# N-FERTILIZER SOURCES FOR DRYLAND CROPS

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For maximum crop production, plant nutrients must be available at levels required to meet the needs of the crop. Generally, any nutrient insufficiency reduces crop growth and production. In the semiarid region, the dryland farmer must conserve and use stored soil water as effectively as possible. This objective may be partially achieved by proper N and P fertilization. Mineralization of soil organic nitrogen and phosphorus and availability of nutrients from fertilizer sources may also depend on the supply of soil water. Hence, knowledge of the availability of nutrients from different fertilizer sources applied to dryland soils is needed to develop systems of efficient soil management. Results of several dryland field studies conducted at Mandan, North Dakota, utilizing different sources of nitrogen, are summarized in this paper.

Nitrogen carriers used in the different experiments included urea, ammonium nitrate, ammonium sulfate and calcium nitrate, with the latter three fertilizers common to all experiments. Annual applications rate ranged from 30 to 160 pounds N per acre in the various experiments. Fertilizers were applied for either four or five years in all experiments, and either drilled in before seeding spring wheat or corn, or broadcast on the soil surface for bromegrass and crested wheatgrass.

Carryover effects were evaluated by cropping for three years to barley after fertilizer application to corn and bromegrass, for four years to spring wheat after fertilization of spring wheat, and for six years to crested wheatgrass after fertilization of crested wheatgrass. Experiments were terminated when yields from fertilized plots were no longer greater than that of the check. Results of this study are summarized in terms of dry matter yield, fertilizer production efficiency, and soil pH. To facilitate comparisons between fertilizer sources and crops, yields were adjusted to a uniform N rate of 60 pounds per acre for all experiments by plotting yield as a function of N rate for each crop experiment and determining yield at the 60-pound N rate. This does not necessarily mean that this adjusted rate of 60 pounds N per acre was the optimum rate for the various crops.

Spring wheat fertilized with ammonium nitrate, ammonium sulfate or calcium nitrate produced similar amounts of dry matter during eight years of cropping. No differences were found between the fertilizers during either the fertilization period or the carryover period (Fig. 1). Cumulative grain yields (not shown) for the various fertilizer N sources followed trends similar to those for dry matter production of wheat. Corn forage yield was somewhat less from calcium nitrate than from the other N sources during the four years of fertilization. Also, slightly less yield was obtained from calcium nitrate in the carryover period (barley was the test crop). Nitrate-nitrogen distribution in the soil indicated that this reduced carryover yield from calcium nitrate was probably the result of nitrate leaching below the root zone, following a period of high precipitation. Soil samples collected at the end of the experiment showed an accumulation of nitrate in calcium nitrate plots at the 6- to 8-foot depth. Other treatments contained appreciably smaller accumulations at these depths.

Cumulative dry matter production by bromegrass was similar for the three N sources, and carryover effects on barley grown on these plots likewise showed little differences between sources. Crested wheatgrass yield was appreciably less from ammonium sulfate than from the other N sources during both the fertilization period and the carryover period.

All crops responded significantly to N fertilization (N vs check). Average annual dry matter production for check and nitrogen treatments (all sources combined) was 4,560 and 6,130 pounds/acre for corn, 2,860 and 4,520 pounds/acre for spring wheat, 1,530 and 3,070 pounds/acre for crested wheatgrass, and 1,060 and 2,740 pounds/acre for bromegrass, respectively. Thus, 60 pounds N/acre increased dry matter approximately 1,600 pounds/acre for all crops.

