both study sites are illustrated in Figures 4 and 5. The study was not initiated until approximately six weeks into the growing season, therefore, the graphs do not account for possible short-term differences in herbage production early in the season.

Grass bugs did not measurably affect forage production at Site I (Figure 4). The results of an analysis of variance (Table 2) indicated no significant ($P \leq 0.05$) difference between infested and control plots at any time during the growing season. Season-long means for control and infested plots were 1667.4 kg/ha and 1641.11 kg/ha, respectively. A significant date effect was observed, but this was an expected result of normal forage growth and development. Field observations on September 18 at Site I revealed numerous broken seedheads and considerable grasshopper damage on the control plot. This probably accounts for the abrupt decline in the herbage production curve for that date as represented in Figure 4. The disappearance of seedheads by late summer is indicated in Figure 6.

Table 2. Analysis of variance for herbage production on Site I.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	241.89	241.89	0.39
Date	5	21944.94	4388.98	7.00*
Treatment x Date	5	3620.89	724.18	1.15
Error	142	89038.26	627.03	
Total	153			

*($P \leq 0.05$)

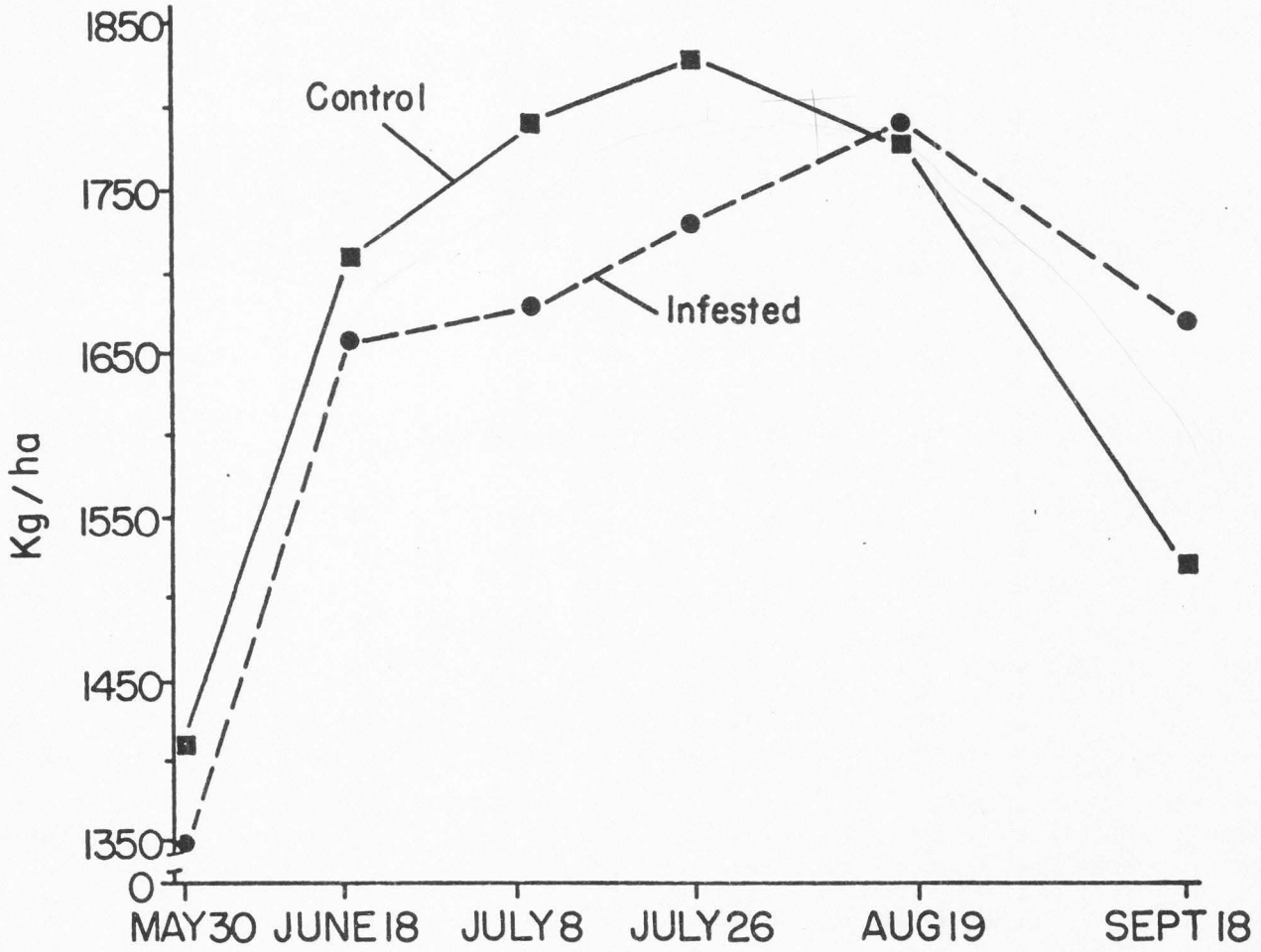

Figure 4. Forage production at Site I (Kg/ha dry weight).

