Nitrogen Carryover on Range

test plots on sagebrush range indicate effectiveness of nitrogen fertilizer can carry over into third growing season

B. L. Kay, J. E. Street, and C. W. Rimbey

Nitrogen fertilizers applied to rangeland in amounts greater than the forage plants require during the first growing season produced increased yields in the second and third seasons in tests in Modoc County.

Experimental plots were established on the site of an old wildfire burn near Likely to study the carryover value of fertilizers. Ranges in the area are mostly in association of big sagebrush—*Artemisia tridentata*—and cheatgrass—*Bromus tectorum*. All of the sagebrush on the experimental site was killed by wildfire seven years before the plots were started. The remaining—unfertilized—vegetation was about 77% cheatgrass—based on oven dry weights of samples—8% tansy mustard—*Descurainia pinnata*—and traces of redstem filaree—*Erodium cicutarium*—squirrel tail—*Sitanion histrix*—sandbergs bluegrass—*Poa secunda*—and others.

Rainfall averages about 12½″ although seasonal totals vary widely. The elevation is 4,500′. The growing season is short and variable. The native range of annual bromegrass may germinate as early as October. However, grazable growth may not start until May of the following year. In a warm wet spring, growth may start as early as the middle of February. In all years the annual grasses are dry by the end of June. Winter temperatures may fall below zero.

The shallow soil—classified as Lassen Stony Clay Loam—developed on basaltic bedrock, under low rainfall, moderately cold winters with some snow, dry summers and a relatively short growing season. Subdrainage is restricted by bedrock at a shallow depth—0″-20″—but surface drainage is good. An erosion pavement is evident. The soil is given a Storie Index of 18, as compared with 100 for Yolo Fine Sandy Loam.

Laboratory tests show a pH—relative acidity-alkalinity with 7 as neutral—of 6.1. Greenhouse tests with barley and lettuce on this soil indicate an acute deficiency of nitrogen and sulfur. It was on the basis of these tests that a field plot containing various rates of nitrogen and sulfur was established. Rates of 0, 20, 40 and 80 pounds of actual sulfur—as gypsum—per acre were applied singly and in combination with each of 0, 30, 60 and 120 pounds of nitrogen—as ammonium nitrate—per acre in plots 15′ square.

Response to Carryover of Nitrogen
Second year responses of native range species to carryover nitrogen. Figures are pounds of air dry forage per acre, average of twelve replications.

Treatment	Misc. minor species	Tansy mustard	Cheatgrass	Total production
Check				
No nitrogen	38	19	187	244
Nitrogen per acre broadcast				
30#	41	44	326	411
60#	37	94	483	614
120#	39	115	540	694
L.S.D.* (.01)		50	146	128

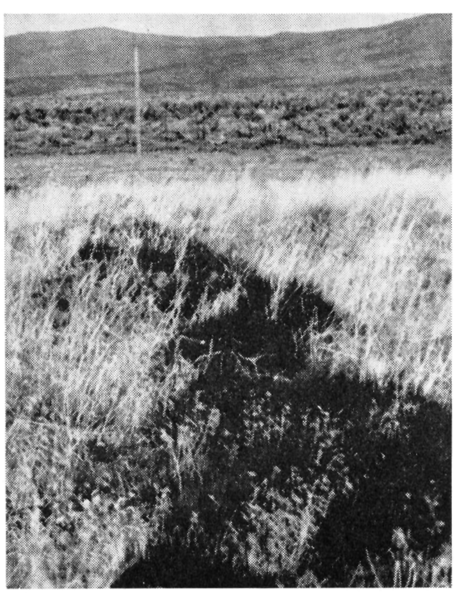
* Least significant difference.

The fertilizers were broadcast by hand on May 3, 1955—early in the growing season—when the native annual forage plants were less than 1″ high.

Observations were made on May 18, June 12 and on July 7, 1955. There was no visible response to either nitrogen or sulfur. Similar plots—established on November 2, 1954—also had failed to show any response to either element. The 1955 check plots were harvested and yielded an average of 202 pounds of oven dry forage per acre.

