

FALL APPLICATION OF NITROGEN FERTILIZER



Better Labor Distribution
Speeds Planting Operations
Lowers Fertilizer Costs

By Ralph A. Young

WHERE nitrogen fertilizer is used at moderate to heavy rates, much of it should be broadcast rather than applied in the row to avoid seed germination injury. Broadcasting in the spring requires an extra operation in a busy season. Spreading fertilizer in the fall gives a desirable distribution of labor. The quantity of fertilizer handled at seeding time may be reduced by fall application, thus speeding up planting operations. Fertilizer often can be purchased at a saving in the fall.

These facts, plus 1957's experimental results, show that applying nitrogen fertilizer on nonfallow land in the fall is a good practice.

There are a number of processes which may cause loss or reduced efficiency of nitrogen applied far in advance of seeding. These include leaching, runoff and loss as ammonia or nitrogen gas.

In areas of high rainfall, available forms of nitrogen may be leached into lower depths or even below the root zone. The nitrate form is more subject to leaching than the ammonium form. Ammonia, however may be converted rapidly to the nitrate form when soil is warm and other conditions are favorable for the bacteria which cause the change.

Because of low precipitation in fall and winter, leaching is a minor problem in North Dakota. Use of the ammonium form of nitrogen rather than nitrate, and application in late fall when soil temperature is low, should reduce chances of loss by leaching.

The ammonium form is more subject to loss as a gas from limy soils than is nitrate. Escape of ammonia from ammonium fertilizers may be a problem in North Dakota because about half of the soils are limy. It appears that loss by this method may be reduced considerably by plowing under. Liquid or gaseous fertilizer should be injected 4 to 6 inches deep. Use of the nitrate form, of course, would eliminate this method of loss.

RALPH A. YOUNG is associate soil scientist.

Bacterial conversion of nitrate to nitrogen gas is known to occur. It is favored by poor aeration, warm temperatures and the other factors favorable for growth of bacteria. Loss in this way can be reduced or stopped by applying the material in late fall.

Loss by erosion or runoff of applied nitrogen can occur from sloping land. Low precipitation in late fall and winter in North Dakota reduces the importance of this problem. Working the fertilizer into the soils after spreading should reduce loss.

It is thought that loss or reduced efficiency from all the processes mentioned usually will be small, and late fall application of nitrogen fertilizer is an acceptable practice in North Dakota.

Nine field experiments were conducted in the state this past year to determine with more certainty whether or not fall application is a desirable practice and which form of nitrogen is best for North Dakota conditions.

In these trials, each of two forms of nitrogen (ammonium and nitrate) was applied in the fall at the rates of 0, 30 and 60 pounds of nitrogen per acre after soil temperatures dropped below 55° F., and in the spring just before final seedbed preparation. Hard red spring wheat was used in 5 trials, durum in 2, corn and oats in 1 each.

The experimental sites covered a wide range of soil conditions, varying from sandy loam to silty clay, from moderately acid to moderately alkaline, from non-limy to limy, and from level to moderately sloping.

All sites had been cropped to small grain, flax or corn the previous year. Some were relatively weed-free while others were badly infested with wild oats. One site had received considerable quantities of barnyard manure in the past while the use of manure or legumes had been moderate to none at the other locations.

All sites received a broadcast application of 0-30-15 fertilizer and 0-46-0 was used as a row application to insure adequate phosphorus and potassium fertility.

Numerous measurements were made, among which were yield of all crops and test weights of the small grains.

Yields

Yields of the various crops in bushels per acre are presented in table I.

Rates of Nitrogen Fertilization

Oats did not respond to nitrogen fertilization at Buffalo where considerable barnyard manure has been used in the past. At Lark the use of 30 pounds of nitrogen returned only a very small profit and 60 pounds resulted in no increase

over the check plots. The other 7 trials showed moderate to large responses to nitrogen. Maximum profit was shown by the 60-pound rate in 3 trials.

Test weights of wheat, durum and oats were not affected appreciably by nitrogen fertilizer at rates which gave yield responses. Where more nitrogen than that needed for maximum yield was used, test weights usually were lowered.

The results of these trials are not unusual as evidenced by the results of over 100 field trials conducted since 1948 on nonfallow land in North Dakota by or under the direction of E. B. Norum, Armand Bauer, R. A. Young and J. C. Zubriski.¹

In these trials, 70 percent gave profitable increases in yields for the use of nitrogen fertilizer.