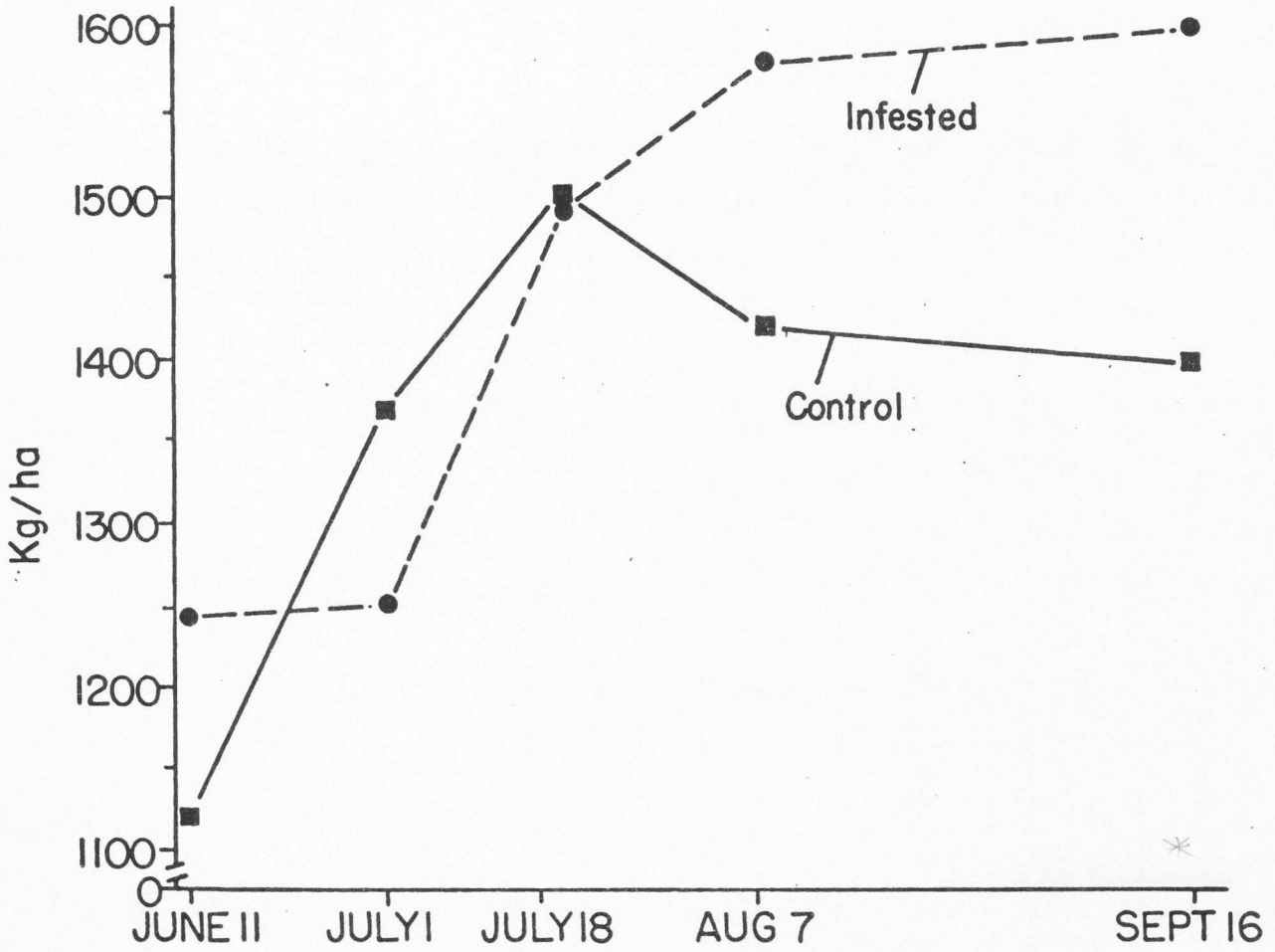

Figure 5. Forage production at Site II (kg/ha dry weight).

In contrast to Site I, season-long herbage production on Site II was significantly ($P \leq 0.10$) different between the control and infested plots. Season-long means for the control and infested plots were 1355.14 kg/ha and 1428.24 kg/ha, respectively. Production on the infested plot was apparently retarded somewhat by July 1 (Figure 5), but uninhibited on the control plot at that time. Even during this stress period the comparative difference in herbage production due to accumulated damage was only 112.5 kg/ha (1361 kg/ha for the control vs. 1248.5 kg/ha for the infested plot). Although no measurements were taken to determine range site potentials of the plots, the infested plot ultimately produced slightly more herbage, probably in response to slightly more favorable site conditions.

A significant ($P \leq 0.05$) interaction effect was indicated by the statistical analysis (Table 3). As can be seen from Figure 5, interactions probably occurred at two periods during the growth cycle. Grass bug feeding in early June apparently retarded plant growth until early July; whereas plants on the control plot grew at a rapid rate from early June to July. Grass bug feeding activity had ended by mid-July and herbage production on the infested plot was equivalent to production on the control plot.

Production rates on the two plots again deviated from mid-July to early August. The reason for the apparent decline in forage yield on the control plot was not clear. Field observations in August and September revealed an abundance of mature plants which shattered easily when the herbage sampling ring was moved about. This was less common on the infested plot due to the delayed maturity of infested

grasses. This may have resulted in sampling error which could account for the disappearance of herbage.

Table 3. Analysis of variance for herbage production on Site II.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	1826.51	1826.51	3.67**
Date	4	20762.08	5190.52	10.46*
Treatment x Date	4	5242.26	1310.56	2.64*
Error	130	64525.50	496.35	
Total	139			

LSD = 19.62

*($P \leq 0.05$)
**($P \leq 0.10$)

Statistically significant differences (Tables 4 and 5) in seedhead production (Figures 6 and 7) between infested and control plots were found on both sites.

Table 4. Analysis of variance of seedhead production at Site I.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	636.05	636.05	6.65*
Date	5	5506.16	1101.23	11.52*
Treatment x Date	5	1340.33	268.07	2.80*
Error	142	13573.78	95.59	
Total	153			

*($P \leq .05$)

LSD = 8.61

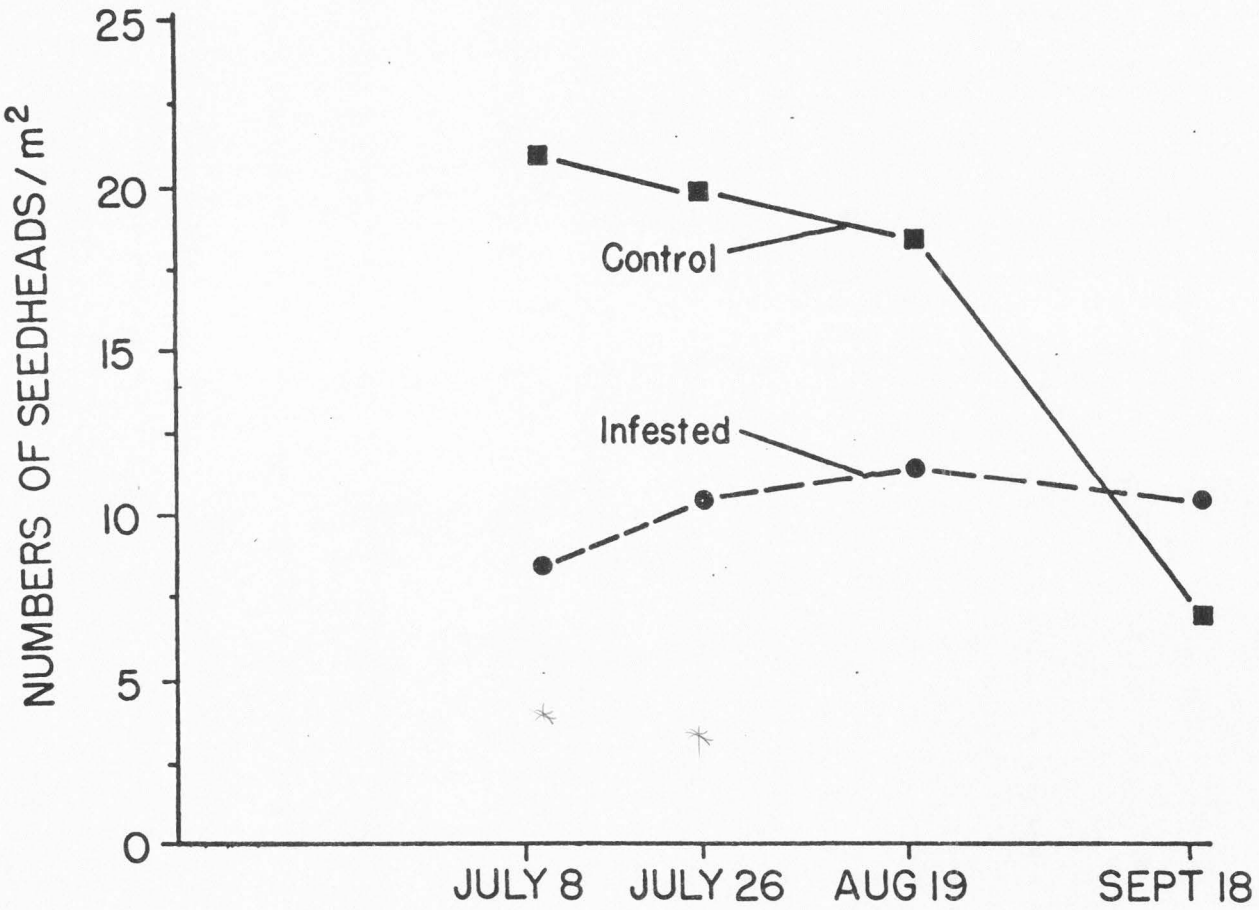

Figure 6. Seasonal production of seedheads at Site I (Nos./m^2).