Observations made as early as May of 1956 indicated that there would be a response to carryover nitrogen in the plot fertilized the year before. The plot was harvested by mowing two strips 21″ × 10′ from each 15′ × 15′ plot on July 25, 1956. The forage had reached a mature dry stage. The samples were oven dried and weighed to the nearest gram. Separations of species were made by hand and crude protein content was determined.

Third year growth response to nitrogen. Area in the foreground was fertilized with 1,000 pounds of 16-20-0 on November 2, 1954. Photo was taken on May 7, 1957. Unburned sagebrush range is in background.



An analysis of variance applied to the yields indicated there was no significant response to sulfur at any of the rates tested. The increases due to the addition of 30 and 60 pounds of nitrogen were significant at the 99% level. The increase between the addition of 60 and 120 pounds of nitrogen was not significant at the 95% level. Apparently moisture became a limiting factor before the 120 pounds of nitrogen could be utilized.

Cheatgrass comprised 78% and tansy mustard, 17% of the increase in forage between the check plots and plots receiving 120 pounds of nitrogen. Field observations indicated that the increase in forage was due to an increase in the amount of tansy mustard in the fertilized stand. There appeared to be a much larger percentage of mustard in the stand under the higher levels of nitrogen. Hand separating of the harvested samples showed that tansy mustard constituted a higher percentage by weight of the samples from the higher rates of nitrogen than from the check. However, the amounts of mustard varied widely between plots. There was an average of 18.8 pounds of oven dry tansy mustard per acre on the plots receiving no nitrogen and 115 pounds on the plots receiving 120 pounds of nitrogen per acre. This means that the tansy mustard increased six times, while the over-all total yield increased less than threefold.

Analysis indicated there was a significant increase in the crude protein content of the mature forage samples as a result of fertilizing with nitrogen or sulfur. Increases in protein due to applications of sulfur were significant at 0.95% and nitrogen at 99%. Results of the analysis of mature dry samples varied from 3.5% crude protein on the check to 5.0% crude protein on the plot receiving 80 pounds sulfur and 120 pounds nitrogen. This was the only ob-

Concluded on page 10

WATER

Continued from page 2

planning. The state's ability to exercise eminent domain and police power might be sufficient if proper legislation authorized such action.

Another possibility might be for the interests internal to basin operation to organize a new district or association which would represent their internal interests with respect to the broader external interests. Precedent for such action has been cited.

A principal role of the public district in the integrated management of ground and surface water is to provide the organizational structure for integration. Integration is achieved by having the internal interests to the management plan represented within the district structure, to provide a means for reaching common interests. And these interests can in turn be represented to external interests by the district form of organization.

Stephen C. Smith is Associate Specialist in Agricultural Economics, University of California, Berkeley.

FLOW

Continued from page 4

These studies indicate that where the spring water is dependent on the local watershed, some increase in flow can be expected as a result of manipulation of the plant cover.

During these studies, roots of grasses, shrubs, and trees were excavated in the field to determine rooting depth. Soft chess was found to penetrate the soil to a depth of 39″, and foxtail fescue to 23″. Both of these annual grasses are important components of the resident vegetation. Ryegrass, an annual commonly planted in the study area on burned over brushlands, extended its roots to 42″. In other studies this species penetrated to 54″. Tarweed is deeper rooted than the grasses and during those years when abundant it depletes the soil moisture to a greater depth than the grasses.

Roots of three 5-year-old wedgeleaf ceanothus plants were excavated and all were found to extend to a depth greater than 10′. The roots of 11-year-old ponderosa pine were traced down 12′ but—by the size of the root at the 12′ depth—they went much further.

Another factor in plant cover manipulation and spring flow involves plants that have their roots in free water. When the tops of such plants are removed, more water may become available immediately for spring or creek flow.

The excavations of wedgeleaf ceanothus may give some indication of how upland plants tap free water. The roots of three plants excavated on April 29, 1952 extended to 10′ where they reached granite and were beginning to grow horizontally. At this level they were in water flowing over bed rock. Thus, in addition to the water removed from the soil it seems that these deeply rooted plants can sometimes tap underground flows of water. This may be important as far as increase in spring flow immediately after brush removal is concerned. When the tops—transpiration surface—are removed by burning or cutting, this water is then permitted to enter spring flow. This principle probably accounts for the quick increase in flow in Finegold Creek, Willow Spring, Grapevine Spring, and possibly the others except for Rock Spring.

