Nutrient Management and Nutrient Cycling

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Fertilizer Recommendations

1. Should follow Land Grant University Research
2. Make fertilizer recommendations that go across state lines
3. Use equations instead of tables

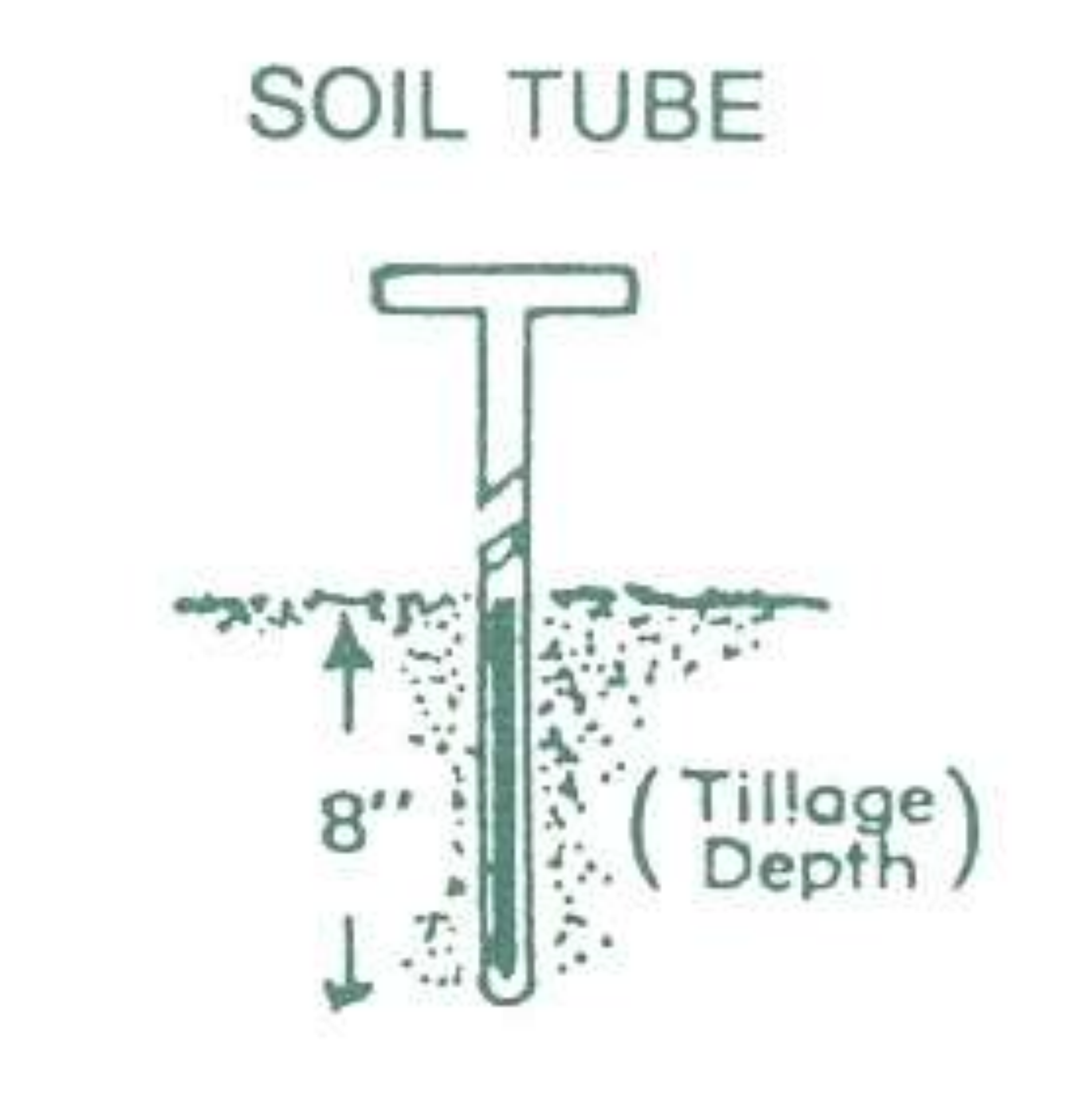