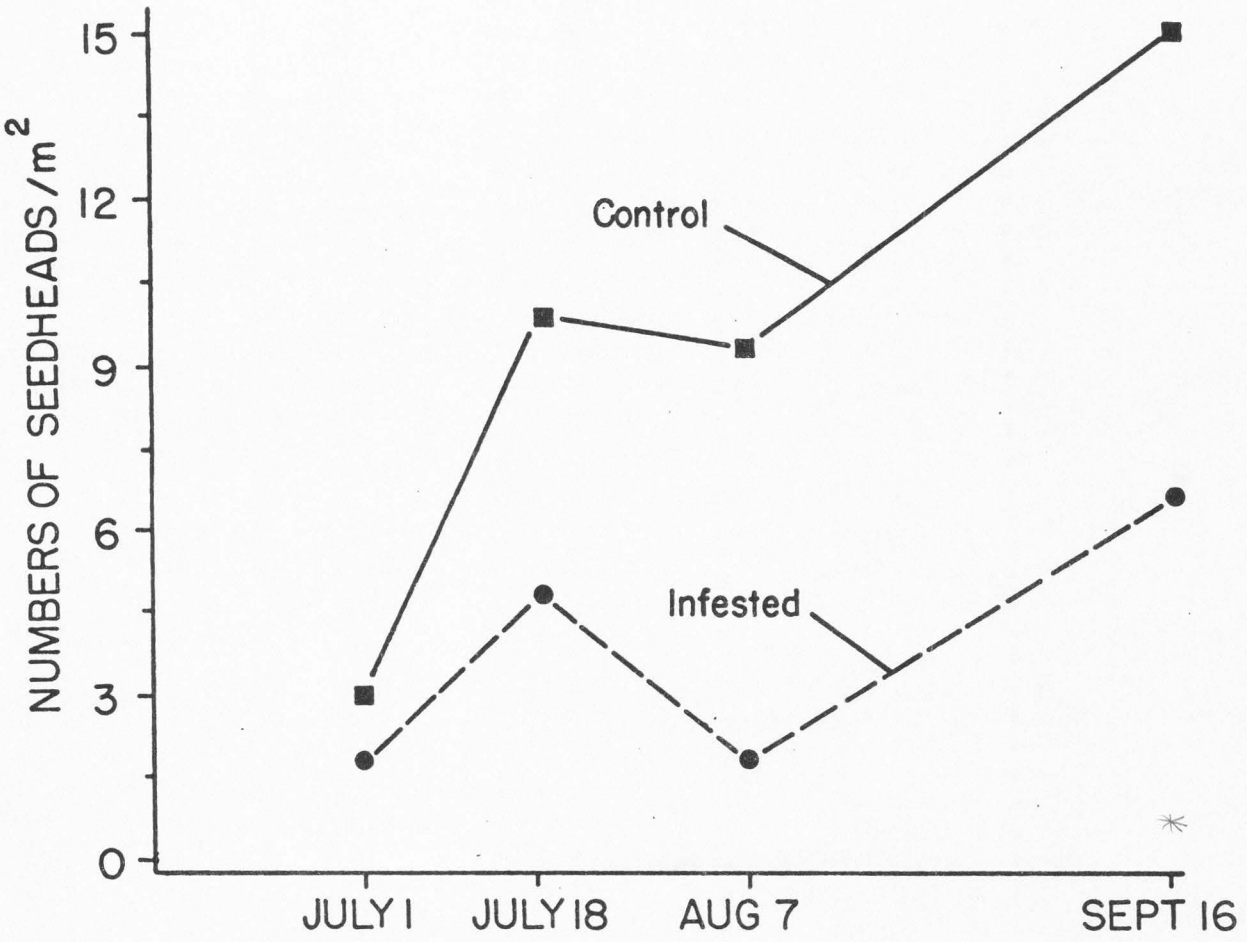

Figure 7. Seasonal production of seedheads at Site II (Nos./m^2).

Table 5. Analysis of variance of seedhead production at Site II.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	664.01	664.01	11.98*
Date	4	1787.24	446.81	8.06*
Treatment x Date	4	349.52	87.38	1.58*
Error	130	7205.90	55.43	
Total	139			

*($P \leq .05$)

LSD = 8.24

Seedhead production (Figure 6) on the control plot at Site I peaked at about 22 seedheads per square meter in mid-July. However, peak production on the infested plot occurred in mid-August at about 12 seedheads per square meter. The infested plot thus produced only 56 percent as many seedheads and also experienced an apparent delay in the emergence of these structures. A sharp decline in the presence of seedheads on the control plot from August 19 to September 18 was probably due to grasshoppers and breakage due to the normal drying and curing of mature forage. Field observations on September 18 revealed many grass plants with broken culms and the presence of grasshoppers.

Seedhead production at Site II (Figure 7) peaked simultaneously at both infested and control plots. The infested site produced a maximum of about seven seedheads per square meter. The control plot had twice the production at about 15 seedheads per square meter. Perhaps the physiological stress placed on the plant by the grass bug damage was great enough to decrease seedhead production.

Herbage dry matter content

The leaves of infested grasses (Figures 8 and 9) appeared whitish-yellow in color after considerable accumulated feeding activity by grass bugs. During mid-afternoon when temperatures were highest, the leaves of bug-infested plants appeared to be more convoluted than the leaves of the control plants. Casual observation of this condition gave the impression that bug-infested grasses were in a wilted or drying condition. However, an analysis of herbage dry matter on Site I indicated no difference between infested and control plants (Table 6 and Figure 10).

Table 6. Analysis of variance for percent dry matter in plants on Site I.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	5.35	5.35	.84
Date	5	27539.99	5507.99	865.83*
Treatment x Date	5	19.36	3.87	.60
Error	142	903.2	6.36	
Total	153			

*($P \leq .05$)

Dry matter content of plants at Site II (Figure 11) was slightly, but significantly greater on infested plots than on control plots during the first two sampling dates (Table 7). These differences are probably of little importance since actual values differ only by two or three percent during periods of peak bug infestation. An increase in dry matter content over time was observed at both Site I and II, but this was an expected result of normal forage growth and development.

