

NITROGEN MANAGEMENT

- NITROGEN HAS THE HIGHEST CONCENTRATION OF THE MINERAL ELEMENTS IN PLANT TISSUE
- MAJOR CONSTITUENTS OF THE AMINO ACIDS WHICH MAKE UP PROTEINS
- MAJORITY OF THE SOIL N IS CONTAINED IN THE SOIL ORGANIC MATTER POOL

SOIL ORGANIC MATTER (HUMUS)
LIVING ORGANISMS
PLANT AND ANIMAL RESIDUES

- SOILS RELEASE 25-75 lb/a/year FROM THE SOIL ORGANIC POOL

THIS AMOUNT IS ACCOUNTED FOR IN RECS.

SOIL N STATUS IS DRIVEN BY MICROBIAL ACTIVITY
PLANT AVAILABILITY AFFECTED BY SEVERAL PROCESSES

THE NITROGEN CYCLE (FIGURE 9.2)

- N₂ FIXATION = A SYMBIOTIC RELATIONSHIP BETWEEN A BACTERIA (RHIZOBIA) AND A PLANT ROOT.

ATMOSPHERE IS 79% N₂ AND 34,500 TONS OF N₂ IS OVER EACH ACRE. IT IS UNAVAILABLE TO PLANTS. SMALL AMOUNTS FIXED BY LIGHTENING IN AG SYSTEMS MOST ARE ADDED A INOCULANTS BUT SOME LIVE FREELY IN THE SOIL

BACTERIA INFECT ROOT CREATING A NODULE.
PLANT GETS FIXED N, BACTERIA GET CHO.

N₂ FIXATION IS CONTROLLED BY THE ENZYME NITROGENASE OF WHICH Mo IS A COMPONENT

SOYBEANS HAVE BEEN SHOWN TO FIX ABOUT 100 lb N/a/yr, BUT ITS GRAIN ALONE REMOVES MORE. SOME SUGGEST THAT SOYBEAN IS A "N MINER"

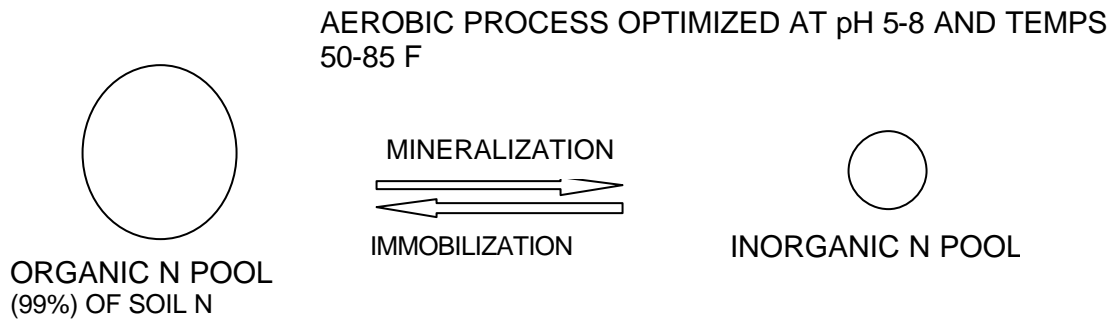
ALFALFA HAS BEEN SHOWN TO FIX ABOUT 250 lb N/a/yr. N FERTILIZATION REDUCES FIXATION RATE AS IT IS ENERGY CHEAPER FOR THE PLANT TO ABSORB SOIL N

SNAP BEANS FIX 40-60 lb N/a/yr AND ARE OFTEN FERTILIZED, ESPECIALLY ON SANDS

BLACK LOCUST IS AN EXAMPLE OF A N_2 FIXING TREE

SOME FREE-LIVING BACTERIA AND ALGAE CAN FIX N IN LOW N, ORGANIC MATTER CONDITIONS

- MINERALIZATION (AMMONIFICATION) = CONVERSION OF ORGANIC N TO AMMONIUM (NH_4^+)



NUMEROUS MICROORGANISMS PARTICIPATE IN MINERALIZATION

CALLED AMMONIFICATION BECAUSE THE END PRODUCT OF THEIR METABOLISM IS AMMONIA (NH_3) WHICH QUICKLY COMBINES WITH WATER TO FORM AMMONIUM (NH_4^+)

LITTLE N IN MINERALIZED IN SWAMPS BECAUSE OF ANEROBIC CONDITIONS. ONCE DRAINED THEY CAN SUPPLY CONSIDERABLE N

SANDY SOILS AND DESERT SOILS MINERALIZE ONLY SMALL AMOUNTS OF N BECAUSE OF THEIR LOW ORGANIC MATTER CONTENT

- NITRIFICATION

CONVERSION OF AMMONIUM ULTIMATELY TO NITRATE. A TWO STEP PROCESS.



