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Fertilization of Mixed
Cheatgrass-Bluebunch
Wheatgrass Stands

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Highlight
On both dense and sparse blue-
bunch wheatgrass stands, cheatgrass
became dominant with increasing
applications of ammonium sulfate.
High and repeated fertilizer applica-
tions (80 lb N/A in 4 successive
years) depressed bluebunch wheat-
grass yield 50%.

Annual and perennial grasses
growing in competition often re-
spond differently to nitrogen fer-
tilization. In Colorado, ammo-
nium nitrate at 40 lb N/A in-
creased sixweeks fescue (Festuca
octoflora Walt.) yield 146%, but
increased blue grama (Bouteloua
gracilis (H.B.K.) Lag. ex Steud.)
yield only 18% (Hyder and
Bement, 1964). In California,
ammonium sulfate at 60 lb N/A in-
creased yield of annual grasses
91%, but did not increase yield of
hardinggrass (Phalaris tube-
rosa (Hack.) Hitchc.) (Martin
et al., 1964). Only at high nitro-
gen rates (240 lb N/A) was
growth of hardinggrass appreci-
ably stimulated. In northeastern
California, ammonium sulfate at
60 lb N/A increased percent
ground cover of cheatgrass (Bromus
tectorum L.) but decreased
ground cover of intermediate
wheatgrass (Agropyron inter-
medum (Host) Beauv.) (Kay
and Evans, 1965). In southeastern
Washington, nitrogen fertilizer
greatly increased the yield of
cheatgrass (Patterson and Young-
man, 1960). Although nitrogen at
20 or 40 lb/A applied for 3 and 4
years had little effect on blue-
bunch wheatgrass (Agropyron
spicatum (Pursh) Scribn. and
Smith), 60 or 60 lb N/A applied
for the same period reduced
bluebunch wheatgrass yield.

In southeastern Washington,
cheatgrass is palatable and nutri-
tious during 6 to 8 weeks in the
spring, but is less desirable as
forage than bluebunch wheat-
grass throughout the remainder
of the year. Consequently, fer-
FERTILIZATION

This paper reports changes in mixed cheatgrass-bluebunch wheatgrass stands induced by nitrogen-containing fertilizers.

Procedure

Two experiments, separated by about 20 miles, were located within the Agropyron spicatum-Poa secunda habitat type described by Daubenmire (1942). The first site was located 8 miles southwest of Lacrosse, Washington, on a moderately deep (20 to 36 inches) Benge silt loam soil. The second site was located 8 miles northwest of Dodge, Washington, on a deep (more than 60 inches) Ritzville silt loam soil. Both sites had an elevation of 1,400 feet and a slope of approximately 10% in a northeasterly direction. During the study, 1961-1964, average October to June precipitation reported by the Lacrosse and Pomeroy stations was 13.8, 11.2, 10.1 and 10.4 inches. This was slightly lower than the 13.2-inch average during the preceding 10 years.

At each location, studies were conducted on adjacent good and poor condition sites (dense and sparse bluebunch wheatgrass stands) which were the result of past management on different sides of an old fenceline (Fig. 1). Five replications were established at each site with a randomized complete block design. Ammonium sulfate was applied every year or every second year in October or March at rates of 0, 20, 40, and 80 lb N/A. In the fall of 1960 the sites were fenced to exclude cattle. Little evidence of grazing by game animals or rodents was observed.

Yields were measured in subplots (0.5 x 2.0 meters) within each major plot. Subplots were clipped in a new location each year. Time of clipping was determined by the phenological development of bluebunch wheatgrass. When this species reached the soft-dough stage, plants were clipped to the ground level, separated by species, oven-dried, and weighed. In August each year, after all species were dormant, the entire area was clipped at 4 inches above ground level and the herbage removed from the plots.

Results

Yields of cheatgrass and bluebunch wheatgrass were measured in 1961 and 1962. Because response at the two locations (Lacrosse and Dodge) and for the two application dates (October and March) was not significantly different, yield data were combined.

Average yields of unfertilized bluebunch wheatgrass were about 2.5 times higher on good than on poor condition sites (Fig. 2). The reverse was true of unfertilized cheatgrass yields; poor condition sites yielded slightly more than twice as much cheatgrass as good condition sites. This was expected because good sites were selected to have more bluebunch wheatgrass and less cheatgrass.