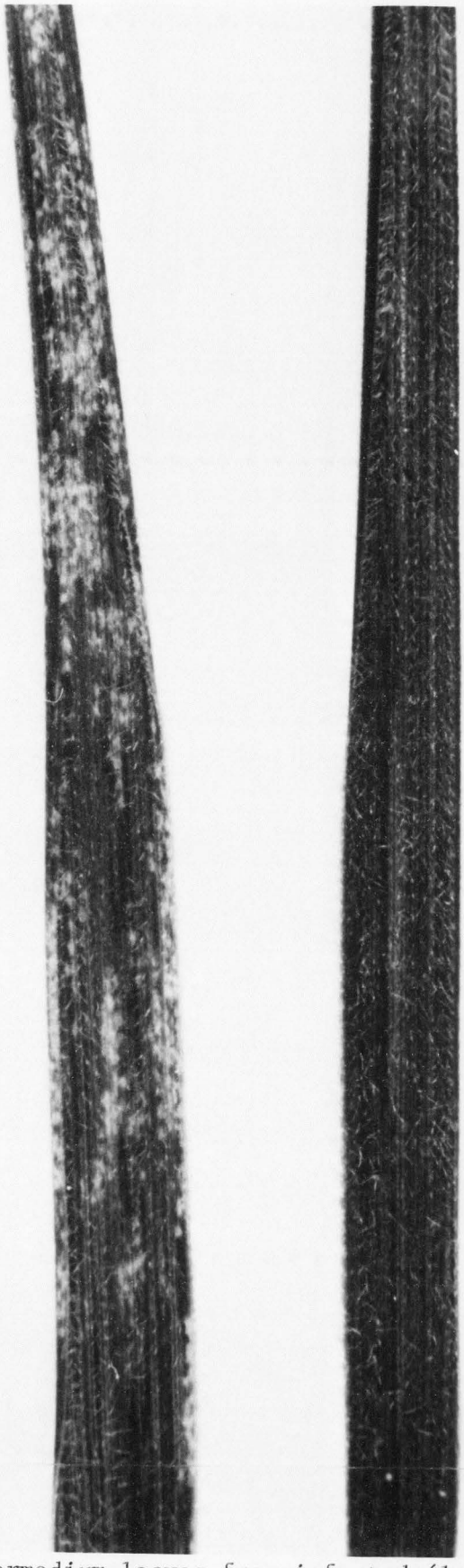

Figure 8. A. intermedium leaves from infested (left) and from control (right) plots at Site I.

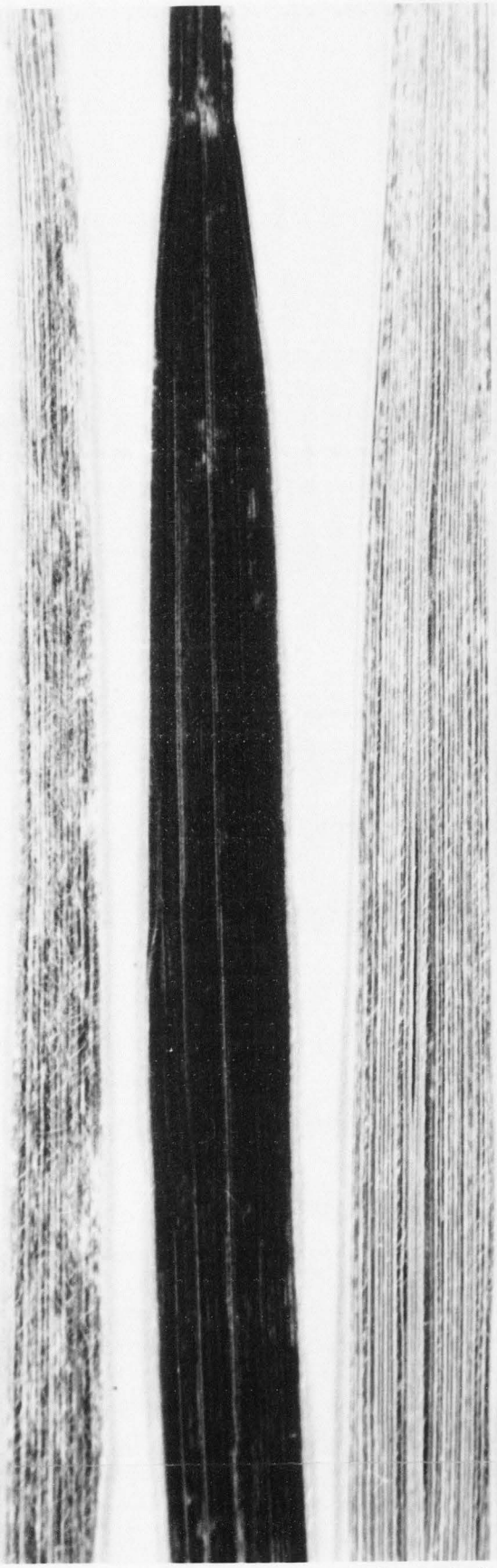

Figure 9. A. intermedium leaves from infested (outside) and control (center) plots on Site II.

