of the nitrogen fixation by legume bacteria would take place during the warmer spring months. It is evident that little or no nitrogen was added to the forage between February and May of the 1958 and 1959 seasons, the poor clover years. Studies to pursue the relationship between annual clovers and their contribution to soil nitrogen are in progress.

Summary and Conclusions

During one wet year and two dry years urea was applied to different plots at six dates over a seven month period from September to March. Applying urea early in the fall was generally more effective in producing winter feed than late fall applications, but for production of spring feed the date of application made no consistent difference except that March application was too late to produce maximum yields.

At the February sampling date plots fertilized with urea the previous September, November, December, and January yielded forage with a progressively higher nitrogen content as the date of application advanced. At the May sampling date the month of urea application produced no consistent difference in nitrogen content of the forage except that plots fertilized in March produced forage in May with the highest nitrogen content.

Total nitrogen uptake was increased by urea fertilization but the date of application produced no significant difference at the February sampling. At the May sampling date, application of urea in February of the two driest years resulted in the greatest yield of nitrogen per acre. During the wet year there was no significant difference in pounds of nitrogen produced as affected by date of application.

LITERATURE CITED


Effect of Selective Grazing by Sheep on the Control of Leafy Spurge (Euphorbia esula L.)

A. Johnston and R. W. Peake

Agronomist, and Head, Forage Crops Section, Canada Agriculture Research Station, Lethbridge, Alberta

Perennial noxious weeds are a problem in many areas, one of the most serious being leafy spurge (Euphorbia esula L.). Recommendations for the control of leafy spurge involve at least two years of intensive cultivation, the use of selective herbicides, or the use of soil sterilants. Such measures are expensive and may be difficult to apply effectively (Hanson and Rudd, 1933, and Muencher, 1930). There are many infested areas where these control measures cannot be efficiently utilized because of cost or other factors. These are light soil areas where the danger of wind erosion is great, stony lands where farm machinery cannot be successfully used, and native pastures where only a cheap, effective measure can be considered.

The competition provided by a perennial grass sown on leafy spurge-infested areas has been suggested as one means of control (Pavluchenko and Kirk, 1946). This method reduced the density of shoots but did not result in death of the roots. Grazing by sheep has been advocated...
as an effective type of control (Wood, 1944, and 1945), although no data of a quantitative nature were given in support of this view.

The objectives of this study were to determine the effects of selective grazing by sheep on a mixed crested wheatgrass-leafy spurge pasture.

**Methods**

An area near Pearce, Alberta, that had become severely infested with leafy spurge was selected for the study. In 1940 the area had been seeded with crested wheatgrass (Agropyron cristatum L.) in a four-replicate rate and space of seeding experiment involving 17 treatments in a randomized complete block design. While good stands of crested wheatgrass were obtained from all seedings, the competition provided by the grass did not control leafy spurge. By 1952 the experimental area supported a uniform stand of crested wheatgrass mixed with a variable cover of leafy spurge. By 1952 the experimental area supported a uniform stand of crested wheatgrass mixed with a variable cover of leafy spurge. The experimental design mentioned above was used in the analysis of vegetation, each of the original plots being considered a sampling unit, four replicates of each being available for study and analysis. The terms 'sampling unit' and 'replicate' have been retained for convenience in spite of the fact that the entire area was grazed by sheep from 1952 to 1956 inclusive.

The vertical point method (Levy and Madden, 1933) was used in making vegetation analyses in September of each year. Five hundred points per sampling unit were examined and only those points striking the base of a plant of leafy spurge or crested wheatgrass at ground level were recorded as 'hits.' Notes were made on the relative acceptability of species present, on the reaction of sheep to grazing the cover, and on the behavior of leafy spurge plants present in an adjoining ungrazed field of crested wheatgrass.

The 30-acre field was stocked with mature ewes each year at a rate of one and one-half head per acre for a grazing period that lasted approximately from May 1 to September 30. In 1952 it was not possible to start grazing until June 11.

Percentage basal area data were subjected to angular transformation before the data shown in the accompanying tables were analysed (Snedecor, 1946). The analysis also showed a significant difference (P<0.01) in basal area of leafy spurge between years. This reduction in weed cover was due to selective grazing by sheep. By using the percentage data obtained during the course of the experiment and calculations not shown herein, a decrease of 98 percent in the basal area of leafy spurge was shown to have occurred over the five-year period.

%Table 1. Average basal area of leafy spurge per sampling unit by replicates for the period 1952-1956 (data transformed).

