Nitrogen Materials and Their Use in Indiana

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Higher Crop Yields From Improved Soils


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Higher Crop Yields from Improved Soils

Purdue University
Cooperative Extension Service
Lafayette, Indiana

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NITROGEN MATERIALS AND THEIR USE IN INDIANA

Agronomy Department

Nitrogen-Soil Reactions

Nitrogen fertilizer can be bought in many different forms. Each nitrogen material is equally effective but only if properly used. To know how to use the various materials, some facts about soils, plants and nitrogen fertilizers must be understood.

Nitrogen exists in the soil in organic and inorganic forms. Organic forms (decayed plant, animal and microbial residues) can not be used by the plant since they only take up the nitrate \( \text{NO}_3^- \) and ammonia \( \text{NH}_3 \), or inorganic forms. Nitrate and ammonia can be converted into organic forms unavailable to the plant. However, they are reconverted back into the inorganic form by organisms. Practically all of these conversions are brought about by biological activity in the soil. Like all other forms of life, this activity is affected by many factors, such as temperature, oxygen supply, kind and amount of organic materials, soil acidity, nutrient supply, etc.

Forms of Nitrogen

NITRATE form of nitrogen is very soluble and is free to move with the soil water into tile lines or deep drainage channels. However, when the water evaporates, nitrates accumulate at the soil surface. Almost all highly productive soils lose at least 20 to 40 pounds of nitrogen per acre to the air, even when no nitrogen fertilizers are applied. Much of it is believed to be lost as free nitrogen gas from the reduction of nitrates by denitrifying organisms. Therefore, nitrates can be lost by leaching out of the root zone and as nitrogen gas.

AMMONIA form of nitrogen is absorbed by the soil clay and organic matter, which hold it in place. It contains no oxygen and cannot be directly converted to free nitrogen by reduction. Therefore ammonia is not lost to the atmosphere.

Ammonia in water is free to volatalize into the air if not attached to a nitrate or a sulphate. Organic matter or clay present in the water will hold ammonia, but their absorbive ability is limited. One hundred pounds of average dry silt loam soil (about a cubic foot) will hold about 0.2 pounds of ammonia. Ammonia may be lost by volatilization from ammonium sulfate applied on the surface of a calcareous soil (pH 7.5 or above). Such a loss does not occur with ammonium nitrate.

UREA is water soluble and moves with the soil water. Some may be lost in well-drained soils through movement out of the root zone caused by heavy rains soon after application and before it is converted to ammonia. Urea is rapidly converted to ammonia by an enzyme in the soil and in most plant material. This conversion is completed within several days under favorable moisture and temper-
ature. Urea does not contain anything which will hold the ammonia, so when converted to ammonia on the soil surface, some may be lost to the atmosphere by volatilization. Low temperatures slow the conversion to ammonia. However, enzyme reactions are not as sensitive to temperature and other environmental factors as microbial activity. Urea which is plowed or disked under or leached into the soil by rain is not lost by ammonia volatilization.

Table 1. Characteristics and Uses of the Principle Carriers of Fertilizer Nitrogen

<table>
<thead>
<tr>
<th>Forms</th>
<th>Percent Nitrogen</th>
<th>Amount of Material to Supply 20 Pounds Nitrogen</th>
<th>Form of Nitrogen</th>
<th>Adaptation for Top Dressing Small Grain and Side Dressing Corn Plow Under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Forms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>33.5</td>
<td>60 pounds</td>
<td>1/2 ammonia</td>
<td>excellent</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>20.5</td>
<td>98</td>
<td>1/2 nitrate</td>
<td>excellent</td>
</tr>
<tr>
<td>Urea</td>
<td>45</td>
<td>44</td>
<td>ammonia forming</td>
<td>good</td>
</tr>
<tr>
<td>Calcium cyanamide</td>
<td>21</td>
<td>95</td>
<td>ammonia forming</td>
<td>fair</td>
</tr>
</tbody>
</table>

Liquid Forms

<table>
<thead>
<tr>
<th>Forms</th>
<th>Percent Nitrogen</th>
<th>Amount of Material in Liquid under Pressure</th>
<th>Form of Nitrogen</th>
<th>Adaptation for Top Dressing Small Grain and Side Dressing Corn Plow Under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous ammonia</td>
<td>82</td>
<td>24.4</td>
<td>ammonia</td>
<td>unadapted</td>
</tr>
</tbody>
</table>

Water Solutions

<table>
<thead>
<tr>
<th>Forms</th>
<th>Percent Nitrogen</th>
<th>Amount of Material in Water Solutions</th>
<th>Form of Nitrogen</th>
<th>Adaptation for Top Dressing Small Grain and Side Dressing Corn Plow Under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea and ammonium nitrate</td>
<td>32</td>
<td>5.8 gal.</td>
<td>1/4 nitrate</td>
<td>excellent</td>
</tr>
<tr>
<td>Ammonium nitrate and ammonia</td>
<td>40.7</td>
<td>5.2 gal.</td>
<td>3/4 ammonia</td>
<td>unadapted</td>
</tr>
<tr>
<td>Ammonium nitrate and ammonia</td>
<td>37</td>
<td>5.5 gal.</td>
<td>2/3 ammonia</td>
<td>unadapted</td>
</tr>
<tr>
<td>Ammonium nitrate and ammonia</td>
<td>42</td>
<td>4.9 gal.</td>
<td>3/4 ammonia</td>
<td>unadapted</td>
</tr>
<tr>
<td>Urea and ammonia</td>
<td>24.6</td>
<td>10.9 gal.</td>
<td>ammonia</td>
<td>unadapted</td>
</tr>
</tbody>
</table>

1/ Many combinations of nitrogen salt and ammonia in water solutions are possible. The National Plant Food Institute nomenclature helps define their composition. An example of the composition nomenclature is 420 (20-66-6). The first three digits give the total nitrogen content of the solution to the closest tenth of a percent with the decimal removed (which means 42.0 percent nitrogen). The numbers in parenthesis refer to the percentage of ammonium nitrate and urea, respectively, on a weight basis to the closest full percent.

