UNIVERSITY OF IDAHO
College of Agriculture

NITROGEN

What Farmers Should Know About It

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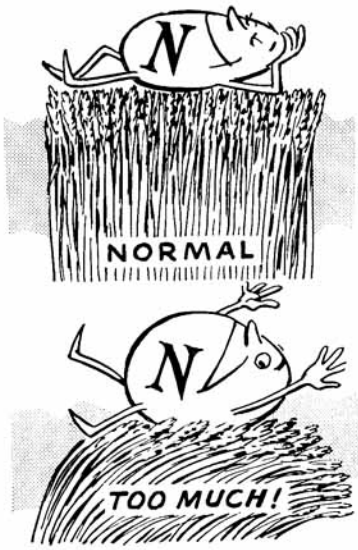
IDAHO Agricultural Extension Service

Bulletin 275
June 1957



THE COVER PHOTOS

Darker color and increased growth of winter wheat resulting from nitrogen fertilizer applied in strips. (Latah County)

Improved color and growth of potatoes from the use of nitrogen fertilizer. (Bingham County)

NITROGEN

What Farmers Should Know About It

G. ORIEN BAKER and C. G. PAINTER*

IDAHO farmers have tripled their use of nitrogen fertilizers in the last 5 years. They are now using about 14,000 tons per year. This represents a cost of around $5,000,000.

Increased use of nitrogen has resulted in larger yields. It has also brought many new problems.

There are many questions about the use of nitrogen and its place in soil management.

Let's discuss some of these questions.

What Influence Does Nitrogen Have on Plant Growth?

- Encourages vegetative growth.
- Produces rapid growth.
- Gives green color to crops.
- Increases protein content of crop.
- Essential for seed production.

What Effect Does Too Much Nitrogen Have on Plant Growth?

- Produces rank, succulent growth.
- Delays maturity.
- Reduces or limits flower production.
- Makes plants more susceptible to disease.
- In low rainfall area, available soil moisture is exhausted by increased growth resulting from excess nitrogen, and plants dry up before maturity.
- Produces excessive straw in cereals and grasses. This results in lodging.

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What Are the Plant Symptoms Indicating Nitrogen Deficiency?

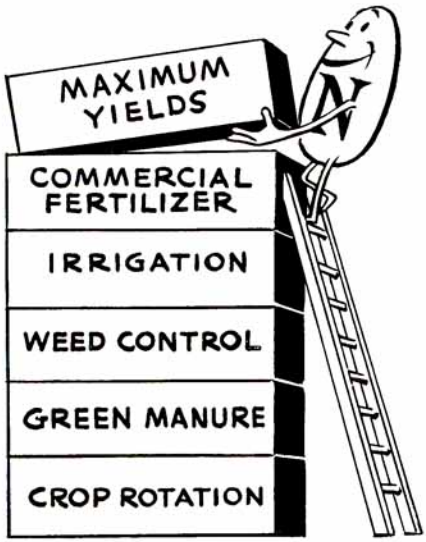
- Light green or yellowish color.
- Dwarf or stunted plants.
- Limited tillering or stooling in cereals and grasses.
- Yellowing and dropping of lower leaves in extreme deficiency conditions.
- Reduced production.

What Are the Benefits of Using Nitrogen Fertilizer?

The major benefits from using nitrogen correctly are increased yields and increased returns. However, three other benefits should be mentioned. First, nitrogen from some source is necessary to change a portion of the crop residue into soil humus. Second, the presence of nitrogen aids in the decomposition of the crop residues. Third, when nitrogen is deficient, the addition of nitrogen fertilizer results in more efficient utilization of moisture by the plant.

What is the Place of Nitrogen Fertilizer in Crop Production?

Nitrogen fertilizers can make an important contribution to crop production. However, they should be considered as supplemental to good soil management practices such as use of crop rotations, use of green and barnyard manures, crop residue utilization, control of weeds, and use of good cultural practices.



Some nitrogen is released every year from the breakdown of soil humus. Nitrogen is also released from the breakdown of green manures and crop residues. If the fertility level of the soil is high, sufficient nitrogen may be released for crop growth. Soils with a low fertility level will not release enough nitrogen for good yields, so it is necessary to supplement the soil-derived nitrogen with commercial nitrogen fertilizer.

Other plant nutrients need to be considered when using nitrogen fertilizer. For example, if phosphorus in southern Idaho, or sulfur in northern Idaho is deficient in the soil, the addition of nitrogen fertilizer will not result in anticipated increases. So other nutrient deficiencies must be corrected to obtain the maximum benefit from nitrogen fertilizers.

On What Crops Should Nitrogen be Used?

