In this study, 30 clusters with a total of 120 plots and 480 subplots were used. However, the number of clusters, number and location of plots, and the number, location and size of the subplots should be suited to the attributes of the vegetation studied and the measurements desired. Likewise, the lengths of marker pipe and re-rod may have to be longer for stability in some soils. This method of plot location would be difficult to use in rocky soils or on steep slopes where soil movement is evident, but should be suitable for most other soil conditions. In areas with frost heaving, care should be taken to make the pipe and marker rod long enough to reach below the level of soil movement or into the upper portion of the parent material. Sheep and antelope did not disturb the marker stakes, although this might be a problem on cattle ranges. On ranges where vehicular traffic occurs, some means of marking the pipe locations may be necessary to avoid tire damage. Threading the top of the pipe and fitting with a cap may be desirable.

The technique has been completely satisfactory for the conditions encountered.

Influence of Phosphorus Fertilizer Placement on two Nebraska Sub-irrigated Meadows

A. W. MOORE, E. M. BROUSE, AND H. F. RHODES

Formerly Assistant Agronomists, and Professor of Agronomy respectively, University of Nebraska, Lincoln.

Highlight

On two Nebraska sub-irrigated meadows drilling phosphorus fertilizer at a depth of 3 to 4 inches resulted in lower dry matter yields and lower percentages of phosphorus as compared with surface application. By labelling superphosphate (35 lb P/ac) with 32P it was shown that grasses, which constituted the bulk of the forage, took up less fertilizer phosphorus when the latter was drilled in than when applied on the surface.

In general, the sub irrigated meadows of the Nebraska Sandhills have shown responses to both phosphorus and nitrogen fertilization (Brouse and Rhoades, 1966; Russell et al., 1965). Since fertilizers have been applied on the sub-irrigated meadows almost exclusively by surface broadcasting, a comparison between surface application and drilling of phosphorus fertilizer was made.

Soils and vegetation at the two sites used in this study have been described by Moore and Rhoades (1966). Both soils were sandy but the soil at site 1 was alkaline throughout the profile (pH 7.3 to 8.0 to 40 inch depth) while that at site 2 was mildly acidic (pH 5.9 to 6.7).

Red clover (Trifolium pratense) was present at both sites and alike clover (T. hybridum) at site 2. Grasses at site 1 included redtop (Agrostis alba) and Kentucky bluegrass (Poa pratensis) but were mainly late-maturing species, viz. prairie cordgrass (Spartina pectinata), bluestems (Andropogon gerardi and A. scoparius), indiangrass (Sorghastrum nutans) and switchgrass (Panicum virgatum). Prairie cordgrass was present at site 2 also but the grasses were dominated by early maturing species, viz. redtop, Kentucky bluegrass and timothy (Phleum pratense). Both sites carried some rushes, sedges and forbs.

A randomized block design with four replications was used. Ammonium nitrate (0 and 80 lb N/ac) was applied by broadcasting on the surface. Four rates of triple superphosphate (0, 35, 105, 315 lb P/ac) were applied in bands 8 inches apart either adjacent to the drill-rows. Site 2 had a high proportion of actively-growing, early-maturing grasses. These grasses tillered and occupied much of the drill-row space and also suppressed legume growth. On a total of 10 plots at site 2 and were unchanged at site 1.

Drilling killed much vegetation adjacent to the drill-rows. Site 2 had a high proportion of actively-growing, early-maturing grasses. These grasses tillered and occupied much of the drill-row space and also suppressed legume growth. On site 1, however, the lesser proportion of early-maturing grasses allowed the legumes to occupy space provided by the elimination of late-maturing grasses which were still comparatively inactive.

Dry Matter Yields

In the first season drilling produced lower yields compared with surface application (Table 1) due to killing of some plants by the drill. Drilling
out of the sod immediately adjacent to vegetation, the percentage of phosphorus in the forage was lower when phosphorus in the forage was lower when drilled. In addition, the drying constituted the greater part of the lower root activity at drill depth than into the sod. There was a similar residual effect in increased phosphorus uptake would also lower on drilled plots as compared with surface application plots at both sites in 1955 (Table 2) and the marked decrease on the plots receiving surface applications may reflect phosphate fixation in the surface layer.

Phosphorus Uptake

There were lower mean phosphorus percentages in forage from the drilled plots at both sites in 1955 (Table 2). There was a similar residual effect in 1955. Total phosphorus yields were also lower on drilled plots as compared with surface application plots (Table 2). Non-legumes exhibited a lower root activity at drill depth than at or near the surface and, since they constituted the greater part of the vegetation, the percentage of phosphorus in the forage was lower when the phosphorus fertilizer was drilled into the sod. In addition, the drying out of the sod immediately adjacent to the drill-rows could have resulted in positional unavailability of some of the fertilizer phosphorus. At site 2 decreased phosphorus uptake would also have resulted from the decrease in legume stand as a result of drilling.