The Best Placement Method

Minimizing
Fertilizer
reaction with soil

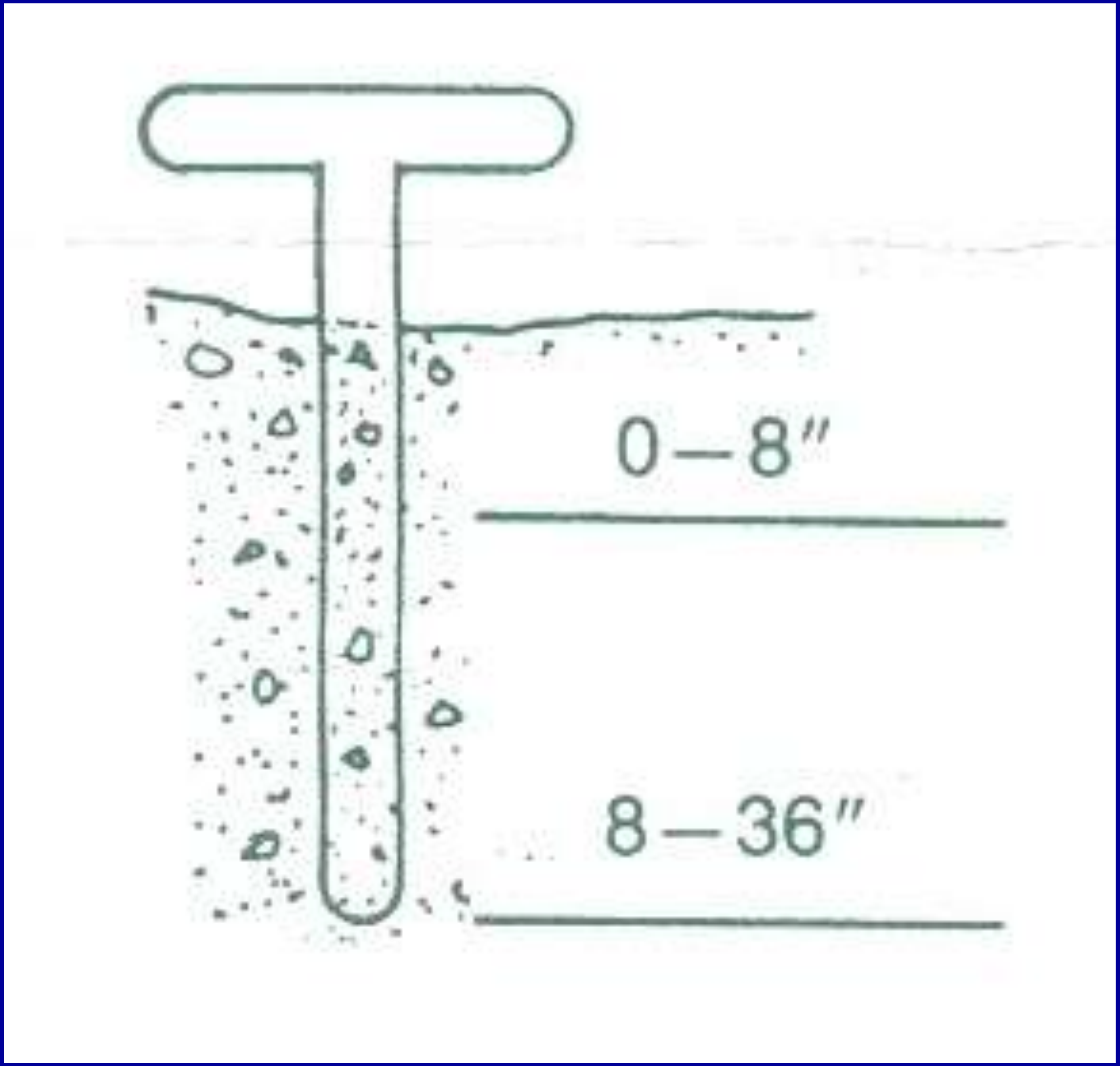
Balance

Maximinzing
contact with
roots

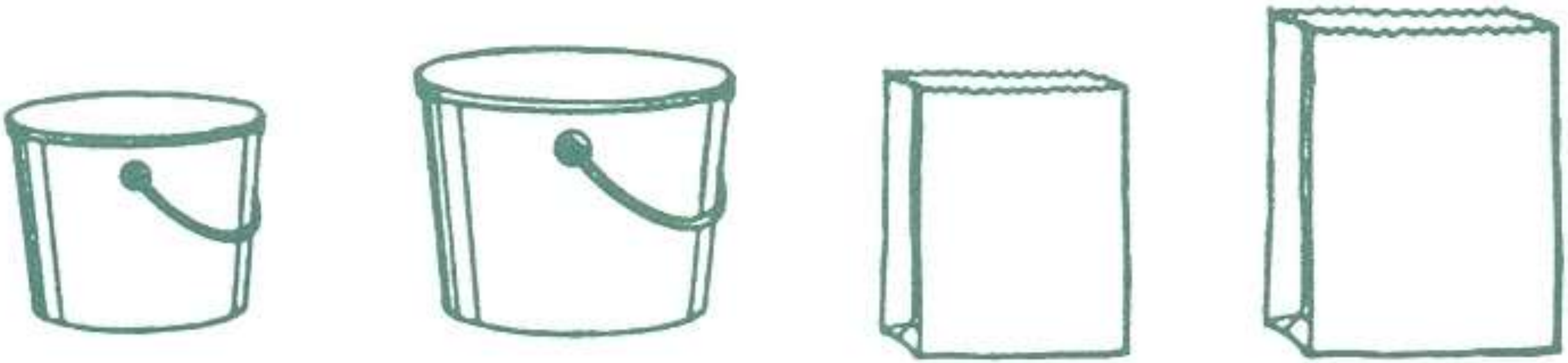
Soil Sample for Fertility



Top and Subsoil Sampling



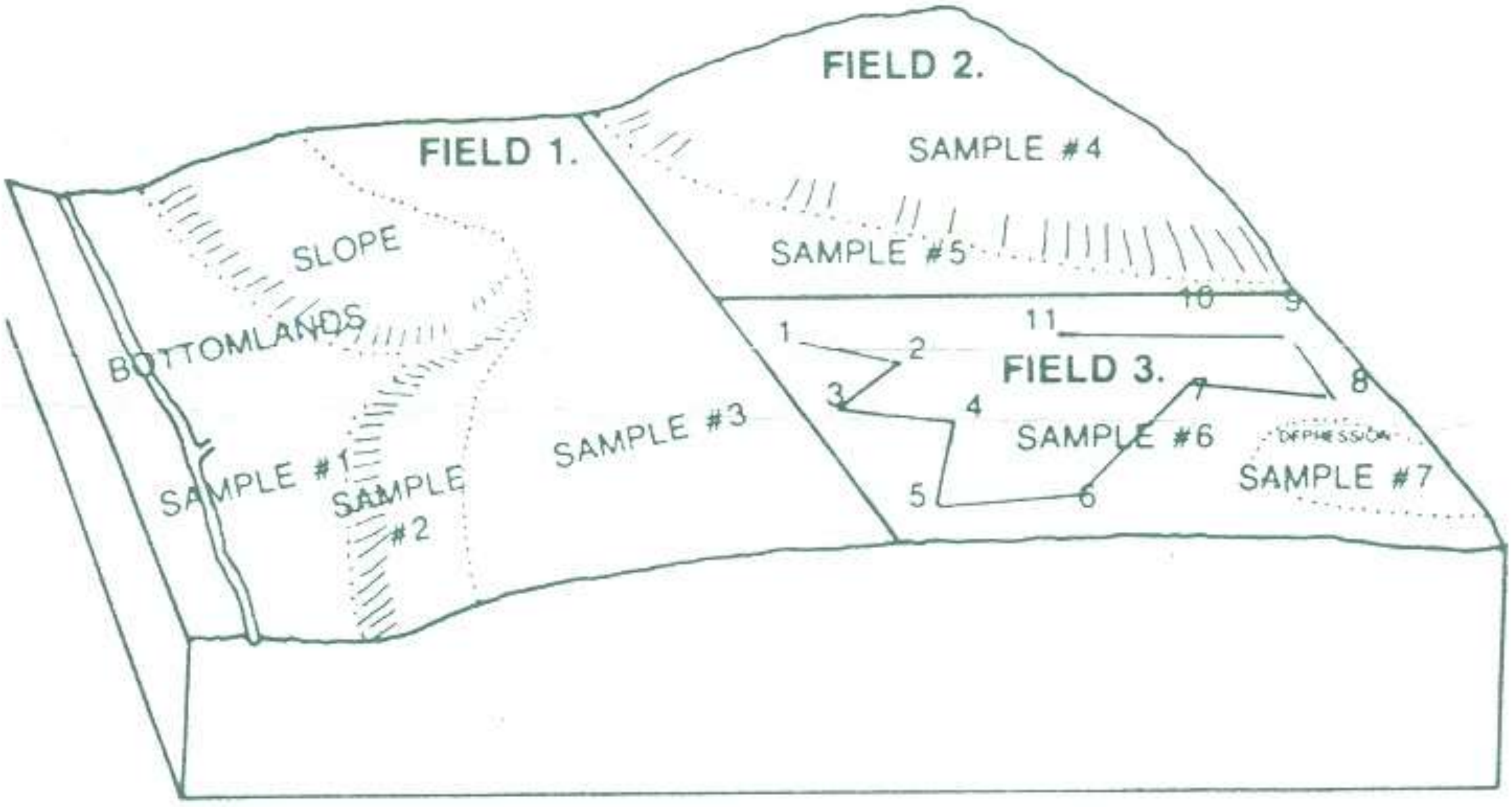
Clean Buckets and Sample Bags