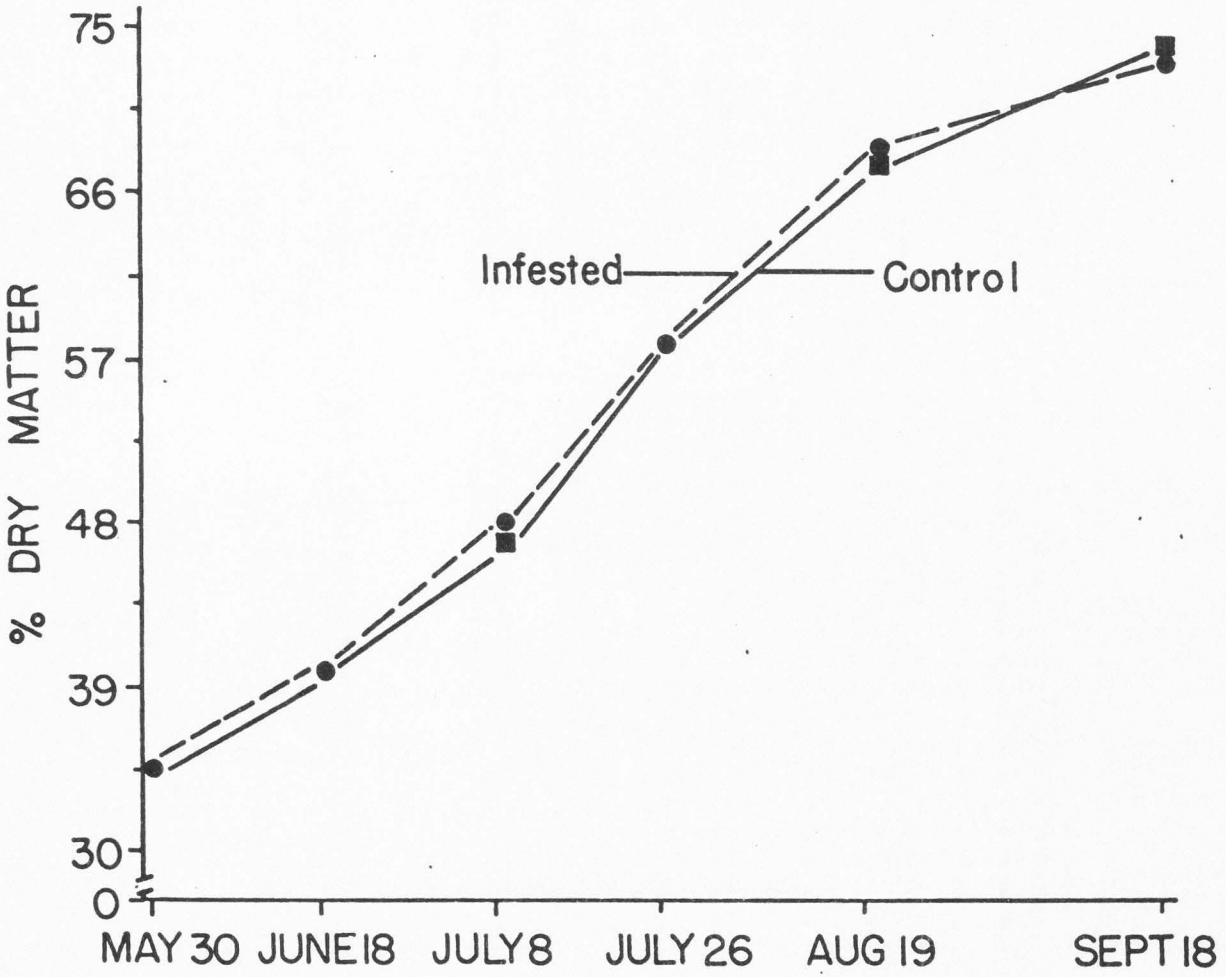

Figure 10. Percentage dry matter of herbage at Site I.

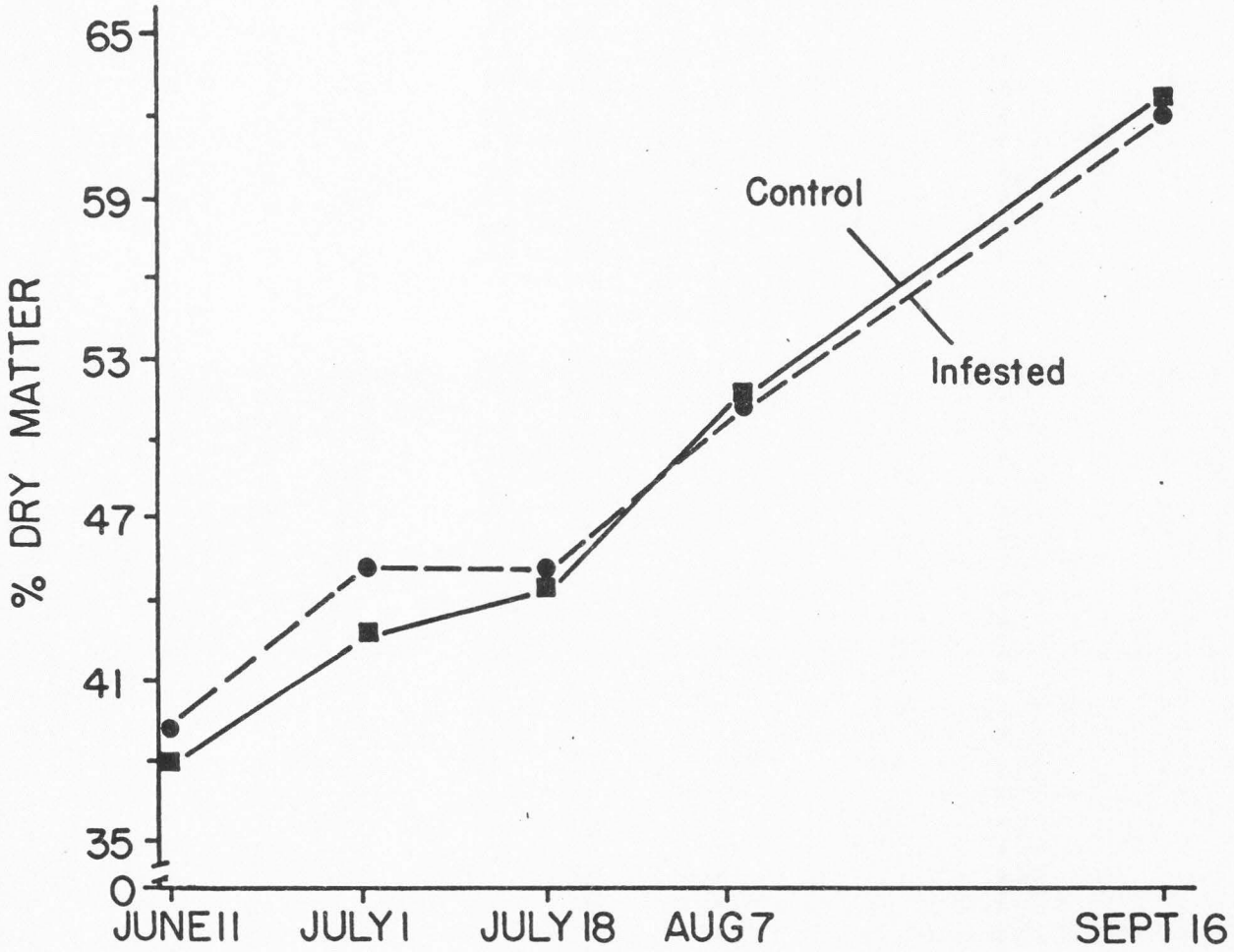

Figure 11. Percentage dry matter of herbage at Site II.

Table 7. Analysis of variance for percent dry matter in plants on Site II.

Source	Degrees of freedom	Sum of squares	Mean square	F
Treatment	1	9.01	9.01	3.16**
Date	4	8906.34	2226.58	780.74*
Treatment x Date	4	42.28	10.57	3.71*
Error	130	370.50	2.85	
Total	139			

*($P \leq .05$)
**($P \leq .10$)

Crude protein content

At Site I, the season-long crude protein content (expressed as percent of total dry matter) of plants on the infested plot (Figure 12) was not significantly different ($P \leq 0.05$) from that on the control plot (Table 8).

Table 8. Analysis of covariance for percent crude protein in plants on Site I.