AMMONIUM TO NITRITE BY NITROSOMONAS, NITRITE TO NITRATE BY NITROBACTER

NITRITE IS VERY SHORT LIVED IN SOILS

NITRIFICATION OCCURS VERY RAPIDLY IN SOILS. WITHIN 2-3 WEEKS UNDER WISCONSIN CONDITIONS

BOTH AMMONIUM AND NITRATE ARE PLANT AVAILABLE. WHAT FORM DOES PADDY RICE USE? HOW ABOUT CORN?

NITRATE IS LEACHABLE. A PRODUCT CALLED N-SERVE DELAYS THE ACTIVITY OF THE NITROSOMONAS

NITRIFICATION RESULTS IN THE PRODUCTION OF HYDROGEN IONS (SOIL ACIDITY). EACH MOLECULE OF AMMONIUM PRODUCES $2 H^+$

- IMMOBILIZATION = THE CONVERSION OF MINERALIZED N (AMMONIUM AND NITRATE) TO ORGANIC N VIA THE UPTAKE BY SOIL MICROBES

CONTINUOUSLY OCCURRING IN SOILS WHERE MICROBES ARE LIVING

IT BECOMES A PROBLEM FOR CROP PRODUCTION WHEN THE MICROBES TAKE MORE THAN THEIR SHARE

INDUCED BY THE ADDITION OF MATERIALS WITH A HIGH CARBON:NITROGEN "C:N" RATIO (NUMBER OF CARBON ATOM vs. NITROGEN ATOMS)

CARBON IS THE ENERGY (FOOD) SOURCE FOR THE MICROBES. THEY ALSO NEED N FOR THEIR PROTEINS

ADDED MATERIALS WHICH HAVE A C:N < 20 WILL RESULT IN A NET RELEASE OF N.
MATERIALS WITH A C:N >30 WILL IMMOBILIZE N. MATERIALS WITH A C:N 20-30 COULD DO EITHER DEPENDING ON ENVIRONMENTAL CONDITIONS

TYPICAL C:N RATIOS FOR COMMON MATERIALS

MATERIAL	C:N
SOIL HUMUS	10
IMMATURE ALFALFA	12
MANURE	20
CORN STALKS	60

STRAW	80
SAW DUST	400
SUGAR	INFINITY

THE ADDITION OF HIGH C:N MATERIALS WILL INDUCE N DEFICIENCY

COMPOSTING REDUCES THE C:N. WHERE DOES THE EXTRA C GO? BEWARE OF IMMATURE COMPOST

OVERCOME HIGH C:N PROBLEMS BY ADDING N. CORN STALKS IMMOBILIZE N IN NO-TILL. AN EXTRA 30 lb N/a IS RECOMMENDED

- DENITRIFICATION = THE GASEOUS LOSS OF N FROM A SOIL BY BACTERIAL ACTIVITY UNDER ANEROBIC CONDITIONS

NITRATE IS CONVERTED BACK TO N_2 OR OTHER GASES LIKE NITROUS OXIDE (N_2O)

MOST SIGNIFICANT LOSS MECHANISM ON MTS. USUALLY ASSOCIATED WITH SEASONALLY FLOODED (POORLY DRAINED) SOILS, BUT CAN OCCUR WITHIN MOIST AGGREGATES ON WELL DRAINED SOILS

USUALLY CONSIDERED DETRIMENTAL IN AGRICULTURAL SETTINGS. CAN YOU THINK OF A SITUATION WHERE DENITRIFICATION WOULD BE BENEFICIAL?