Utilization of Fertilizer Phosphorus

Non-legumes showed a lower utilization of fertilizer phosphorus at both sites as a result of drilling. On site 1, red clover used a small proportion of fertilizer phosphorus on the drilled plots at the beginning of the season, but by the end of the season the utilization from surface applied and drilled phosphate was about equal (Table 3). For red clover on site 2, except for the first cutting, the drilled plots showed a higher utilization of fertilizer phosphorus throughout (data not shown).

Phosphate fertilizer in the soil shows little movement and hence a differential uptake with different placement depths would be expected, since root activity is not uniform throughout a profile. It appears from the literature (e.g. Lawton et al., 1954) that grasses have a higher root activity near the surface than at lower depths and our data support this, although a wider spread of the surface applied bands may be involved also. Although root weight and nutrient uptake are not necessarily related, in these sub-irrigated meadows the weight of roots in the upper 2 inches (control plots) was 3.7 tons/acre for both sites, 0.7 and 1.1 tons in the 2 to 4 inch layer at sites 1 and 2, and 0.4 and 0.6 ton in the 4 to 6 inch layer respectively (Moore and Rhoades, 1966). Most of these roots were grass.

Generally, legumes absorb more fertilizer phosphorus at depths of 2 to 4 inches than they do from surface applications (Lawton et al., 1954; Lipps and Fox, 1964). Red clover on site 2 followed this pattern throughout the season while that on site 1 showed a tendency towards slightly greater activity at the 3 to 4 inch depth near the end of the season. Both showed lower activity at this depth than at the surface early in the season. This may be attributed to lower temperatures below the surface and to some disruption of roots caused by the drill.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Red clover</th>
<th>Non-legumes</th>
<th>Total vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 15</td>
<td>58 20</td>
<td>82 11</td>
<td>41 12</td>
</tr>
<tr>
<td>May 30</td>
<td>56 48</td>
<td>29 15</td>
<td>44 22</td>
</tr>
<tr>
<td>June 14</td>
<td>84 76</td>
<td>40 23</td>
<td>58 36</td>
</tr>
<tr>
<td>July 1</td>
<td>82 86</td>
<td>56 22</td>
<td>63 59</td>
</tr>
<tr>
<td>July 15</td>
<td>89 20</td>
<td>41 28</td>
<td>65 62</td>
</tr>
</tbody>
</table>

| Site 1 | 0.18 | 0.15 | 0.13 |
| Site 2 | 0.25 | 0.33 | 0.29 |

Drilling resulted in significantly (P < 0.01) lower yield at both sites in 1955 and higher yield at site 1 in 1956, compared with surface application.

LITERATURE CITED


LAWTON, K., M. B. TESAR, AND B. KAWIN. 1954. Effect of rate and
Managing Grazing Resources for Profit on Commercial Timberlands

HERBERT B. SMITH
Chief Forester, Pilot Rock Operations, Western Pine Division, Georgia-Pacific Corporation, Pilot Rock, Oregon.

Highlight
Grazing income from commercial timberlands is a source of revenue to a commercial timberland owner. However, grazing plays a minor role and is subordinate to the management and harvesting of timber. The grazing lease itself is an expression of the timberland owner’s policy and is an important tool used in managing the grazing resource. Harvesting forage utilized by big game can be accomplished by leasing cabin sites to selected individuals.

Of primary importance in managing grazing resources for a profit on commercial timberlands is the resource—land—and its complementary factors that make land suitable for grazing.

Georgia-Pacific Corporation is one of the world’s largest tree farmers, owning over 3.5 million acres of commercial timbers. Its Western Pine Division, Pilot Rock, Oregon, consisting of 103,000 acres of these lands, is located within and along a portion of the northerly edge of the Blue Mountains in northeastern Oregon.

The lands lie between 2,000 and 5,000 ft elevation. The terrain is both rolling and mountainous, and is dissected into steep “breaks” along the main drainages. The soil varies from stony loams on upper slopes and on south slopes, to deep silt loams in valleys and on north slopes. By and large, the soils are loess and volcanic in origin.

Temperatures range from -30°F to 120°F. An annual average low humidity creates a rather dry climate. Precipitation varies from 14 to 20 inches annually. A substantial proportion of the moisture received is in the form of snow. Tributaries of the Columbia River drain the area. The water storage capacity and the water from the Corporation’s 103,000 acres is comparable in quality and quantity to that of other lands in the area.

The dominant timber species is ponderosa pine. The associated species are inland Douglas-fir, grand and alpine fir, western larch, Engelmann spruce, and lodgepole pine. The key forage grasses, blue-bunch wheatgrass (Agropyron spicatum), Sandberg bluegrass (Poa secunda), and Idaho fescue (Festuca idahoensis) are found in openings and park-like areas. Other forage grasses include Kentucky bluegrass (Poa pratensis), pinegrass (Calamagrostis rubescens), and elk sedge (Carex geyeri), which occur in forested areas. Cheatgrass (Bromus tectorum) is an important source of early-season forage.

Land Ownership and Management
The timberland ownership pattern is scattered and varies in size of tract. The largest tract being 18,000 acres and the smallest, 40 acres. Currently there are 60 tracts split among 45 stockmen who lease the timberlands for use as summer range. Only the larger tracts lend themselves to more than perfunctory grazing management. However, every acre is leased and contributes some share to