Top Soil 8”   Sub Soil 8-36”   Top Soil Bag   Subsoil Bag

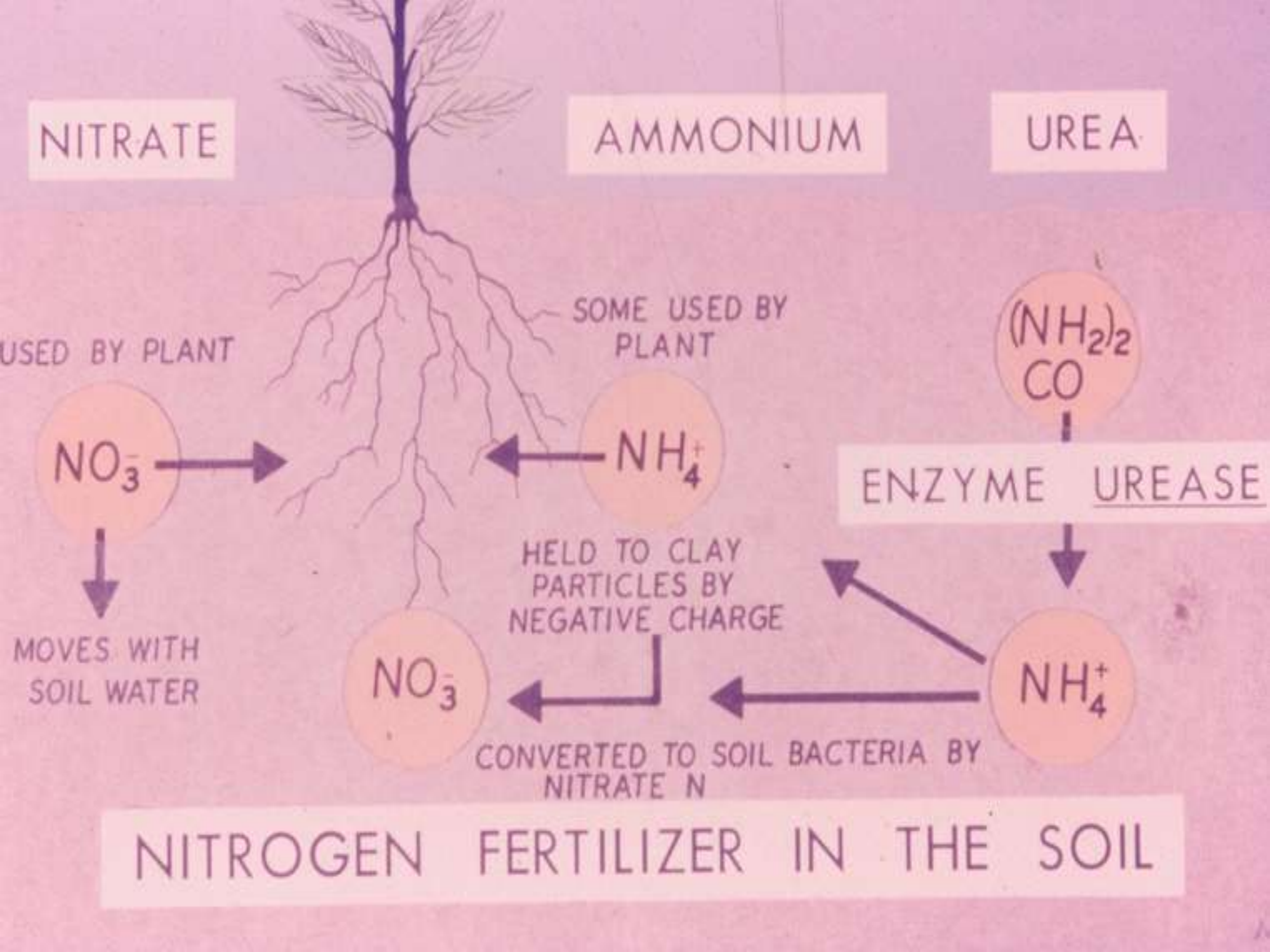
USE PLASTIC PAILS

Field & Zone Sampling

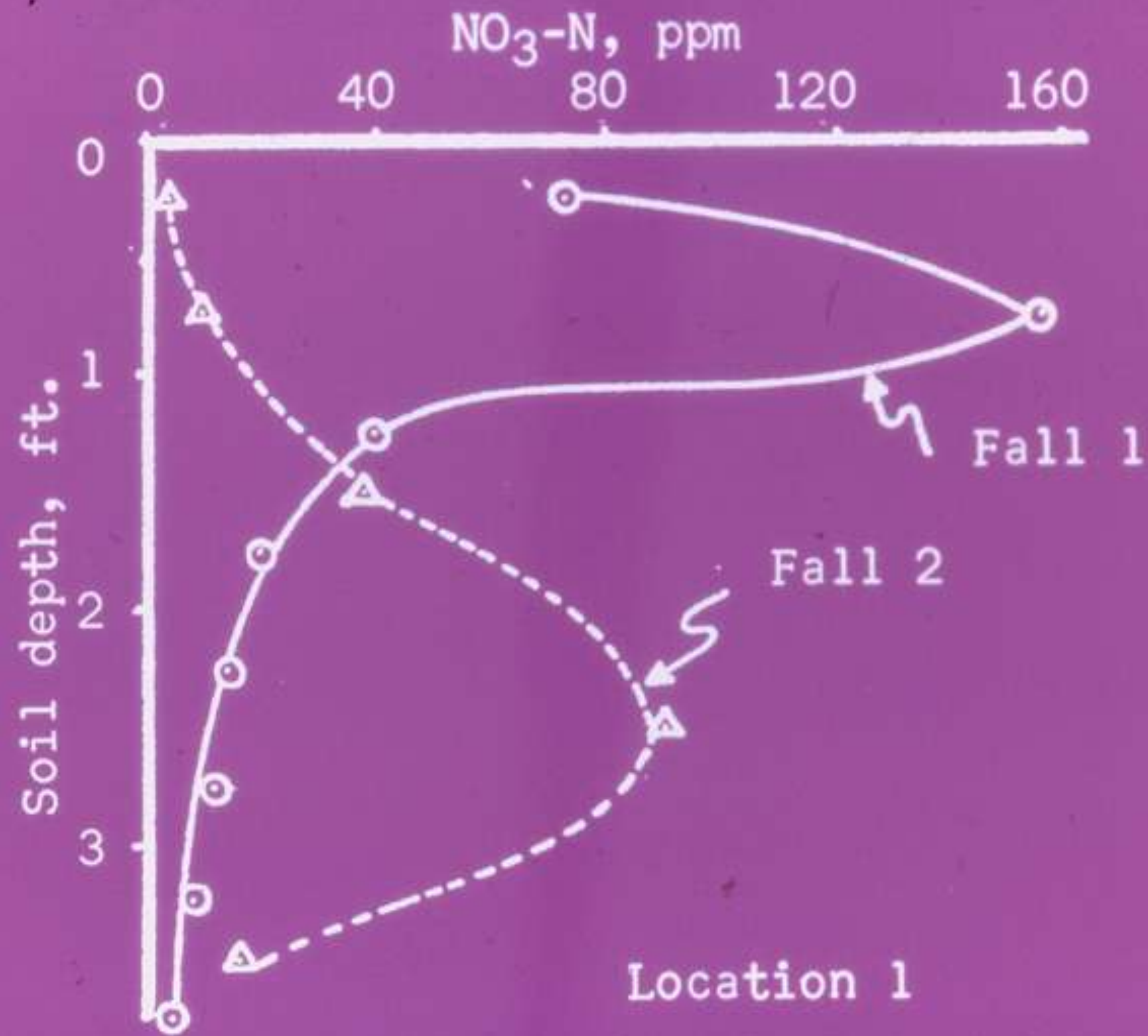


Grid Sampling

– 1	2	3	4	5	6	7	8
– 9	10	11	12	13	14	15	16
– 17	18	19	20	21	22	23	24
– 25	26	27	28	29	30	31	32