In the growing season immediately following either fall or spring application, cheatgrass yields increased with increasing rates of ammonium sulfate. At 80 lb N/A, cheatgrass was dominant in the plots.
lb N/A the trend was still upward. About 30 to 40 lbs of air-dry forage was produced per pound of N applied. However, 1962 yields from plots fertilized in 1961 but not in 1962, and 1962 yields from plots fertilized in both 1961 and 1962 showed little carry-over of fertilizer.

Bluebunch wheatgrass yields failed to increase significantly with increasing rates of ammonium sulfate, except in one instance. This was during the first year of fertilization on good condition sites where cheatgrass competition was at a minimum. Bluebunch wheatgrass yields were increased one-third above similar unfertilized plots by the application of 80 lb N/A.

The high rate of ammonium sulfate applied to poor condition sites in the first year or applied to both good and poor condition sites in two successive years slightly decreased bluebunch wheatgrass yields. Fertilizer treatments were, therefore, continued in 1963 and 1964 to determine the long-term effects of fertilization on yield of bluebunch wheatgrass.

Eighty lb N/A applied to the same plots in 4 consecutive years depressed bluebunch wheatgrass yields approximately 50% on both good and poor condition sites (Table 1). The lower rates of ammonium sulfate had no obvious effect on the bluebunch wheatgrass stand.

Annual application of 80 lb N/A to the same plot for 4 consecutive years quadrupled the number of cheatgrass plants (Table 2). In fertilized plots, cheatgrass was often growing in bluebunch wheatgrass clumps.

In 1963, new plots were treated to separate the influence of cheatgrass competition from the influence of fertilizer application on the yields of bluebunch wheatgrass. Competing species were removed from selected plots on the good condition site at Lacrosse by hand-hoeing.

| Table 1. Effects of ammonium sulfate applications, in the 1961-1964 seasons, on bluebunch wheatgrass yield (lb/A dry weight) measured in June 1964. |
|----------------------------------|-----------------|-----------------|
| Ammonium sulfate | Yield1 | Good site | Poor site |
| (lb N/A) | | | |
| 0 | 520 | 370 |
| 80 | 270 | 160 |

1LSD at 5% level for differences between yields is 100 lb/A on both good and poor condition sites.

| Table 2. Effects of ammonium sulfate, applied in fall or spring, on number of cheatgrass plants per square foot in June 1964. |
|----------------------------------|-----------------|
| Ammonium sulfate | Cheatgrass plants1 |
| (lb N/A) | Fall | Spring |
| 0 | 150* | 120* |
| 802 | 320* | 310* |
| 803 | 580* | 620* |

1Values having the same letter in the superscript do not differ significantly at the 5% level (Duncan, 1955).

Treatments were continued on the same plots for two consecutive years.

In 1963 and 1964, removing competing vegetation doubled bluebunch wheatgrass yield (Table 3). Applying 80 lb N/A to plots without competing vegetation increased yields an additional 30%. Fertilizer applied to plots having competing species increased bluebunch wheatgrass yields about 70% the first year, but only 35% the second year. This indicates the intensified competition with other species resulting from consecutive years of fertilizer application.

In a 1963 experiment at Lacrosse, ammonium nitrate and calcium sulfate were applied, separately and in combination, to determine whether the stimulated growth of cheatgrass was due to nitrogen, sulfur, or a combination. When applied separately, neither ammonium nitrate nor calcium sulfate greatly influenced cheatgrass yield (Table 4). However, when they were applied in a combination that was equivalent to 80 lb N/A using ammonium sulfate, cheatgrass yield increased sixfold.

Discussion
In southeastern Washington, ammonium sulfate fertilizer applied to mixed cheatgrass-bluebunch wheatgrass stands resulted in ecological regression rather than improvement of condition. This was especially true where applications were made in 2 or

| Table 3. Effects of ammonium sulfate applications, in two consecutive years, on yield of bluebunch wheatgrass (lb/A dry weight) in plots with and without competing species. |
|----------------------------------|-----------------|-----------------|
| Ammonium sulfate | Yield1 | With competition | Without competition |
| (lb N/A) | | | |
| 0 lb N/A | 1963 | 560 | 1260 |
| | 1964 | 450 | 890 |
| | Average | 510* | 1080* |
| 80 lb N/A | 1963 | 970 | 1620 |
| | 1964 | 580 | 1250 |
| | Average | 780* | 1440* |

1Yield averages having the same letter in the superscript do not differ significantly at 5% level (Duncan, 1955).