Nitrogen fertilizer is used primarily on row crops, cereals, and grasses. It is not usually used on legumes except on new seedings on the cut-over soils in northern Idaho. When grass is seeded with legumes, supplemental nitrogen will aid in the establishment of grass. However, excessively heavy applications will stimulate the growth of the grass to the detriment of the legume. If barley or other cereal is used as a companion crop for legumes, the use of nitrogen will help the cereal. Heavy application rates of nitrogen should not be used, as the increased growth of the barley will furnish more competition for moisture and sunlight, which will result in poor stands and lower vigor of the legume.

Row crops such as potatoes, sugar beets, corn, onions, and vegetable seed crops respond to nitrogen fertilizer. Since phosphate is usually a limiting factor where these crops are grown, phosphate should be used with nitrogen to obtain the greatest returns.

Pastures are very responsive to nitrogen fertilization.

How to Determine if Nitrogen Fertilizer Should be Used

There are several different methods. However, the most satisfactory way is that of combining results obtained from several methods.

Appearance of Crop

Pale green or yellowish color and stunted growth is an indication of lack of nitrogen. The lack of sulfur in northern Idaho also results in pale green or yellowish color that is very difficult to distinguish from a nitrogen deficiency.

Soil Testing

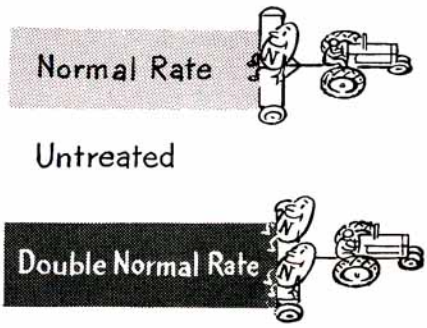
The regular test gives the amount of available nitrogen that is present in the soil. It does not indicate the ability of a soil to supply nitrogen throughout the growing period. In northern Idaho,

testing for the available nitrogen present in fallow land just before fall seeding gives a good indication of whether nitrogen should be used. Where continuous crops are grown, this method will give little usable information. The available nitrogen after summer fallow comes from the breakdown of organic matter by micro-organisms. This takes place largely during the warm summer months when moisture is present.

Under continuous cropping, the growing plants dry out the soil to the extent that micro-organisms cannot break down the organic matter. Hence, there is little or no accumulation of available nitrogen in the soil under these conditions.

Testing on the Farm

A simple method for testing on the farm is to skip a strip in the field when applying the nitrogen fertilizer. This area will show what the yields would have been without any supplemental nitrogen. The area that has been fertilized will show the yields where nitrogen was added. On another strip, make two trips with the spreader. This doubles the rate of application and indicates whether heavier applications would have been better.



Which Kind of Nitrogen Fertilizer Should be Purchased?

Research conducted by the University of Idaho has shown no consistent advantage for any single type of nitrogen fertilizer. Therefore, the recommendation is to buy the fertilizer which can be purchased at the lowest price per pound and fits best into the management system. There is one exception. When applying nitrogen fertilizer in northern Idaho to cereals, grown as a companion crop to new grass-legume seedings, ammonium sulfate or some other nitrogen fertilizer to which some sulfur material has been added is preferred. These materials supply nitrogen for the cereal and grass and also sulfur for the legume.

The cost per pound of nitrogen may be calculated as follows:

$$\frac{\text{Cost per ton of fertilizer}}{\text{Per cent nitrogen in fertilizer} \times 2000} = \text{cost per pound of nitrogen}$$

For example:

Ammonium sulfate $68.00	$\frac{68.00}{.21 \times 2000}$	=	$\frac{68.00}{420}$	=	16.2¢ per pound
Ammonium nitrate $95.00	$\frac{95.00}{.33 \times 2000}$	=	$\frac{95.00}{660}$	=	14.4¢ per pound
Anhydrous ammonia $200.00	$\frac{200.00}{182 \times 2000}$	=	$\frac{200.00}{1640}$	=	12.2¢ per pound

The price of anhydrous or aqua ammonia may be given as price per pound of ammonia (NH_3) or as nitrogen. When comparing costs, the price per pound of nitrogen is used. If the price is quoted as price per pound of ammonia rather than as nitrogen, multiply this price by 1.2 to obtain the price per pound of nitrogen, since ammonia contains 82 percent nitrogen.

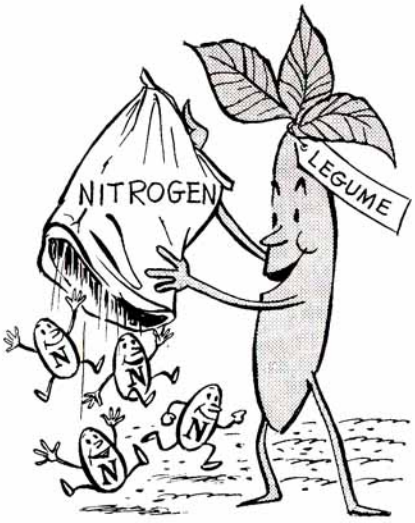
What Are Some of the Factors that Should Be Considered in Determining the Amount of Nitrogen to Apply?