NITRATE
AMMONIUM
UREA
SOME USED BY PLANT
USED BY PLANT
$(NH_2)_2CO$
NO_3^-
NH_4^+
ENZYME UREASE
HELD TO CLAY PARTICLES BY NEGATIVE CHARGE
MOVES WITH SOIL WATER
NO_3^-
NH_4^+
CONVERTED TO SOIL BACTERIA BY NITRATE N
NITROGEN FERTILIZER IN THE SOIL


NO3-N, ppm
0
40
80
120
160
0
1
2
3
Soil depth, ft.
Fall 1
Fall 2
Location 1

Nitrogen Recommendation

N lbs/A = (yield * N req.)

lbs of NO_3-N in 24”

Legume credit

Manure credit

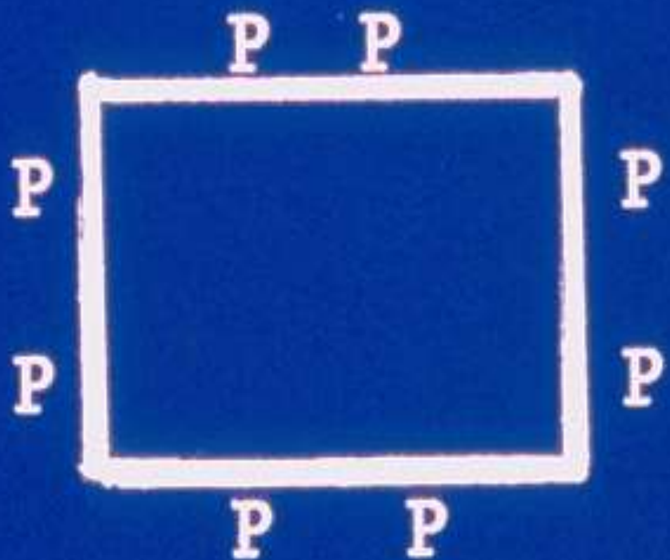
Irrigation water credit

Suggested N Credits for Legume Crops

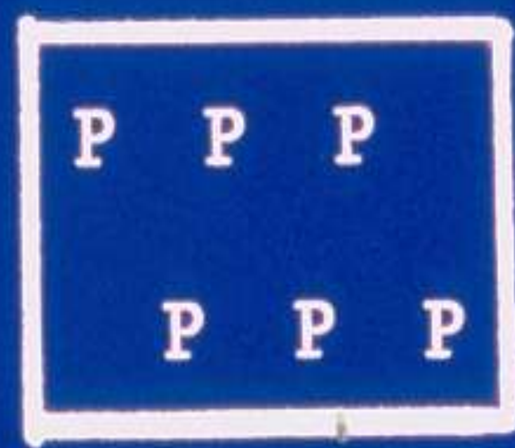
	% Stand	lb. N/A
Alfalfa	100%	100
	50%	50
	less than 50%	none
Sweet Clover		80
Red Clover		50
Soybeans		40-60