<table>
<thead>
<tr>
<th>Year</th>
<th>Rep. 1</th>
<th>Rep. 2</th>
<th>Rep. 3</th>
<th>Rep. 4</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952</td>
<td>1.50</td>
<td>2.84</td>
<td>3.60</td>
<td>4.61</td>
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<td>1953</td>
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<td>5.40</td>
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<tr>
<td>1954</td>
<td>2.66</td>
<td>2.51</td>
<td>3.62</td>
<td>4.86</td>
<td>3.41</td>
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<tr>
<td>1955</td>
<td>0.15</td>
<td>0.15</td>
<td>0.90</td>
<td>0.15</td>
<td>0.34</td>
</tr>
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<td>1956</td>
<td>0.15</td>
<td>0.45</td>
<td>0.15</td>
<td>0.15</td>
<td>0.22</td>
</tr>
</tbody>
</table>

L.S.D. (P=0.05) 0.60
L.S.D. (P=0.01) 0.80

That grazing by sheep, and not some climatic or edaphic factor, was responsible for the reduction in basal area of leafy spurge is management of the sheep, which will be discussed later.

The data also reflected the patchy nature of leafy spurge throughout the study area. An analysis of variance of the data summarized in Table 1 showed a significant difference (P<0.01) in basal area of leafy spurge between replicates. This difference can be attributed to the patchy occurrence of leafy spurge over the study area and to its relative abundance on two of four replicates. This fact had a bearing on

![Figure 1. Several representative grazed plants of leafy spurge (left) and a single ungrazed plant from an adjoining field (right), all of which grew in admixture with crested wheatgrass.](image)
for the period 1952-1956 is pre-
annual cutting for hay produc-
tensity of grazing used was suf-
cient to keep leafy spurge
significantly greater (P<0.01) at the
crested wheatgrass was signifi-
cant. The basal area of crested wheatgrass
plants in the condition shown
crested wheatgrass. Experimental period in spite of
a vigorous condition during the
was more effective in consum-
ing the developing plants than
most abundant, and hence, they
were more effective in consum-
ming the developing plants than
if an attempt had been made
toward uniform utilization of the
whole area. However, uncontrol-
led distribution will eventually
lead to localized over-graz-
ing. Thus an attempt toward
more uniform utilization of the
pasture should be made when,
on the basis of number and vigor
of leafy spurge plants, it appears
that control has been attained.

Occasional losses by poisoning
may be encountered. Sheep
losses were a factor in 1952, when
relatively large plants of leafy
spurge were being grazed, but
not thereafter, when grazing was
started at an earlier date and
only small plants were present.
Post-mortem examinations con-
ducted by the Animal Diseases
Research Institute (Western),
Lethbridge, showed that leafy
spurge was responsible for the
poisoning losses.

Crested wheatgrass appears to
be a useful grass in a leafy
spurge control program. This
grass becomes harsh and unpal-
atable to sheep during the sum-
mer months, and during this pe-
riod it was noted that the ani-
mals tended to graze leafy
spurge and to avoid crested
wheatgrass almost entirely. Ken-
ty bluegrass, a species that
remains green and palatable dur-
ing the summer months, was
present in small volunteer areas
throughout the field. The Ken-
nty bluegrass plants on these
areas were severely weakened
through over-grazing nearly as
rapidly as the leafy spurge.

A further point noted in this
study is that, even after five
years of grazing by sheep, some
plants of leafy spurge remained
alive although much reduced in
vigor. Thus, if such land were
to be used for crop production,
leafy spurge should be carefully
watched, as these remaining
plants could, under poor man-
agement, re-infest the entire
area.

The results reported demon-
strate a tenet of range manage-
ment, namely, that it is possible
to manipulate the vegetation of
an area by taking advantage of
the differing grazing habits of
livestock. In this study, through
selective grazing by sheep over
a five-year period, an area that
was badly infested with leafy
spurge was converted to good
crested wheatgrass pasture con-
taining a very limited amount of
leafy spurge.

Summary

A study was undertaken to de-
termine the effectiveness of se-
lective grazing by sheep on the
control of leafy spurge. A study
site was selected that was badly
infested with leafy spurge and
that had previously been seeded
with crested wheatgrass. Graz-
ing started in 1952 and was con-
tinued until 1956. During this
interval, vegetation changes
were followed with the vertical
point method.

The results show that selective
grazing by sheep is an effective
method for use in controlling
leafy spurge and that at least
four years of grazing are re-

<table>
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<th>Rep. 3</th>
<th>Rep. 4</th>
<th>Average</th>
</tr>
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<td>19.68</td>
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<td>20.01</td>
<td>19.31</td>
<td>19.86</td>
</tr>
<tr>
<td>1955</td>
<td>19.16</td>
<td>19.32</td>
<td>18.31</td>
<td>17.90</td>
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<tr>
<td>1956</td>
<td>22.12</td>
<td>22.63</td>
<td>22.03</td>
<td>21.22</td>
<td>22.00</td>
</tr>
</tbody>
</table>

L.S.D. (P=0.05) 0.70
L.S.D. (P=0.01) 1.01

indicated in Figure 1. The in-
tensity of grazing used was suf-
cient to keep leafy spurge
plants in the condition shown
throughout the grazing period.
It should be noted that leafy
spurge plants from the adjoining
ungrazed field remained in
a vigorous condition during the
experimental period in spite of
annual cutting for hay produc-
tion and competition with crested wheatgrass.