2/ Approximate proportions
Flowering Under or Side Dressing For Corn

Flowering under or side dressing applications of nitrogen for corn (40 to 150 pounds per acre) should prove profitable with favorable mid-summer moisture and under conditions shown below on soils containing or supplied with adequate amounts of phosphate and potash. Phosphate and potash fertilizer should be added according to soil tests. Starter fertilizer should be applied in addition to that plowed under. Early side dressing with nitrogen, placed at least four inches deep (near centers between corn rows), has given good results and is especially recommended for sandy soils.

Conditions most favorable for profitable nitrogen returns on corn.

1. On corn after corn, sorghum, sudangrass, soybeans or small grain (with no clover) on soils with good drainage and moisture-holding capacity.

2. On old timothy or other grass meadows.

3. On high spots of lighter colored soil in mixed soil areas with a legume intercrop, or on thin stands of legumes, if not drouthy.

4. On light-colored silt frequently overflowed and no legumes used.

5. On muck soils with high water table through the summer.

6. In fields planted to high populations of corn.

Top Dressed on Winter Grains

Chances are best for good returns for nitrogen top dressing on good stands of wheat, barley and rye in March in years following summers of high rainfall. For light-colored silt loam soils, 20 to 30 pounds per acre of nitrogen and for sands and sandy loams of light color, 40 to 50 pounds are suggested rates. Light sandy loams and silt loams have given consistent returns with average increases of one bushel of grain for about three to four pounds of nitrogen applied. The average increase for 186 county trials during the past 11 years for an application of 25 pounds nitrogen has been 4.7 bushels wheat per acre. If calcium cyanamide is used, it should be broadcast before growth starts in the spring to avoid a temporary burning effect.

Permanent Pasture

Fifty pounds of nitrogen per acre applied very early to about one-third acre of good grass pasture per cow will speed growth enough to make grazing possible two weeks earlier and save that much barn feeding costs, if the available supply of phosphate and potash is good.

Spring Oats

Fertilizer with a liberal proportion of nitrogen drilled with oats on light colored soils or where there is little danger of lodging may have some advantage. Three hundred pounds per acre of 6-24-24, or 6-12-12 may be expected to increase oats yields and also help the grass and clover seeding. More nitrogen will give larger increases, but a limit of 20 to 25 pounds per acre is recommended where legume seedings are made in the oats. Excellent results from broadcasting solid nitrogen materials within two weeks after seeding have been obtained. Anhydrous ammonia applied just ahead of seeding and ammonium nitrate-urea solution either before or within two weeks after seeding should give similar results.
Table 2. Physical Properties of Nitrogen Solutions

<table>
<thead>
<tr>
<th>Material</th>
<th>Percent Nitrogen</th>
<th>Wt. per Gallon at 60°F</th>
<th>Lbs. N Per Gallon at 100°F</th>
<th>Lbs. Pressure per Sq. Inch at 100°F</th>
<th>Approximate Salting-out Temp. °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous Ammonia (Liquid Under Pressure)</td>
<td>82</td>
<td>5.16</td>
<td>4.23</td>
<td>211</td>
<td>X 1/</td>
</tr>
<tr>
<td>Ammonium nitrate, urea 2/</td>
<td>32</td>
<td>10.84</td>
<td>3.47</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Ammonium nitrate, ammonia 2/</td>
<td>40.7</td>
<td>9.53</td>
<td>3.88</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Ammonium nitrate, ammonia 2/</td>
<td>37</td>
<td>9.86</td>
<td>3.65</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>Ammonium nitrate, urea, ammonia 2/</td>
<td>42</td>
<td>9.82</td>
<td>4.12</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>Ammonia solution</td>
<td>24.6</td>
<td>7.47</td>
<td>1.84</td>
<td>11</td>
<td>X 1/</td>
</tr>
</tbody>
</table>

1/ No salts. These do not crystalize or "salt-out" at low temperatures.
2/ There are many other possible combinations of urea, ammonium nitrate, ammonia and water. See footnote Table 1.

Use Suggestions

1. Get a rough estimate of your nitrogen need from Research Bulletin 474 or Mimeo AY-50A.
2. Adjust this estimate to your specific needs through discussion with your county agent, fertilizer dealer, commercial farm manager or other specialists.
3. Apply nitrate forms near the time of plant use.
4. Apply under the ground all fertilizers containing free ammonia, such as anhydrous and all nitrogen solutions except ammonium nitrate and urea. If applied on surface, increase rate of application to compensate for ammonia losses.
5. Read, study and reread the facts about nitrogen on the front page.
6. Be sure to apply enough nitrogen. It is often your best buy and greatest money maker!!

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