Urea (data not shown) was used as a fertilizer source in all except the spring wheat experiment. When used at rates of 60 pounds N/acre or less,

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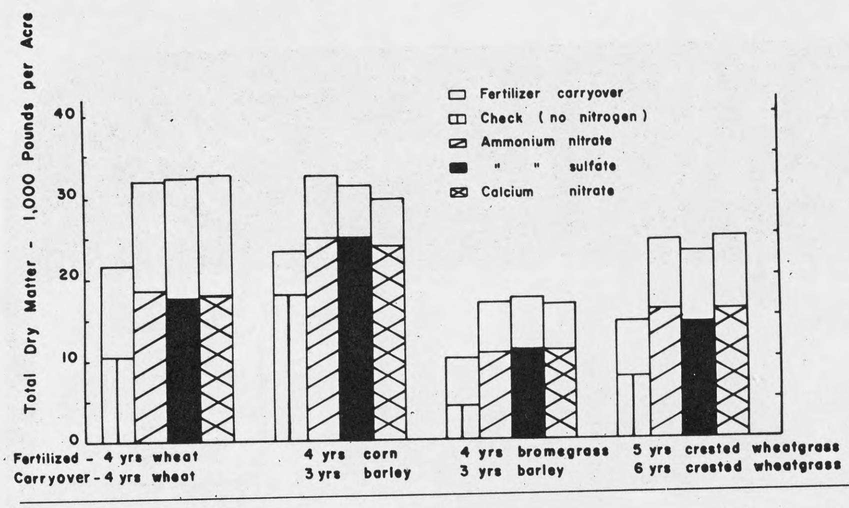


**Figure 1. Cumulative dry matter production for various crops as affected by nitrogen fertilizer sources at Mandan, N. Dak. (comparisons made at 60 pounds N rate).**

dry matter production or grain yield from urea was about equal to that from ammonium nitrate. At higher rates, urea was generally less effective than the other N sources.

Increased crop production per unit of fertilizer applied is a measure of the effectiveness of the fertilizer material. This value, known as fertilizer production efficiency (FPE), was calculated for each period as follows:

$$\text{FPE} = \frac{\text{Fertilized yield - Check yield}}{\text{Fertilizer applied}}$$

Production efficiencies for N fertilizers are shown in Figure 2 in terms of average pounds of dry matter produced per pound of N applied. For spring wheat, FPE was similar for all N sources in both the fertilization and carryover periods. Ammonium nitrate and ammonium sulfate applied annually to corn for four years were much more efficient than was calcium nitrate. During the carryover period (test crop barley), FPE was greater for ammonium nitrate than for the other sources.

FPE for bromegrass was not greatly affected by N sources during both periods. Ammonium sulfate applied to crested wheatgrass was slightly less efficient than the other sources. FPE during the carryover period was lowest for bromegrass and highest for spring wheat. FPE values during the fertilization period were similar for all crops fertilized with ammonium nitrate. Because of greater carryover effect, FPE for both periods combined was significantly greater for spring wheat.

In Figure 3, changes in soil pH in the surface six inches are shown for check and ammonium sulfate treatments. N rate ranged from 60 to 160 pounds N per acre for the various crops and no attempt was made to adjust values to a common rate. Soil pH for ammonium nitrate was intermediate between that of check and ammonium sulfate treatments, and values for calcium nitrate