Solid Phase Phosphorus

Adsorbed



Fixed



Nutrient Uptake and Root Structure

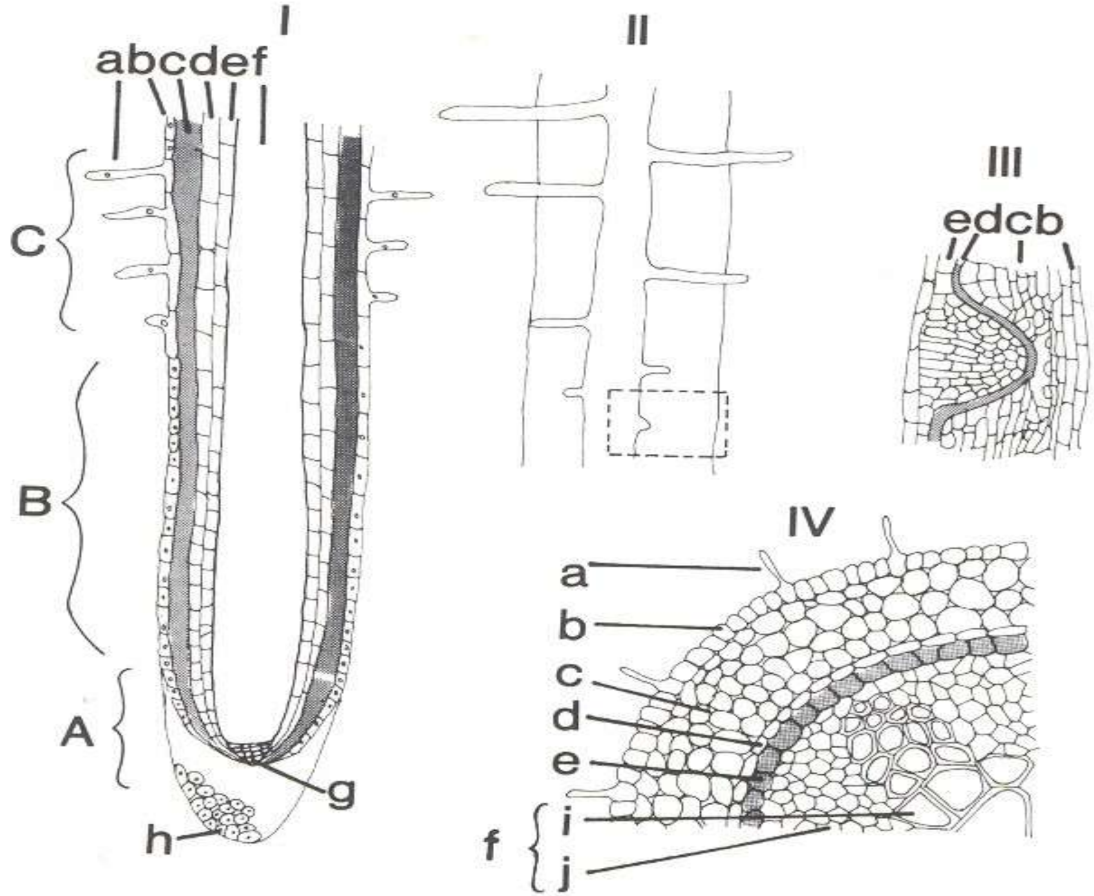


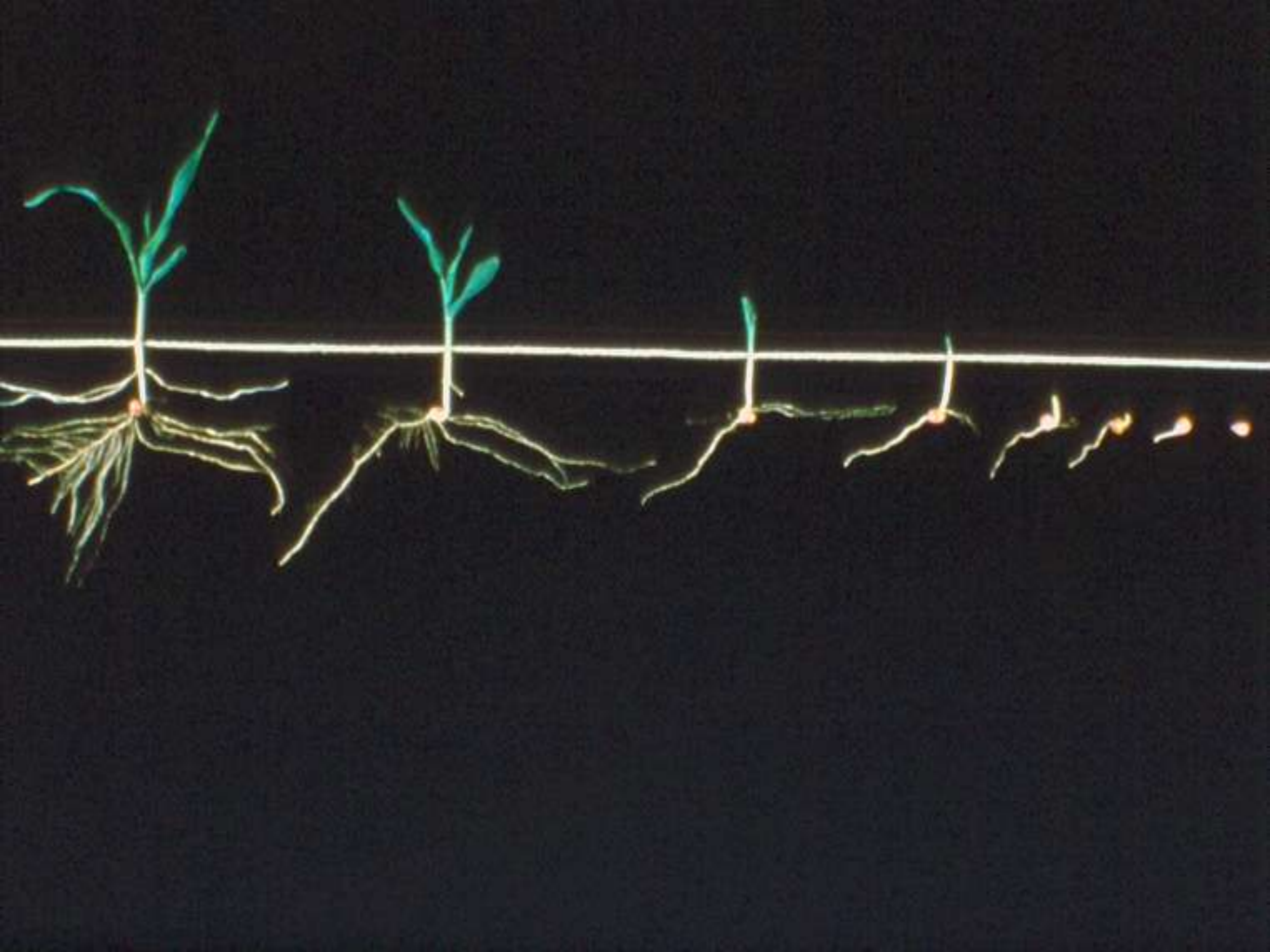
Fig. 10.2. Longitudinal section of herbaceous dicot root. *I.* Root tip with regions of cell division (*A*), elongation (*B*), and maturation (differentiation) (*C*). *II.* Section of mature root with lateral roots in varying stages of development. *III.* Meristem of a lateral root arising from the pericycle. *IV.* Cross section of a young root. Differentiated tissues: root hair (*a*), epidermis (*b*), cortex (*c*), endodermis (*d*), pericycle (*e*), central cylinder or stele (*f*), meristem with quiescent center (*g*), root cap (*h*), xylem (*i*), phloem (*j*).