- LEACHING = LOSS OF N (USUALLY NITRATE) BY THE DOWNWARD MOVEMENT IN SOILS

COMMONLY ASSOCIATED WITH SANDY SOILS

CAN OCCUR ON MTS DURING HEAVY RAINFALL PERIODS OR SNOW MELT. LEACHING MINIMAL AT AVERAGE OR LESS RAINFALL

AMMONIUM CAN LEACH ON SANDY SOILS WITH A LOW CATION EXCHANGE CAPACITY

RESPONSIBLE FOR THE CONTAMINATION OF THE GROUNDWATER. 10 ppm NITRATE-N IS CONSIDERED TO BE THE SAFE DRINKING WATER LEVEL FOR HUMANS.

SELLING GAS ALLOTMENTS FOR HEATING, THAN THEY WOULD IF THEY HAD MADE FERTILIZER.

N FERTILIZERS DERIVED FROM AMMONIA (TABLE 9.3)

ADD	PRODUCT	% N
–	ANHYDROUS AMMONIA	82 %
NITRIC ACID+NH ₃	AMMONIUM NITRATE	33-34 %
CARBON DIOXIDE	UREA	45-46 %
PHOSPHORIC ACID	AMMONIUM PHOSPHATES	11-18 %
SULFURIC ACID	AMMONIUM SULFATE	21 %
AMMONIUM NITRATE+UREA	UAN SOLUTIONS	28-32 %

- FACTORS AFFECTING THE CHOICE OF N FERTILIZER

- AGRONOMIC

- LEACHING
 - VOLATILIZATION

- SAFETY

- AMMONIA TOXICITY TO PLANTS AND HUMANS
 - AMMONIUM NITRATE (BOMBS)

- HANDLING

- LIQUID vs. DRY
 - HYGROSCOPICITY (ABSORBS WATER)

- PRICE

- USUALLY AMMONIA IS THE CHEAPEST

- N FERTILIZATION MANAGEMENT

- RATE

- APPLY RECOMMENDED RATE

- ECONOMIC OPTIMUM NITROGEN RATE SIMILAR IN GOOD YEARS AND BAD YEARS

- TAKE CREDITS FOR MANURE, LEGUMES, NITRATE TESTS

- AVOID LOSSES DUE TO LEACHING AND VOLATILIZATION

- TIMING

- GOAL IS TO PROVIDE N FOR MAXIMUM DEMAND PERIOD

- FALL N APPLICATION ARE LESS EFFICIENT

- MORE TIME FOR NITRIFICATION, LEACHING, DENITRIFICATION

- MIGHT BE PRICE OR TAX BENEFIT

- WAIT UNTIL SOIL IS < 50 F

- USE AMMONIUM FORM

- CONSIDER AN INHIBITOR (N-SERVE, DCD)

- PREPLANT APPLICATION REASONABLE FOR MTS AND FTS. SIDEDRESS OK TOO, BEWARE OF DELAYS FOR WET CONDITIONS

SIDEDRESS APPLICATION ON SANDS (TABLE 9.15)

N RATE (lb/a)	YIELD PP	YIELD SD	REC. PP	REC. SD
0	38	38	--	--
70	88	105	50	73
140	120	136	44	64
210	132	143	40	49

$$\text{RECOVERY} = \frac{\text{N UPTAKE (TRMT.)} - \text{N UPTAKE (CONTROL)}}{\text{N APPLIED}}$$

$$= \frac{150 \text{ lb N/a} - 50 \text{ lb N/a}}{210} \times 100 = 48 \%$$

PLACEMENT

BROADCAST = UNIFORM SPREADING OVER THE SOIL SURFACE

POTENTIAL LOSS OF AMMONIA FROM UREA.
INCORPORATE OR PRAY FOR RAIN

BAND = NARROW STRIP OF FERTILIZER APPLIED SURFACE OR SUBSURFACE

TYPICAL WITH LIQUID N (28%)

SIDEDRESS APPLICATIONS AVOID CONTACT WITH FOLIAGE TO MINIMIZE "BURNING"

INJECTED = APPLIED IN THE SOIL TO SOME DEPTH

OBVIOUSLY NECESSARY WITH ANHYDROUS AMMONIA

COVER KNIFE SLOTS

LIQUIDS ARE COMMONLY INJECTED

FOLIAR = APPLICATION DIRECTLY TO FOLIAGE

LIMIT TO WHAT AND HOW MUCH CAN BE APPLIED (BURNING)

PLANTS NEED A LOT OF N, LIMITED AMOUNTS CAN BE APPLIED FOLIARLY