Source	Degrees of freedom	Mean square	F
Treatment	1	.59	.66
Date	1	46.29	51.89*
Error	9	.89	
Total	11	4.99	

*($P \leq .05$)

A decline in forage protein content over time was observed on both plots at both sites (Figures 12 and 13), resulting in a

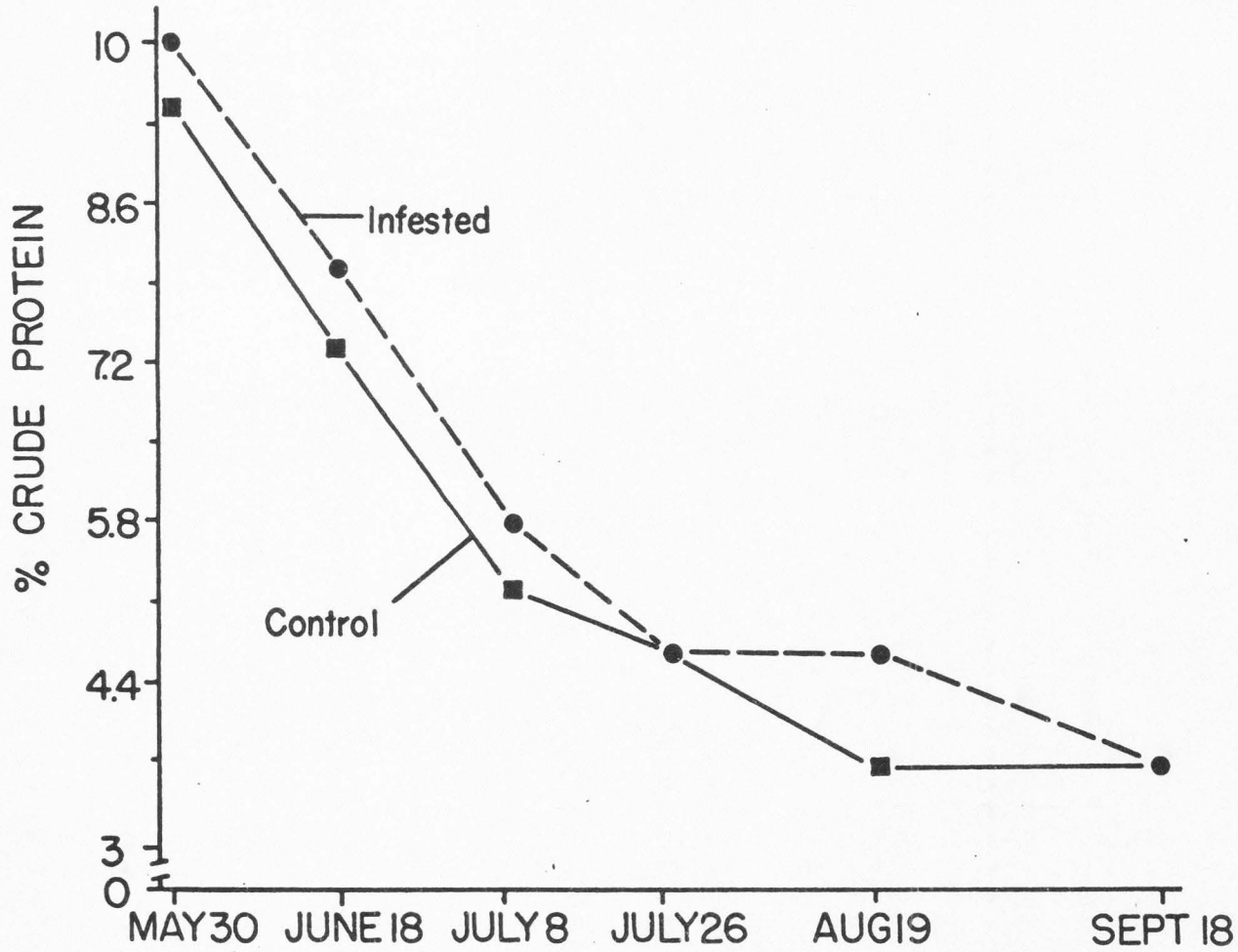

Figure 12. Crude protein content of herbage at Site I.

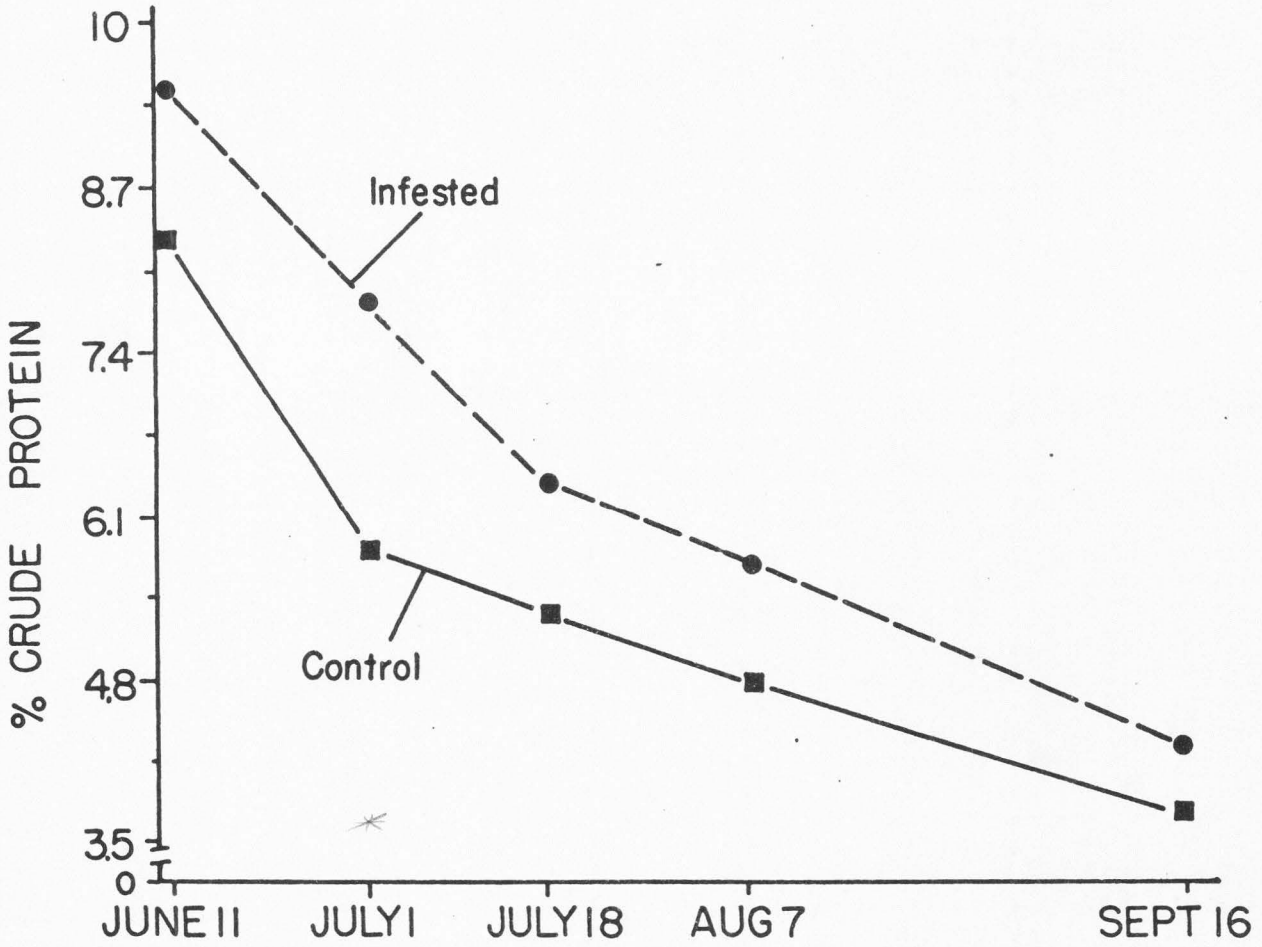

Figure 13. Crude protein content of herbage at Site II.

statistically significant test for the "date" component in Tables 8 and 9. This observation agreed with Rodgers and Box (1967).