A third factor that might possibly apply in plant cover manipulation and spring flow concerns infiltration capacity. If the infiltration should be lowered to the point where most of the rainfall is dissipated through surface runoff and is not permitted to enter the soil, then spring flow might decrease or even stop. This could result from creation of bare soil that becomes sealed, a situation not encountered in these studies.

H. H. Biswell is Professor of Forestry, University of California, Berkeley.

A. M. Schultz is Specialist in Forestry, University of California, Berkeley.

This research was done under Federal Aid in Wildlife Restoration Act Project California 31-R and 51-R.

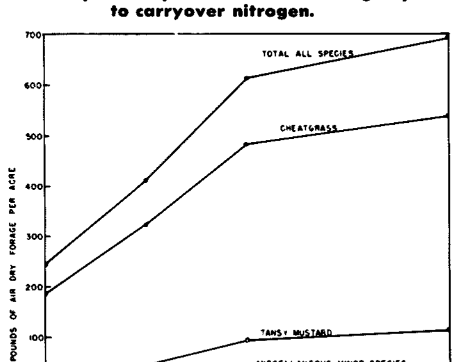
NITROGEN

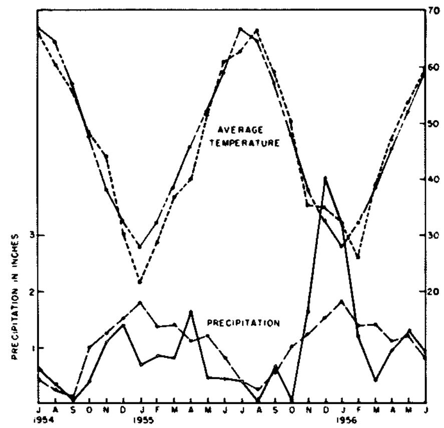
Continued from page 5

served or measured indication that there was a quantity or quality response by native forage plants to applications of sulfur.

Total seasonal precipitation was 8.73″ in the 1954–55 growing season and 14.61″ in the 1955–56 growing season compared to the 41 year average of 12.53″. Thus on a year when rainfall was 3.62″ below normal the native forage failed to respond to applications of nitrogen or sulfur. However, these same plots were able to respond to the initial application of nitrogen when they received an extra 5.88″ of rain or 2.26″ above normal during the second growing season. The 1955–56 growing season also had unusually warm months of December and January.

Second year responses of native range species to carryover nitrogen.





Monthly precipitation and mean temperatures. Solid line indicates monthly precipitation and mean temperatures for the 1954–55 and 1955–56 growing seasons. Broken line shows 38 year average. Data from U. S. Forest Service, Alturas.

The third year observations—made in May 1957—indicated there was a response from the higher rates of the initial application of nitrogen.

Nitrogen carryover has also been noted on barley in Modoc County. Nitrogen, in the form of ammonium sulfate at the rate of 40 pounds per acre, was applied to a dryland barley planting six miles east of Alturas in March of 1955. The 1955 harvest on three acres of check yielded 1,400 pounds of barley per acre. The same yields were harvested on the three acres receiving the 40 pounds of nitrogen. During the next growing season—1956—the barley receiving the nitrogen started growing earlier, grew an extra 6″ in height, and yielded 400 pounds more grain than the check.

These tests indicate that nitrogen fertilizers applied one year may produce increased feed on a range the following year or—in areas of low rainfall—even two years later, where initial application of nitrogen was high.

B. L. Kay is Assistant Specialist in Agronomy, University of California, Davis.

J. E. Street is Associate Specialist in Agronomy, University of California, Davis.

C. W. Rimbey is Farm Advisor, Modoc County, University of California.

Rancher Rob Flourney of Likely, California, W. A. Williams, Assistant Professor of Agronomy, and R. A. Evans, Assistant Specialist in Agronomy, University of California, Davis, and W. E. Martin, Extension Soils Specialist, University of California, Berkeley, cooperated in the studies reported in this article.