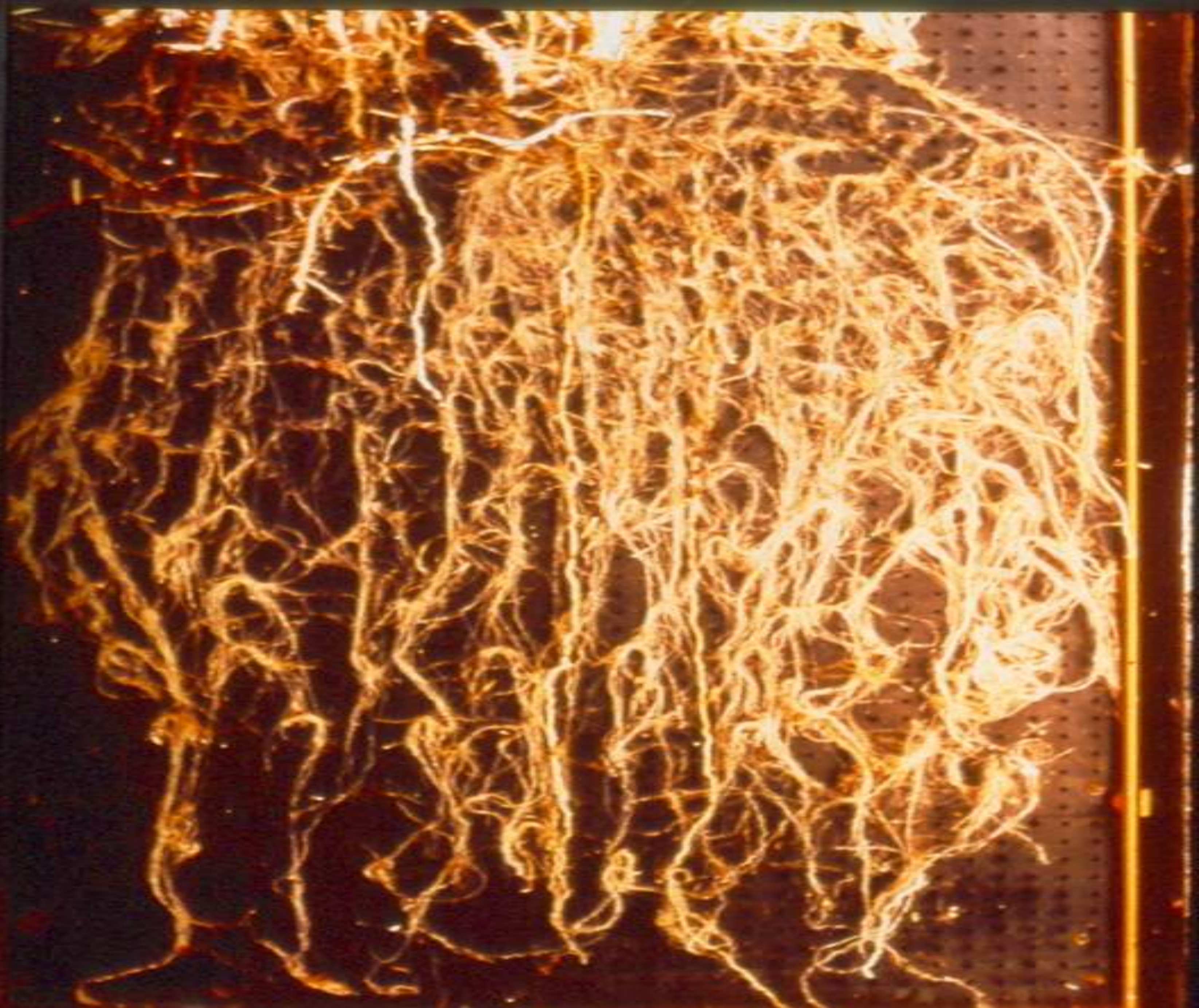
Factors Affecting Active Uptake

Oxygen

Temperature

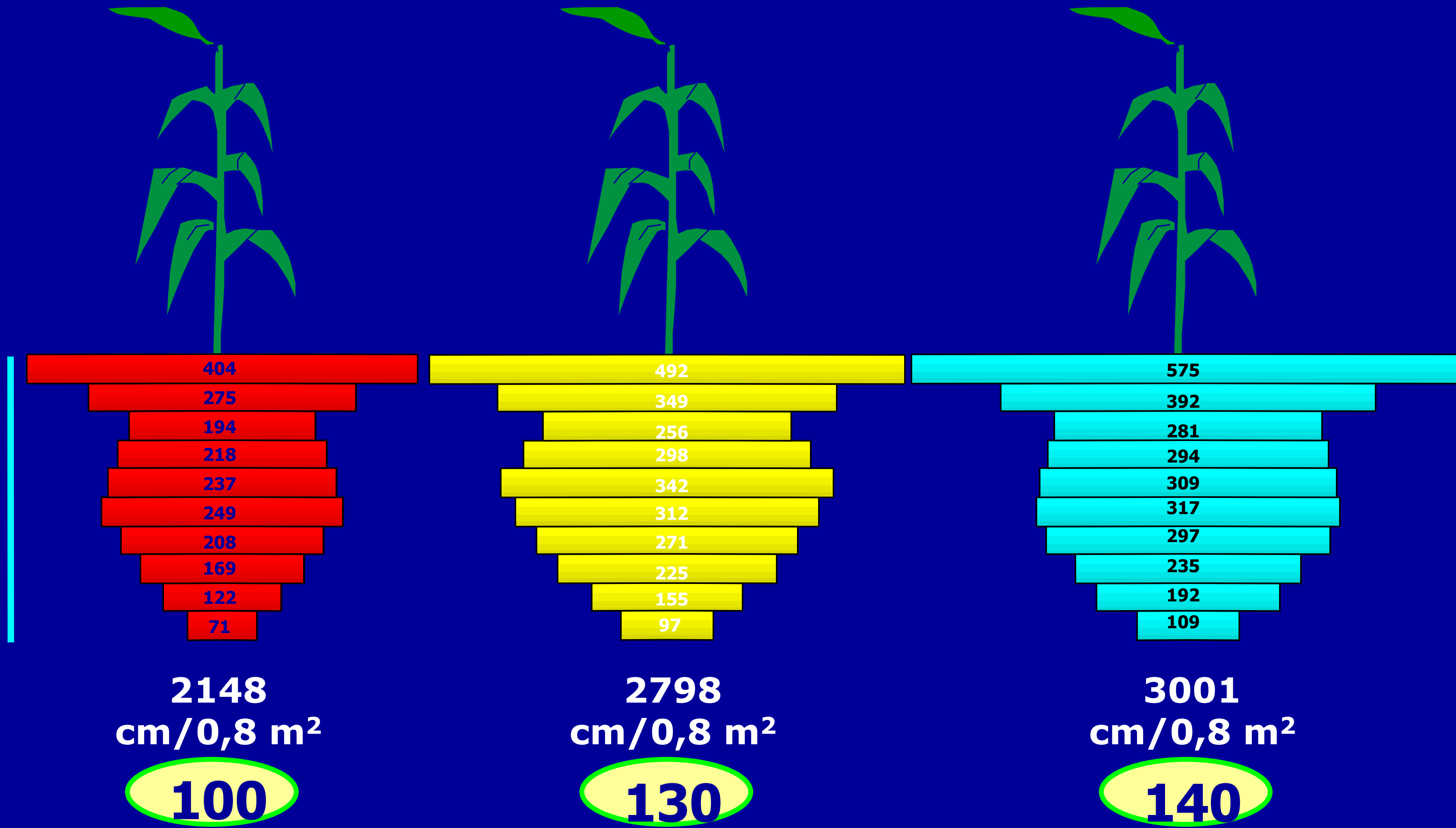
Ion Interference






General view of the research plots (Ponta Grossa - PR)
No residue
5 ton/ha
10 ton/ha

Effect of the amount of residue in the corn root system distribution with depth (Mean 13 hybrids / residue treatment)



Phosphorus Recommendations

P_2O_5 lbs/A =

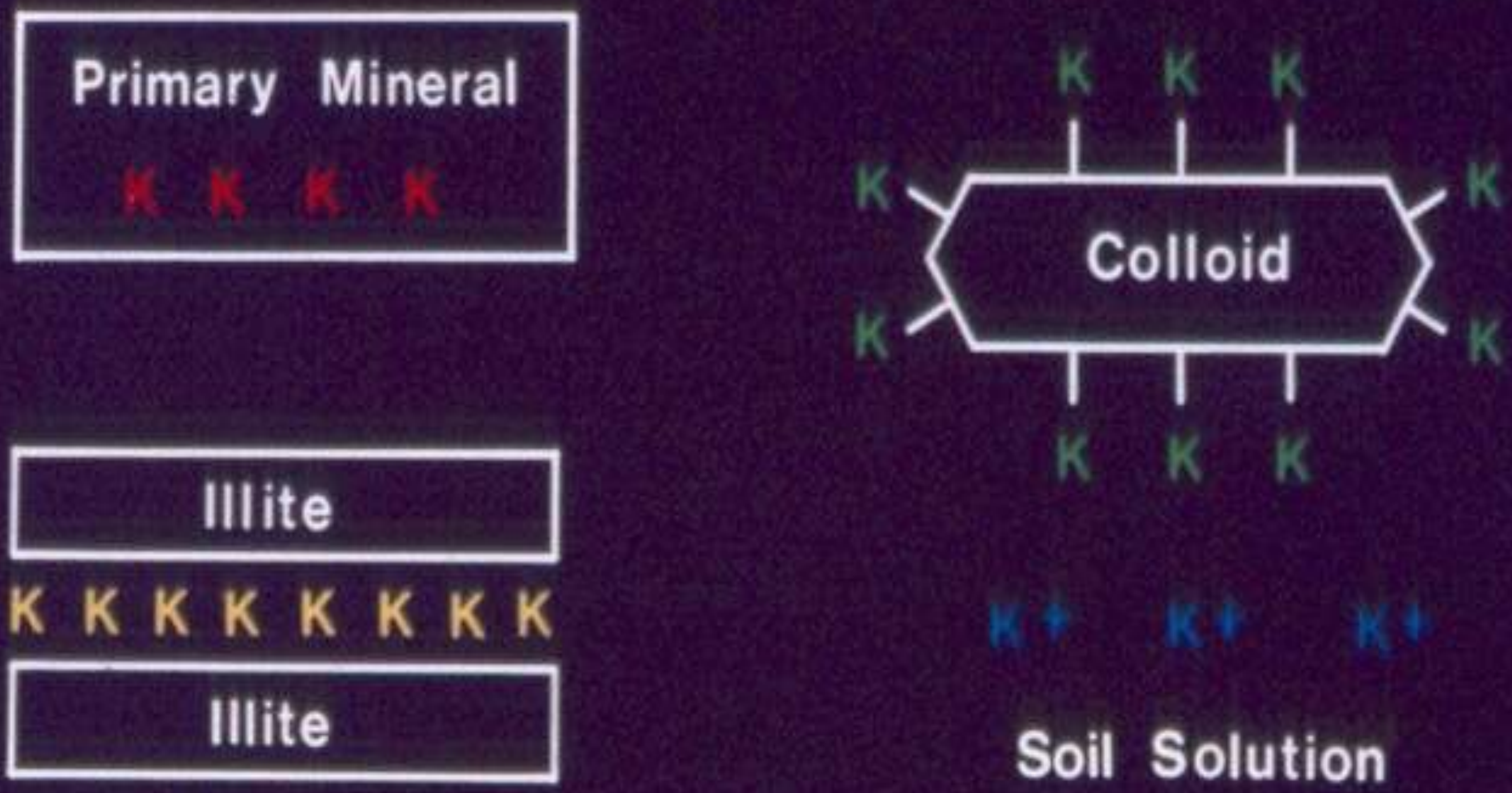
exp [intercept – (slope * ppm P)]