In the 34 trials where more than one rate of nitrogen was used, rates of from 40 to 60

pounds were the most profitable in 12 trials, rates of 20 and 30 pounds gave the greatest return in 12, and in the remaining 10 the use of nitrogen was not profitable. It appeared that response to nitrogen varied not only from soil to soil, but also from year to year, probably because of differences in fertility status, management history and climatic conditions.

Due to the fact that over 70 percent of the trials showed profitable responses and about one-third needed rates of 40 pounds of nitrogen or more for maximum profit, it appears that nearly all nonfallow land in the state should receive at least moderate rates of nitrogen fertilizer every year. The use of 30 pounds of nitrogen is a good average recommendation. It will not pay some of the time but will be too low about as often as it is too high.

¹Unpublished Data—Department of Agronomy (Soils) North Dakota Agricultural Experiment station.

TABLE I.—Yields of Various Crops in Bushels Per Acre.

| Location | 1957 Crop | Rate of Nitrogen** | | | Time of*** Application | | Form of*** Nitrogen | |
|--------------|-----------|--------------------|--------------|-------------|------------------------|--------------|---------------------|---------------|
| | | None | 30 lbs. | 60 lbs. | Fall | Spring | Ni- trate | Ammoni- um |
| Edgeley.... | Corn | 47.0 | 55.0 | 55.8 | 53.8 | 56.9 | 54.7 | 56.0 |
| Langdon.... | Durum | 22.1 | 25.8 | 26.9 | 25.9 | 26.9 | 25.6 | 27.2 |
| Hattan..... | Wheat | 21.8 | 25.3 | 28.2 | 27.5 | 25.9 | 27.4 | 26.0 |
| Cleveland... | Wheat | 16.2 | 24.8 | 30.5 | 27.1 | 28.3 | 29.3 | 26.1 |
| Cummings... | Durum | 26.8 | 34.3 | 41.1 | 38.2 | 37.2 | 40.0 | 35.4 |
| Gardner*.... | Wheat | 22.5 | 28.2* | 27.9* | 26.9* | 28.8* | 28.1 | |
| Flasher..... | Wheat | 17.8 | 24.1 | 25.4 | 25.1 | 24.4 | 25.8 | 23.7 |
| Lark..... | Wheat | 33.1 | 35.7 | 32.9 | 34.7 | 33.8 | 34.3 | 34.3 |
| Buffalo..... | Oats | 108.5 | 101.9 | 100.8 | 102.0 | 100.7 | 101.2 | 101.8 |

*Gardner data are for the nitrate form of nitrogen only, while other data are the mean of the nitrate and ammonium forms.
 **The most profitable rate of nitrogen is in bold type.
 ***Each figure in bold type is significantly greater than the one in adjoining column.

By using test strips of various rates of nitrogen and carefully observing the climatic and management situations for a few years, each farmer can adjust the general recommendation rate up or down to meet the needs of crops under his specific conditions.

Form of Nitrogen

In the 9 trials reported here, 2 forms of nitrogen were used—ammonium and nitrate. Ammonium sulfate and calcium nitrate were used as the carriers. In 3 trials, the nitrate form appeared superior to the ammonium form.

At 2 of these sites, the soils were limy at the surface—a condition which may encourage loss of nitrogen from the ammonium carrier as ammonia gas. Further work is needed to determine how often this type of result will be encountered and the reasons for it.

Form of nitrogen had little effect on test weights of small grains. Until further investigations have been conducted, all

nitrogen fertilizers now being sold in North Dakota are recommended.

Time of Application

Fall application of nitrogen fertilizer appeared about as good as spring application. In only 1 of 9 trials was there a significant difference in yield due to time of application. At Gardner, where only the nitrate form could be compared, spring application appeared better than the fall application.

Because of considerable variation in this trial, due to non-uniform wild oat infestation, this result is not considered very reliable even though statistical analysis shows that the odds are 19 to 1 that the difference in yields was due to time of application.

The average yield of the 7 wheat and durum trials fertilized in fall was 29.3 bushels per acre—exactly the same as where fertilized in the spring. Time of application had little to no effect on test weights of small grains.



This work was supported in part by Regional Research Funds under the North Central Cooperative Regional Project NC-16 on Mineral Deficiencies.