Fertility Level of Land

A soil with a high fertility level and a good supply of active soil humus will need less nitrogen fertilizer than one that is low in fertility and humus.

Previous Crops

Ordinarily, little or no nitrogen is needed where legume or legume-grass is plowed under as a green manure. Where grain follows grain, supplemental nitrogen is needed, the rate being influenced by the amount of straw present from the previous crop and the fertility of the land. Where wheat follows peas and the pea straw is returned, less nitrogen is needed than where wheat follows wheat. Pea straw contains 20-25 pounds of nitrogen per ton, while wheat straw contains only 5-10 pounds per ton.



More nitrogen fertilizer is usually required the longer the land has been "out of a soil building crop" or the longer the period between applications of barnyard manure.

Fertilizer Applied to Previous Crop

Where nitrogen is applied with crop residues, part of it is temporarily tied up in the soil and may not be released the first year. When heavy rates of nitrogen are used, there is usually some carry-over for the next crop. In low moisture years, this carry-over will be greater than in good moisture years.

Available Moisture

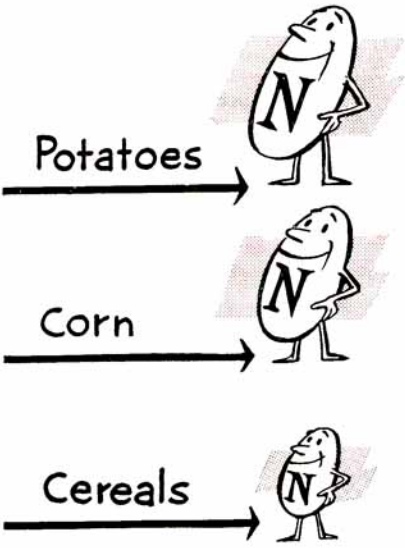
Moisture is required for plant growth. Since nitrogen stimulates vegetative growth, it means more water is required to produce the greater yields. It is known that when nitrogen is applied to nitrogen-deficient soils, more efficient use is made of the moisture by the plant. In low rainfall areas or in dry years, the increased growth resulting from the use of nitrogen fertilizer may deplete the soil moisture before the wheat matures. This results in premature ripening and reduced yields. Moisture conditions must be considered in the use of nitrogen fertilizer.

Physical Condition of the Soil

In order to secure the greatest return for the fertilizer applied the soil must have good tilth, i.e., be friable, take water readily, etc.

Kind of Crop Being Grown

Some crops require greater quantities of nitrogen for maximum production than others. For example, potatoes, onions, and corn require more nitrogen than cereals.



How to Calculate the Pounds of a Nitrogen Fertilizer Needed to Supply the Recommended Amount of Nitrogen Per Acre

Divide the pounds of nitrogen to be applied per acre by the percentage of nitrogen in the fertilizer.

$$\frac{\text{Pounds of nitrogen to be applied per acre}}{\text{Percent of nitrogen in fertilizer to be used}} = \text{Pounds of nitrogen fertilizer needed per acre}$$

Let us assume that 50 pounds of nitrogen per acre are recommended:

Ammonium sulfate contains 21 percent nitrogen.

$$\frac{50}{.21} = 238 \text{ pounds to supply 50 pounds of nitrogen}$$

Ammonium nitrate contains 33 percent nitrogen.

$$\frac{50}{.33} = 152 \text{ pounds to supply 50 pounds of nitrogen}$$

Anhydrous ammonia contains 82 percent nitrogen.

$$\frac{50}{.82} = 61 \text{ pounds to supply 50 pounds of nitrogen}$$

NITROGEN AND OTHER NUTRIENT CONTENT OF NITROGEN FERTILIZERS

	Chemical symbol	Nitrogen content %	Other nutrients %
Ammonium sulfate	$(NH_4)_2SO_4$	21.0	Sulfur—24%
Ammonium nitrate	NH_4NO_3	33.5	None
Anhydrous ammonia	NH_3	82.0	None
Aqua ammonia	NH_4	20.0	None
Calcium nitrate	$Ca(NO_3)_2$	15.5	Calcium—19%
Urea	$CO(NH_2)_2$	45.0	None
Calcium cyanamid	$CaCN_2$	21.0	Calcium—38%
16-20-0		16%	20% available P_2O_5 14% sulfur