| Table 4. Cheatgrass yield (lb/A dry weight) in response to nitrogen, sulfur, or nitrogen and sulfur. |
|----------------------------------|-----------------|
| Fertilizer treatment1 | Cheatgrass yield2 |
| | | |
| Unfertilized | 290* | |
| 90 lb S/A | 210* | |
| 80 lb N/A | 440* | |
| 90 lb S & 80 lb N/A | 1900* | |

2Values having the same letter in the superscript do not differ significantly at the 5% level (Duncan, 1955).
more consecutive years at the highest level tested. In the first year of application and on good condition sites where wheatgrass yields exceeded cheatgrass yields more than 2:1, the application of 80 lb N/A reversed the yield to favor cheatgrass 2:1.

Wheatgrass bunches were invaded by cheatgrass on plots receiving heavy and repeated annual fertilization. Cheatgrass seedlings crowded wheatgrass plants by growing closely around and within established bunches. These bunches became progressively smaller under the pressure of competition.

Important in this competitive relationship is the ability of cheatgrass to grow and reproduce under the extreme habitat variations found in eastern Washington. When moisture and nutrients are limiting, cheatgrass may mature as a single stem 3 to 4 inches tall and produce only one spikelet containing one or two viable seeds. On the other hand, when growing conditions are favorable, cheatgrass plants may develop 10 to 15 tillers 2 to 3 feet tall, each producing 50 or more viable seeds.

When fertilizer was applied in successive years, the density of cheatgrass increased. New bluebunch wheatgrass seedlings were not observed in either fertilized or unfertilized plots. Therefore, scattered wheatgrass bunches would not be as effective as dense cheatgrass in utilizing surface applied fertilizer.

Periodicity in growth also favors cheatgrass in its competition with bluebunch wheatgrass. Because it reaches maximum growth earlier than bluebunch wheatgrass (Hull, 1949), cheatgrass often completes its life cycle before soil moisture is depleted. But bluebunch wheatgrass, normally green until mid-July, is damaged when heavily fertilized cheatgrass depletes moisture by early June.

Removal of cheatgrass competition is much more effective than fertilization in stimulating bluebunch wheatgrass growth. Preliminary trials, using selective herbicides which remove cheatgrass without obvious harm to wheatgrass, show promise in providing a practical means of increasing vigor of established bluebunch wheatgrass plants.

Under normal conditions, during the short period when cheatgrass is green and grazable, a surplus of forage exists. Fertilizing to provide more forage at this time may be wasteful, except in special cases. Examples where the use of fertilizers on cheatgrass may be economically feasible include: (1) fertilization of drop range near lambing sheds or (2) fertilization of a small area of annual spring range to shorten the winter livestock feeding period and allow later turn-out on perennial grass range. Grazable cheatgrass was produced 2 to 3 weeks earlier on fall fertilized plots than on unfertilized plots. In considering fertilizer applications, however, the cost and returns of fertilizing must be weighed against the cost of alternative sources of forage. Any plan for fertilizing in this region should include preliminary trials to determine whether sulfur is required in addition to nitrogen.

In general, fertilization of semi-arid ranges in southeastern Washington appears undesirable. Even excellent condition sites have a small population of cheatgrass plants which have the potential to increase and take over a site as a result of fertilization. In most situations, there are adequate amounts of cheatgrass to fill the needs for forage of this species without fertilization. Generally, management objectives on these ranges should include increasing the amount and vigor of bluebunch wheatgrass.

Summary

Range sites having dense bluebunch wheatgrass and sparse cheatgrass or sparse bluebunch wheatgrass and dense cheatgrass were fertilized with increasing amounts of ammonium sulfate. Rather than improving range, heavy fertilization (80 lb N/A in 4 consecutive years) produced a retrogression in range condition: bluebunch wheatgrass yields decreased 50%, cheatgrass yields increased 400 to 600%. This retrogression occurred regardless of the initial density of bluebunch wheatgrass.

In the absence of competing vegetation, bluebunch wheatgrass was not responsive to fertilization. On plots with competing vegetation removed and fertilized with 80 lb N/A, bluebunch wheatgrass yielded only 30% more than on similar unfertilized plots.

Neither ammonium nitrate nor calcium sulfate greatly influenced cheatgrass yield; in a combination, equivalent to 80 lb N/A using ammonium sulfate, they increased cheatgrass yield sixfold.

LITERATURE CITED