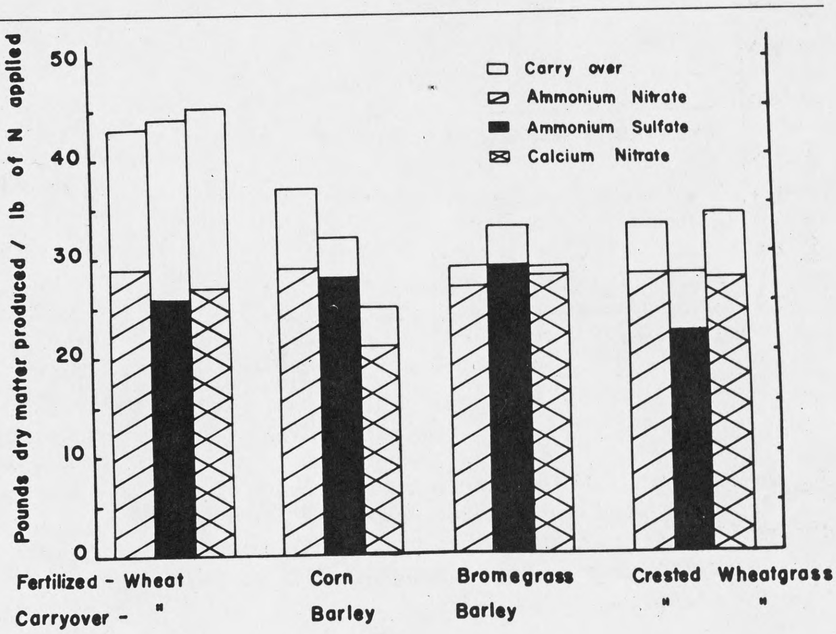


**Figure 2. Fertilizer production efficiency for various crops as affected by nitrogen sources.**

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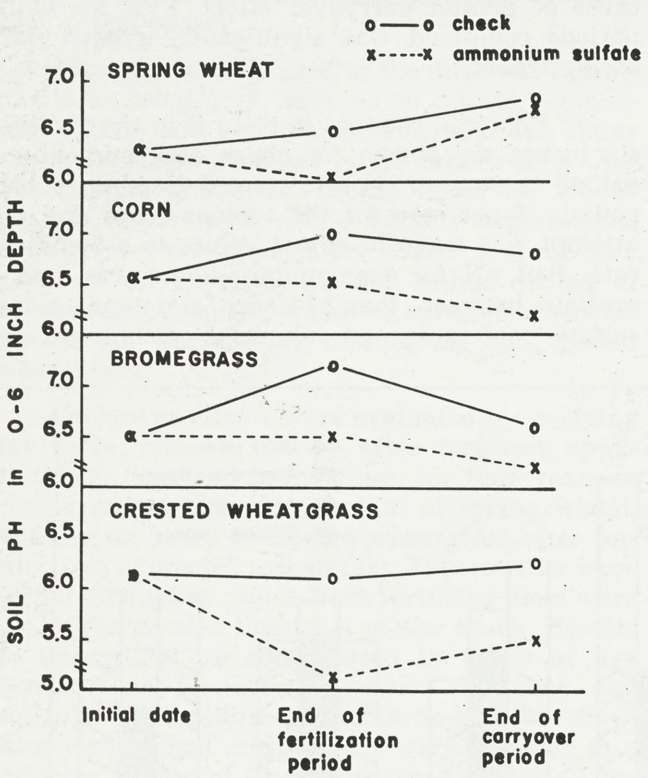


**Figure 3. Effect of N fertilization on soil pH for various crops. Spring wheat received 60 pounds N/A, corn and bromegrass 100 pounds N/A, and crested wheatgrass 160 pounds N/A.**

were similar to those of the check. The pH data indicate that increased soil acidity resulting from fertilization usually remained after fertilization was discontinued. At the end of both periods, the pH in fertilized soil was lower than that in unfertilized soil. Changes in pH of check plots with time were not associated with the treatments under study. However, neither N source nor N rate seriously affected crop stand or plant growth.

Results of this work indicate that fertilization with ammonium nitrate usually produces dryland crop yields equal to or greater than yields obtained from other N sources. However, ammonium sulfate and calcium nitrate are in most respects only slightly less efficient during the fertilization period. Where included in the experiments, urea was as effective as ammonium nitrate at low to moderate rates of application, but not at the higher rates. Since fertilizer N source had no influence on water use (all available water in the root zone is normally used by harvest for most dryland crops), fertilizer N sources providing the greatest production also provided the greatest efficiency in water use. By proper selection of fertilizer materials, the dryland farmer eliminates N as a growth limiting factor and obtains near maximum yield and water-use efficiency from available water. However, a long-term reduction in soil pH resulting from N fertilization and consequent carryover effects may require future changes in fertilizer management practices for these semiarid soils.