A summary of the data on
basal area of crested wheatgrass
for the period 1952-1956 is pre-

tended in Table 2. The data
showed that the basal area of
crested wheatgrass was signifi-
cantly greater (P<0.01) at the
end of the test than at the be-

inning. This indicated that the
g grass cover was not damaged as
result of the grazing treatment.

Observations made during the
course of the experiment sug-
gested that there are a number
of points that should be noted by
individually interested in con-
trolling leafy spurge through se-
lective grazing by sheep. It is
important that grazing be started
early in the season before the
weed makes much growth. It
was observed that sheep read-
ily grazed small plants of leafy
spurge but were reluctant to
consume the more mature plants.
A mature stand of leafy spurge,
therefore, should be mowed be-
fore grazing is permitted. Sheep
in numbers sufficient to keep
the weed closely cropped should
be used. Control of leafy spurge
through grazing is accomplished
by exhausting the carbohydrate
reserves in the roots, and this
can be done only by preventing
or severely reducing the develop-
ment of leafage.

It is not advisable to attempt
to control distribution of the
sheep for at least the first three
years of grazing. During this
study it was noted that the sheep
tended to congregate on those
areas where leafy spurge was
most abundant, and hence, they
were more effective in consum-
ing the developing plants than
if an attempt had been made
toward uniform utilization of the
whole area. However, uncontrol-
led distribution will eventually
lead to localized over-graz-
ing. Thus an attempt toward
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Crested wheatgrass appears to
be a useful grass in a leafy
spurge control program. This
grass becomes harsh and unpal-
atable to sheep during the sum-
mer months, and during this pe-
riod it was noted that the ani-
quired before such control can be attained. During the study period the basal area of crested wheatgrass increased significantly (P<0.01) whereas that of leafy spurge showed a significant decrease (P<0.01). Observations made during the course of the experiment are discussed. These are of practical interest to pasture managers.

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**Integration in the Use of Public and Private Range in Pacific Northwest Ranching**

TOM WILSON

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This subject seems to be simplicity in the greatest degree, but when one begins to analyze all the aspects, many problems appear. The first problem arises from the word “Northwest.” I have taken the Northwest to be roughly that area covered by the Northwest Section of this Society—Oregon, Washington and British Columbia. This vast territory presents numerous problems, all vital to range management.

Let us consider climate. On the Pacific coast slopes we have an area with extremely heavy precipitation. Southwest Oregon is a semi-desert region. Other districts vary between these two extremes in precipitation. There are regions with little or no frost while others have temperatures of 50 to 60 degrees below zero. We have rangelands with nearly 200 frost-free days and others that get frosted every month of the summer.

Then, too, we have great variations in topography from the sea level delta lands to the high ranges with elevations of 10,000 feet. Between these extremes we have level plains and mountainous terrain.

Such variations in climate and topography together with soil differences require Northwest ranchers to deal with extremely different types of vegetation in their livestock operations. These types vary from open grasslands along the low elevations, deep canyons, such as the Snake River, which are best used for winter range to open grasslands above timberline which can be used only in summer. Extensive open pine grasslands and natural forests, vast acreages of which have been burned over and are now a tangle of lodgepole or fir reproduction, provide late spring summer and fall grazing.

Consequently, diversified ranch operations will often work best for the Northwest rancher. As a result some ranch operations are a cow-calf production while others merchandize 2 or 3-year-old steers off grass.

These great variations in climate, topography and range type constitute some of the natural obstacles to year-long livestock operations in the Northwest. Also to be considered are some man-made problems which make the picture more complex. The number of public land administration agencies with which Northwest ranchers must cooperate is an example. Fortunately for ranchers in British Columbia this problem is minimized in that the Forest Service controls most public lands. However, our rancher neighbors to the south normally deal with a number of agencies for grazing privileges on lands under their administration. They may deal with the Forest Service, the Bureau of Land Management, the Bureau of Indian Affairs, the State Land Department, and even counties for grazing lands. Each of these has its own land management regulations and objectives with which the rancher must comply and which greatly influence the complexity of his ranching operations. These regulations and objectives, so I've been told, are not always co-ordinated for efficient use of natural and human resources and have sometimes created hindrances to a sound range utilization program. However, when these groups elect to work together they have adequate personnel and finances to create an integrated program far superior to anything that could occur on an individual basis.

An example of how these groups can work together for the mutual benefit of all, and particularly the land user, was brought to my attention by a recent article in the Western Livestock Journal, December 1959 issue, outlining the work done by the Beaver Soil Conservation District in Utah. The agencies cooperating in this vast program were the Soil Conser-