+ yield adjustment

General Phosphorus Recommendation

Soil test ppm P	Rating	lbs P2O5/A
0-5	Very Low	60-140
6-12	Low	35-75
13-25	Medium	20-45
26-50	High	0-30
51+	Very High	None

FOUR FORMS OF K



Potassium Recommendations

K_2O lbs/A =

exp [intercept– slope * ppm K)]

+ yield adjustment

General Potassium Recommendation

Soil Test ppm	K Rating	lbs K2O
0-40	Very Low	90-200
41-80	Low	50-120
81-120	Medium	25-60
121-200	High	0-35
201+	Very High	None

Sulfur Soil Test

Soil Test ppm S	Rating
0-3	Very Low
4-6	Low
8-12	Medium
13-20	High
20+	Very High

Sulfur Recommendation Example

Wheat 80 bu/A Yield Goal

Sulfur Requirement is .28 to .35 lb S/bu

Total S Required is 22 to 28 lbs/A

Sulfate Soil Test is 8 ppm S

8 ppm X .3 X 8 inches = 19 lbs S/A

Recommendation is 3 to 9 lbs S/A

Sulfur Recommendations
lbs S per acre

Soil Sulfur Test

	5 ppm S	7 ppm S
Corn, 200 bu/A	28	23
Milo, 150 bu/A	21	16
Canola, 50 bu/A	27	22
Wheat, 100 bu/A	21	16
Alfalfa, 8 ton/A	25	20

Zinc Recommendations

Soil Test ppm Zn	Corrective Rate lb Zn/A
0-0.25	3-12
0.26-0.50	1-7
0.51-.75	0-6
0.76-1.00	0-3
1.01+	None

*Annual rate: Divide Corrective Rate by 6.

Copper Soil Test (DTPA) and Recommendations

Cu Soil Test, ppm	Rating	Cu Rate** Lbs/A
0-0.10	Very Low	3-6
0.11-0.20	Low	1-2
0.21-0.30	Medium	0
0.31-0.60	High*	0
0.61+	Very High	0

- * Specialty crops get Copper up to 0.60 ppm
- ** Corrective application rate

Boron Soil Test and Recommendations

Boron Soil Test, ppm	Rating	Boron Rate Lbs B/A
0 – 0.25	Low	0.5 – 3.0
0.26 – 0.50	Medium	0.0 – 1.7
0.51 +	High	0

Alfalfa, clover, peanuts, cotton and sugar beets require more boron than other crops.

WARD Laboratories, Inc.

Chloride Soil Tests and Chloride Recommendations

Soil Test, ppm Cl	lbs of Cl/A
< 4 ppm Cl	20 lbs/A
4 – 6 ppm Cl	10 lbs/A
> 6 ppm Cl	0 lbs/A

KSU based on average Cl in 0 - 24 inch soil root zone.

Plant Analysis

- Diagnose growth problems within a field
  - Slow crop growth
  - Poor color
- Monitor nutrient level
  - Avoid hidden hunger

Corn Grain Nutrient Removal, lb/Bu and for 130 bu/A

Nutrient		lb/bu	130 bu/A
Nitrogen	N	0.75	98
Phosphorus	P2O5	0.32	42
Potassium	K2O	0.23	30
Sulfur	S	0.09	12
Zinc	Zn	0.001	0.13
Manganese	Mn	0.0006	0.08
Copper	Cu	0.0004	0.05

Wheat Grain Nutrient Removal, lbs/Bu and for 80 bu/A

Nutrient		Wheat	80bu/A
Nitrogen	N	1.20	96
Phosphorus	P2O5	0.52	42
Potassium	K2O	0.26	21
Sulfur	S	0.12	10
Zinc	Zn	0.003	0.24
Manganese	Mn	0.0002	0.02
Copper	Cu	0.0007	0.06

Soybean Nutrient Removal, lb/bu and for 60 bu/A

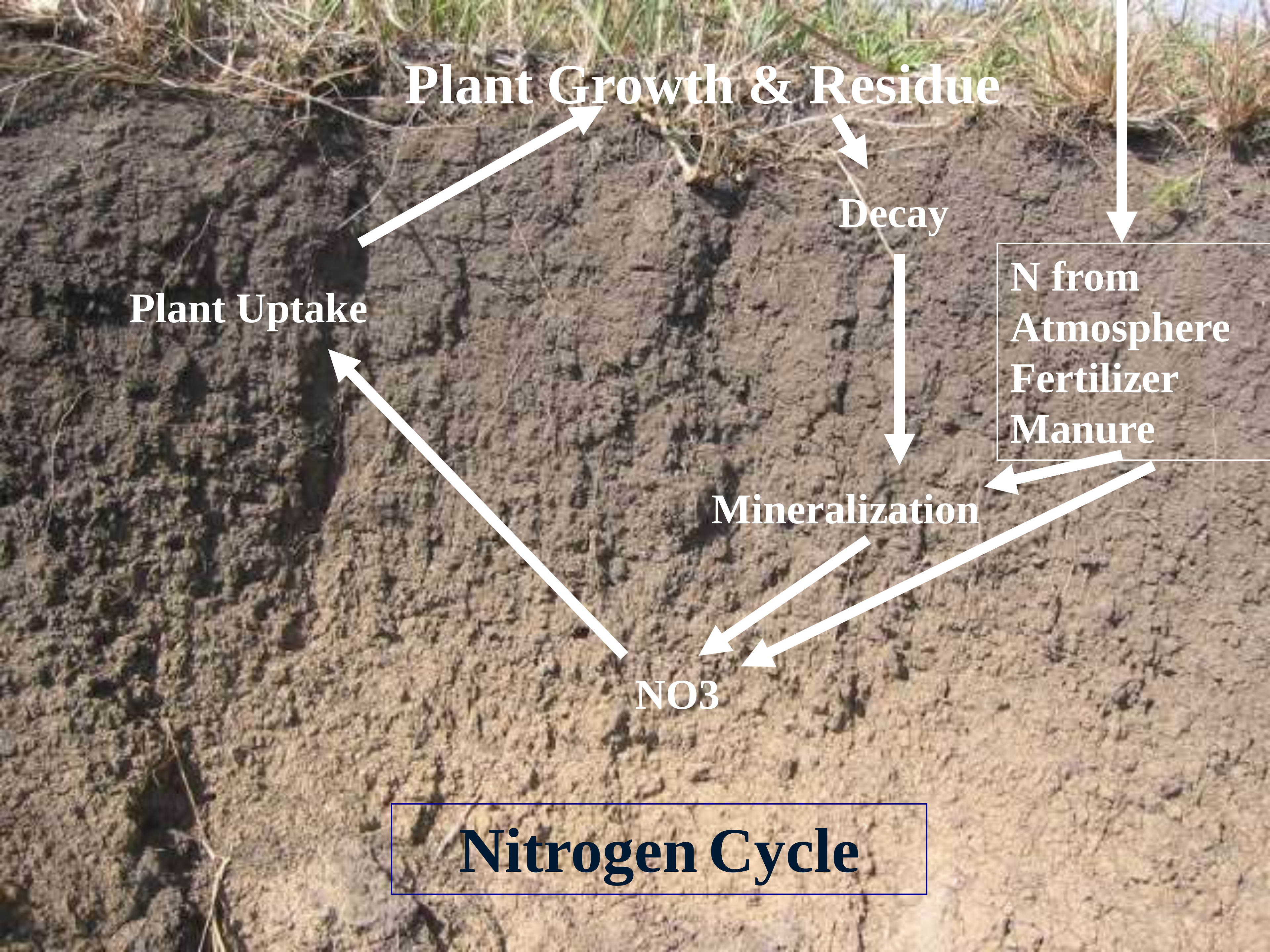
Nutrient	Soybeans	60 bu/A
Nitrogen, N	3.70	222
Phosphorus, P2O5	0.77	46
Potassium, K2O	1.40	84
Sulfur, S	0.37	22
Zinc, Zn	0.002	0.12
Manganese, Mn	0.001	0.06
Copper, Cu	0.001	0.06