Rule-of-Thumb Relationships for Approximate Calculations

- Pounds of soil humus that must be completely decomposed to make available 1 pound of nitrogen for crop growth under average conditions ..... 20 pounds.
- Pounds of nitrogen per ton of straw that should be added as fertilizer to have sufficient nitrogen present so the straw will not have a depressing influence on available nitrogen in the soil under annual cropping practice ..... 15-20 pounds.
- Pounds of soil humus that may be produced per ton of dry crop residue returned to the soil under the most favorable conditions ..... 500 pounds.
- Fraction of total plant nutrients released from plant materials returned to the soil under average conditions:

First year	1/2
Second year	1/4
Third year	1/8

- To estimate the amount of soil organic matter present when the total soil nitrogen percentage is known—multiply percent nitrogen by 20.
  Example: .20% nitrogen x 20 = 4.0% organic matter
- To estimate the amount of total soil nitrogen in a soil when the soil organic matter percentage is known—divide the organic matter percentage by 20.
  Example: $\frac{4.0\% \text{ organic matter}}{20} = .20\%$ nitrogen
- When alfalfa is properly inoculated and adequately fertilized the plants will take from the air ..... 2/3 of their nitrogen needs
- Relative ability of different legumes to fix atmospheric nitrogen under the same conditions:

Alfalfa	100
Sweet clover	65
Clovers (Red, White, Alsike)	58
Beans, peas	25

- Ratio of tops to roots:

	Tops : Roots
Alfalfa	2 : 1
Wheat	10 : 1
Grass	1 : 3-10

- To estimate the pounds of straw from the yield of wheat:

  Dry land—multiply the pounds per acre of wheat by 2.

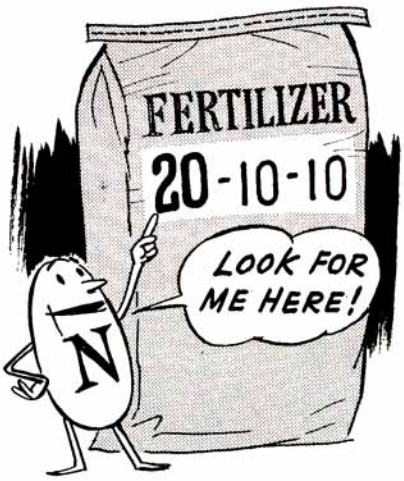
  Example: 30 bu. wheat yield = 1800 pounds wheat
  1800 x 2 = 3600 pounds straw

  Irrigated land—multiply the pounds per acre of wheat by 1.5

NITROGEN REMOVED BY MAJOR CROPS IN IDAHO

Crop	Pounds Nitrogen
Grain or seed (100 pounds)	
Wheat	1.99
Barley	1.83
Oats	2.02
Beans	3.83
Peas	3.93
Clover	3.00
Corn	1.62
Hay (air-dry ton)	
Alfalfa	48.0
Sweet clover	39.0
Red clover	39.6
Grasses	21.6

Crop	Pounds Nitrogen
Straw or stover (air-dry ton)	
Wheat	9.0
Barley	11.6
Oats	11.6
Beans	19.4
Peas	26.6
Corn	19.6
Roots, Tubers, Bulbs (harvest ton)	
Potato tubers	7.0
Potato tops	12.0
Sugar beet roots	4.0
Sugar beet tops	8.4
Onions, bulbs	6.0



Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the University of Idaho Agricultural Extension Service, James E. Kraus, Director; and the United States Department of Agriculture, cooperating.

Other University of Idaho Publications On Fertilizers and Related Crop Production Subjects

What Farmers Should Know About Phosphorus. Extension Bulletin No. 276.

Fertilizers For Sweet Corn. Experiment Station Bulletin No. 223.

Plants Need Food—Know the Signs of Plant Food Deficiency. Extension Circular No. 110.

Buy Commercial Fertilizers Wisely. Extension Circular No. 112.

Fertilizer Recommendations for Idaho Soils. Extension Circular No. 120.

Soils Do Respond. Extension Circular No. 128.

Protein and Mineral Content of Forage Legumes and Grasses in Idaho. Experiment Station Bulletin No. 245.

Producing Early Gem Potatoes in Idaho. Experiment Station Bulletin No. 262.

The Establishment of Sweet Clover in Dry Land Areas. Experiment Station Bulletin No. 227.

Green Manure Crops for Idaho Farms. Extension Circular No. 105.

Irrigation of Russet Burbank Potatoes in Idaho. Experiment Station Bulletin No. 246.

Phosphate Fertilization Studies in Idaho Using Radioactive Phosphorus. Research Bulletin No. 35.

Copies may be obtained from county agricultural agents; or by writing to the University of Idaho, College of Agriculture, Moscow; or the University of Idaho Agricultural Extension Service, Boise.