TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE BERKELEY, CALIFORNIA SOIL CONSERVATION SERVICE

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The soil conservationist is frequently called on in his planning and application work with farmers to answer questions relating to various types of fertilizers and their effect on soil and crop yields. In the past ten years, the use of Nitrogen fertilizers has increased by more than 1000 percent. The following excerpts from research conducted at State Experiment Stations and by the Agricultural Research Service USDA present the latest findings in regard to two of the most recently introduced types of Nitrogen fertilizers -- aqua ammonia and anhydrous ammonia.

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AQUA AND ANHYDROUS AMMONIA

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Plant injury resulting from the use of aqua ammonia or anhydrous ammonia as sources of nitrogen has occured when the materials were placed relatively close to young plants and - usually - at high rate of application. Ammonia injury reduces plant growth, delays maturity and yields are unsatisfactory. Usually injury is characterized by a burning-off of the smaller plant roots and by a yellowing or browning of the larger roots.

Anhydrous ammonia - ammonia gas - contains 83% nitrogen by weight and can be injected directly into the soil or it can be dissolved in the irrigation water. Ammonia gas dissolved in water becomes aqua ammonia and it, too, can be injected into the soil or applied in irrigation water. Aqua ammonia is often marketed as a solution containing 20% nitrogen by weight.

Effect of Soil Type. Why aqua ammonia and anhydrous ammonia may injure plants while ammonium sulfate may not is not definitely known. However, under alkaline soil conditions, there is greater movement in the soil of the ammonia from anhydrous and aqua than from ammonium sulfate.

In some light-textured soils ammonium sulfate was found to move only about 3" from where it was banded into the soil, while under comparable conditions, ammonia from aqua and anhydrous moved as much as 6".

Actually - when dealing with alkaline soils - it is not the same kind of nitrogen from aqua and anhydrous ammonia as from ammonium sulfate, even though all three materials supply ammonia nitrogen.

Aqua ammonia consists of ammonia molecules dissolved in water, while nitrogen of ammonium sulfate exists as the ammonium ion. It is highly possible that the ammonium ion is much less toxic than the ammonia molecule.

To lessen or eliminate possible plant injury from aqua and anhydrous ammonia, the materials usually should be placed 6" or 7" deep in the soil instead of only 4". In some tests placement of the materials as little as several inches out from the plant row has greatly reduced the plant toxicity. Smaller increments of fertilizers applied several times during the growing season will lessen the injury. Crops that require some nitrogen close to the plants at the time of planting should be treated with materials like ammonium sulfate, ammonium nitrate or calcium nitrate at planting. After the crop is established, the remainder of the nitrogen can be applied as a side-dressing with aqua or anhydrous ammonia.

Considerable research work has been conducted in California and elsewhere by many individuals relative to the use of aqua and anhydrous ammonia. They have found that the depth of penetration of ammonia applied in the irrigation water is dependent primarily upon soil texture. In a coarse, sandy soil penetration may be as deep as 6" or more. In a clay there is little penetration below 1" and practically none below 2":

Even in a loam soil or no penetration can be expected below 2". The lack of penetration means that there will be no, or practically no, losses of ammonia from the soil due to leaching by the irrigation water.

Soil Alkalinity Temporary. The immediate effect of adding either aqua or anhydrous ammonia is to make the soil alkaline. The alkalinity is temporary, and may last for only several days in some cases, or for as long as several weeks in others.

When aqua ammonia has been injected in bands in cool moist soils, the soil in the area of the band has remained alkaline for as long as several weeks. After the ammonia applied to the soil nitrifies, it will make the soil more acid than it was originally.

The rate of conversion of ammonia to nitrate in the soil depends largely on how the ammonia is applied. If it is applied in the irrigation water, where it is dispersed in a large volume of soil, it is practically all nitrified within three weeks or less under warm conditions. In contrast, when these materials were banded in the shoulder of the bed during cool weather, considerable quantities existed as ammonia after being in the ground for as long as three months.

Aqua ammonia, injected as a band, will nitrify under most conditions much less rapidly than when it is applied in the irrigation water. Also, in some soils, ammonium sulfate nitrifies less rapidly than does aqua ammonia. This is probably related to the fact that ammonia sulfate diffuses less in alkaline soils, and thus remains more concentrated near the area of application. The importance of rate of nitrification may be exaggerated, however, because it is known that plants can use ammoniacal nitrogen directly. It does not need to be converted to nitrate nitrogen before plants can use it.

Application of aqua ammonia in the sprinkler irrigation water is usually not satisfactory. If the ammonia concentration in the sprinkler water is 20 pounds or more per acre inch of water as much as 60% of it may be lost to the atmosphere by volatilization.

Placement Important. Losses of ammonia from any ammonia salt applied in the sprinkler irrigation water will be too great when the solution has a relative alkalinity above pH 8.0. When the solution is as alkaline as pH10, half of the ammonia may be lost by volatilization. Relative alkalinity-acidity - pH - 7 is neutral.

Both aqua ammonia and anhydrous ammonia are good sources of nitrogen fertilizers, and their use presents no special problems. However, they should be placed farther away from the plant and deeper in the soil than most of the other nitrogen fertilizers.

NITROGEN LOSS IN GASEOUS FORM FROM SOILS AS INFLUENCED BY FERTILIZER AND MANAGEMENT

by

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Experiments were conducted in the greenhouse to measure gaseous loss of nitrogen in Spencer silt loam, as affected by pH, form of nitrogenous fertilizer, energy material, and cropping. Four additions of nitrogen (150 ppm. each) were made to both cropped and fallow soils; four successive oat crops were grown on cropped soils.

At field moisture levels large volatile loss of nitrogen occurred from the fallow soil regardless of treatment. Over an 11-month period these losses ranged from 35% of the nitrogen added as $(NH_4)_2SO_4$ with straw at pH 5.5 to 72% where the $(NH_4)_2SO_4$ was added without straw at pH 6.5. In similarly treated soils cropped with oats, the losses (7 to 8%) were markedly less.

The levels of nitrate, ammonium, and total nitrogen in fallow Spencer silt loam (pH 6.5) were measured 8 times during a 1-year period. Irrespective of treatment, the greatest decrease in total nitrogen came during the first 6 weeks after fertilization. The level reached at this time remained more or less constant over the remainder of the year. Approximately 1/2 the 300 ppm. added nitrogen was volatilized. Concurrent increases in nitrate nitrogen levels occurred without exception. These results support the belief that the soil embodies a mosaic of aerobic and anaerobic areas permitting nitrification and denitrification to proceed simultaneously.

THE RETENTION AND REACTIONS OF ANHYDROUS AMMONIA ON DIFFERENT SOIL TYPES

by

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Soil texture had a pronounced effect on ammonia movement and retention. The greatest movement of ammonia occurred in the sand and silt loam soils; and the least movement in the clay. The loss of ammonia from the air-dry, acid sandy soil at a 6-inch depth of application was 44 times the loss from the calcareous clay receiving ammonia at comparable moisture and depth. The retentive capacity of a soil for ammonia increases greatly as the texture becomes heavier. The loss from the air-dry, calcareous clay soil was negligible even at the 3-inch depth of application.

The addition of anhydrous ammonia to the soil increased the availability of sodium, potassium, and calcium when measured in the saturation extract 2 months after its injection. This fact is supported also by the increased uptake of these elements by oats grown in the presence of ammonia.

The presence of high concentrations of ammonia in a localized area resulted in the partial breakdown of the soil organic matter.