Plants fed upon by grass bugs at Site II (Figure 13) contained roughly one to two percent more crude protein ($P \leq .05$) than control plants throughout the entire season (Table 9).

Table 9. Analysis of covariance for percent crude protein in plants at Site II.

Source	Degrees of freedom	Mean square	F
Treatment	1	2.96	6.80*
Date	1	24.18	55.61*
Error	7	.43	
Total	9	3.35	

*($P \leq 0.05$)

A slight increase in the crude protein content of grass bug-infested grasses was also found by Todd and Kamm (1974) at higher levels of infestation. They suggested that the increase may have been relative. Rautapaa (1970) also reported a slight increase in crude protein of wheat due to feeding injury by the plant bug Leptopterna dolobrata (L.).

Ruminants utilize crude protein to synthesize microbial protein. Therefore, the increased protein content of infested grasses could be a benefit to rumen micro-organisms.

Another possible explanation for the increased nitrogen levels of infested plants might be that the plants are retarded in phenological development. If so, then the younger tissue of the infested

plants would be relatively higher in protein than the older, more phenologically advanced control plants.

Cell contents

The season-long averages for the percent of cell contents (expressed as percent of total dry matter) found in herbage from treated and control plots were found to be significantly different on both Site I (Table 10, Figure 14) and Site II (Table 11, Figure 15).

Table 10. Analysis of covariance for percent cellular contents in plants on Site I.

Source	Degrees of freedom	Mean square	F
Treatment	1	13.82	3.37**
Date	1	69.16	16.86*
Error	9	4.10	
Total	11	10.90	

*($P \leq .05$)
**($P \leq .10$)

Table 11. Analysis of covariance for percent cellular contents in plants at Site II.

Source	Degrees of freedom	Mean square	F
Treatment	1	30.63	9.02*
Date	1	22.04	6.50*
Error	7	3.40	
Total	9	8.50	

*($P \leq .05$)

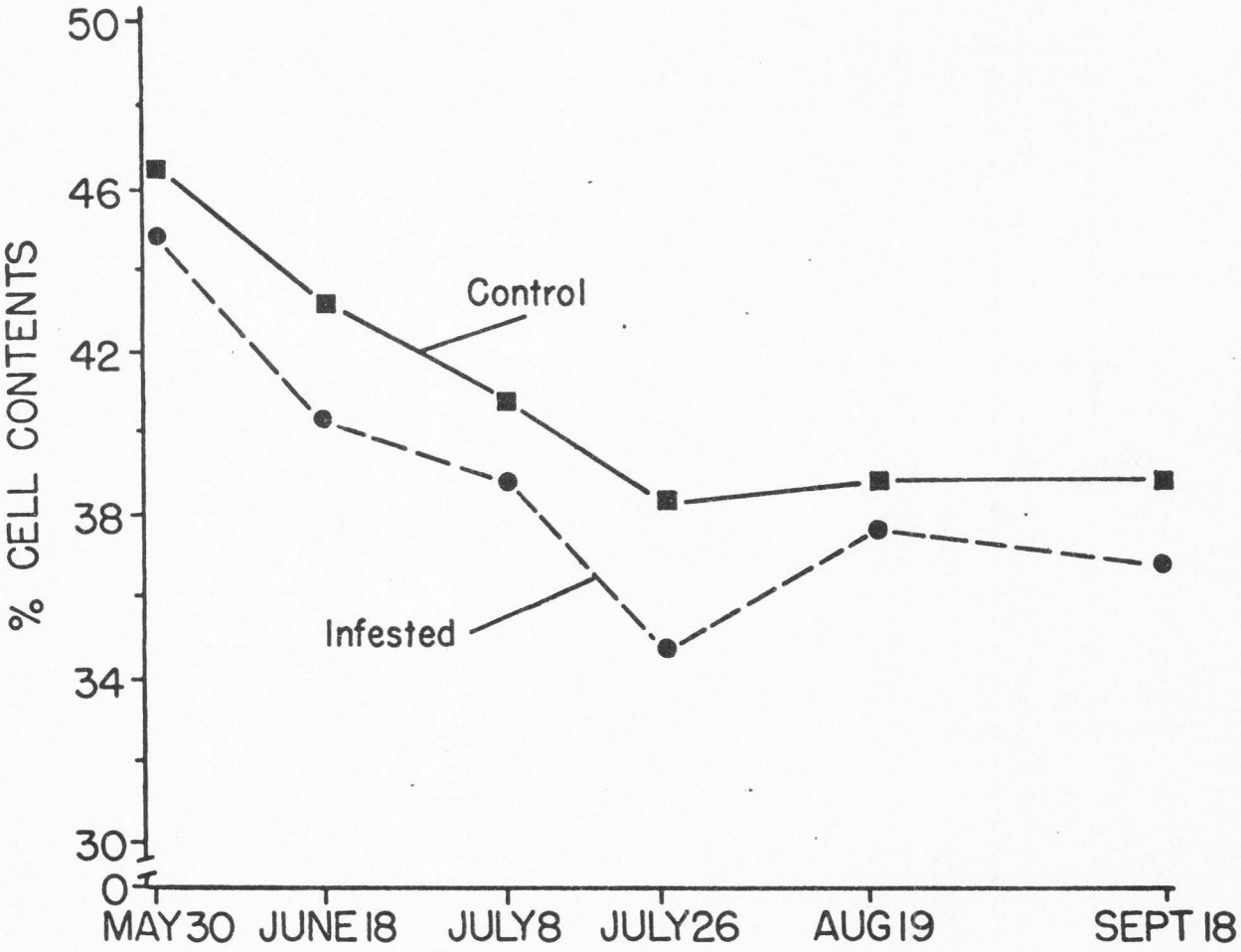

Figure 14. Percentage of cell contents of herbage at Site I.

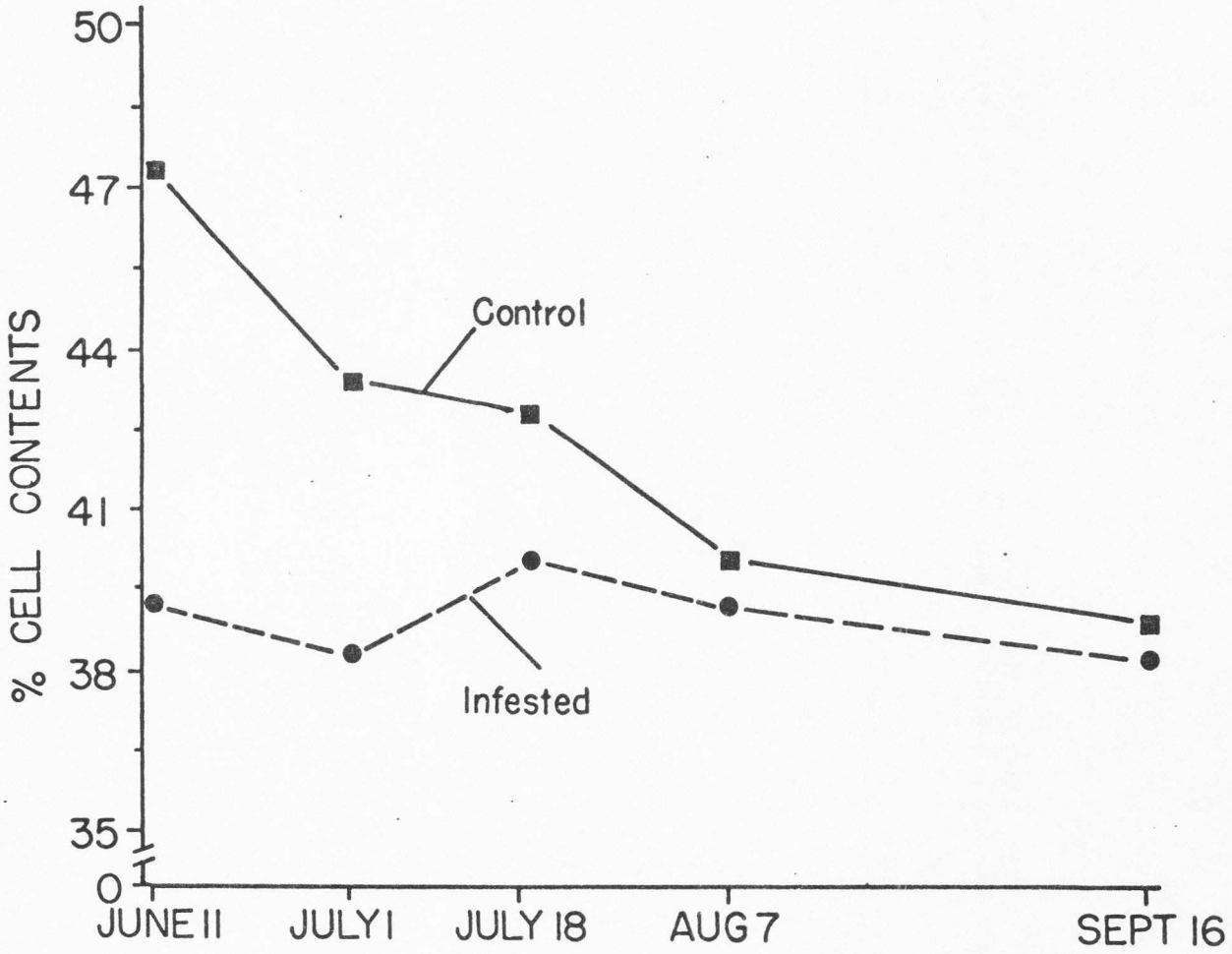

Figure 15. Percentage cell contents of herbage at Site II.

Plants at Site II on June 11 contained 39 and 48 percent cell contents on infested and control plots, respectively. This maximum difference of eight percent occurred during the period of peak bug numbers but the differences diminished as the season progressed. However, an apparent difference of one percent was detected even at the end of the growing season.

SUMMARY AND CONCLUSIONS

Two intermediate wheatgrass stands with different levels of Labops infestation were studied to determine the effects of grass bugs on herbage and seedhead production and nutritional quality of forage.

At Site I, a comparative evaluation was made between a plot with an infestation of 113 bugs per sweep and a control plot with no apparent bug population. At Site II, an infested plot with 210 bugs per sweep was compared to a control plot which had been treated with an insecticide the year before the study. This control plot was not completely free of grass bugs, however, damage was negligible. Even though the higher infestation at Site II was not as severe as the 120 bugs per 0.96 $ft.^2$ reported by Todd and Kamm (1974), the density of bugs and their resulting effects were quite impressive even with casual appraisal.

Herbage production on the more highly infested plot at Site II appeared to be depressed at the height of bug activity. However, recovery began almost immediately after feeding injury ended and total production surpassed that of the control plot by the end of season. No difference in season-long herbage production due to the effect of Labops damage could be detected on either site. Differences between treated and control plots on Site II late in the growing season were thought to be due to differences in range site potential.

Herbage production at Site I was apparently not decreased by the lower infestation of grass bugs. Total biomass production appeared

about the same on treated and control plots. No difference in herbage production due to the effect of Labops could be detected by the end of the growing season.

Seedhead production appeared to be sharply reduced by grass bug feeding injury. Feeding injury by grass bugs may have retarded the plants ability to synthesize carbohydrates for reproduction. Studies of range plant physiology (Donart and Cook, 1970) have shown the reproductive process to be related to stores of soluble carbohydrates in the plant. The infested plots at Sites I and II exhibited decreases in seedhead production of 45 and 56 percent, respectively.

Seedhead production does not play a major role in maintenance of seeded grass stands in the Intermountain West. Intermediate wheatgrass plants in good vigor normally reproduce vegetatively by tillering or expanding in basal area, rather than from the establishment of new seedlings. Therefore, seed production is not crucial to stand longevity. However, it may be an important indication of plant vigor and may signal danger if the competitive ability of desirable grasses is reduced. Seedhead production per se may be of concern to commercial seed producers and to graminivorous birds and rodents.

Infested grasses had become yellow and appeared dry by the time of peak bug numbers. The leaves of infested grasses were convoluted and appeared to be under moisture stress at mid-day; but no important differences in dry matter content were found between infested or control plots.

Crude protein was slightly higher in grasses that had been fed upon by grass bugs. The reason for this was not known. It may have

been the result of either a plant physiological response to feeding injury or a delay in plant phenological development.

Cell contents of infested plants were lowered about eight percent in comparison to control plants at the time of peak infestation on Site II. Further growth by affected plants after feeding injury resulted in a diminution of this difference. At Site I an average difference of only about one percent in cell contents was found for the entire season.

According to Van Soest (1967), cell contents are 98 percent digestible. Therefore, an incremental decrease in cell content would result in an equivalent decrease in digestibility by herbivores. It follows that an eight percent decrease in the digestible amount of dry matter at Site II would probably result in an equivalent decrease in the digestible amount of dry matter of infested plants. Under these circumstances livestock gains may be decreased slightly unless the animal compensates by increasing forage intake. The effect of grass bugs on the digestibility of the cell walls is unknown.

In conclusion, grass bugs at the levels of infestation observed in this study were probably not detrimental to the short-term production of high quality forage for livestock. However, bug populations apparently increase considerably each year if not controled. Their accumulated effects on plant vigor is unknown, but perhaps important. High levels of infestation may have an important effect on plant palatability to the grazing animal. It has been reported that livestock often avoid damaged grasses when foraging.

It appears that grass bugs had no practical effect at the levels of infestation examined in the study. Therefore, control measures may not be economical at these infestation levels.

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