Canola Nutrient Removal, lbs/bu and for 50 bu/A

Nutrient	Canola	50 bu/A
Nitrogen, N	1.90	95
Phosphorus, P2O5	0.91	46
Potassium, K2O	0.46	23
Sulfur, S	0.34	17
Zinc, Zn	0.002	0.1
Manganese, Mn	0.001	0.05
Copper, Cu	0.001	0.05

Nutrient Cycle?

1. Nutrients are removed from the land any time grain or forage is transported from the area.
2. How are the nutrients replaced? Higher yields - the more nutrients that have to be replaced.
3. Carbon comes from the air and from microorganisms decomposing organic matter.
4. Others come from soil minerals, decomposition of organic matter, soil microbes including Rhizobia, manures and fertilizer.


Plant Growth & Residue
Decay
Plant Uptake
N from
Atmosphere
Fertilizer
Manure
Mineralization
NO3
Nitrogen Cycle

C:N Ratio and Rate of Residue Decomposition

1. Average microbe C:N ratio is 8:1
2. 1/3 of the carbon used by microbes is incorporated into their cells
3. 2/3 of the carbon is respired as CO_2
4. Therefore, microbes need 1 lb N for every 24 lbs of carbon in their food
5. If the C:N ratio is greater than 24:1 the microbes must scavenge soil solution for Nitrogen

C:N Ratio: An Example

- Wheat Straw
- 100 lbs per bushel of wheat grain
- 50 bushels of wheat/A = 5000 lbs Straw
- 42 % C in straw = 2100 lbs of Carbon/A
- 4 % Protein in straw = 32 lbs of N/A
- C:N Ratio = 66:1

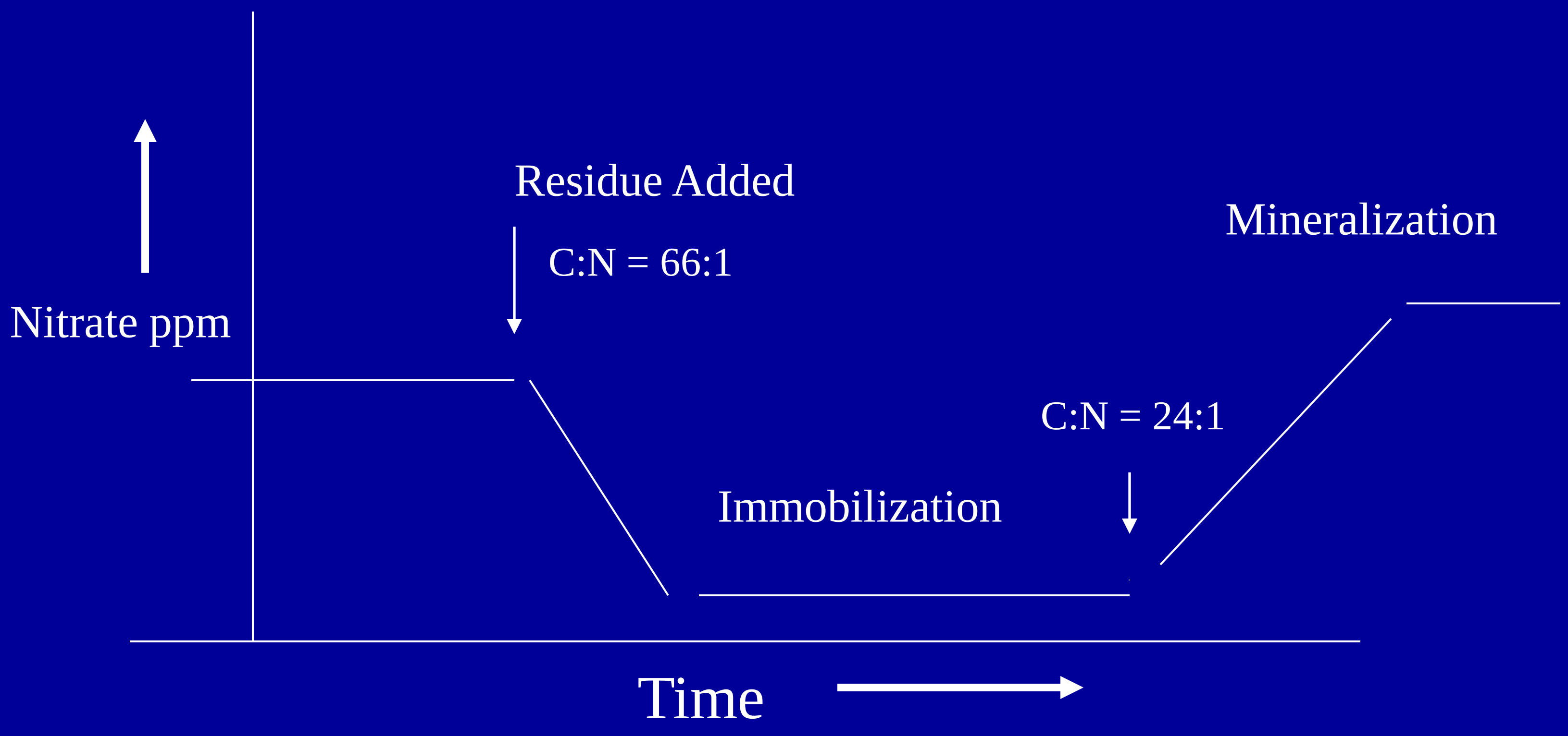
N Release From Wheat Straw

C:N ratio 66:1
5000 lbs of straw/acre

Carbon: 2100 lbs of lbs of Carbon per acre
88 lbs of N is needed to bring the C:N ratio to 24:1
88 – 32 = 56 lbs of N will be taken from the soil by the decomposers before N can be released.

Nitrogen Tie-up or Nitrogen Release

- Wheat Straw C:N = 66:1



Cover Crop Contribution

Grass cover crop

12 to 15 inches tall, about 2000 lbs of dry hay with 13 % protein.

This is 2.1 % N or 42 lbs of N/ton or a C:N ratio of 20:1

If left on the soil it will be available to succeeding crop, however, release of N will be less and slower. Higher the protein the more available N.

If cover crop is removed, no N value to next crop

Cover Crop Contribution

Legume cover crop

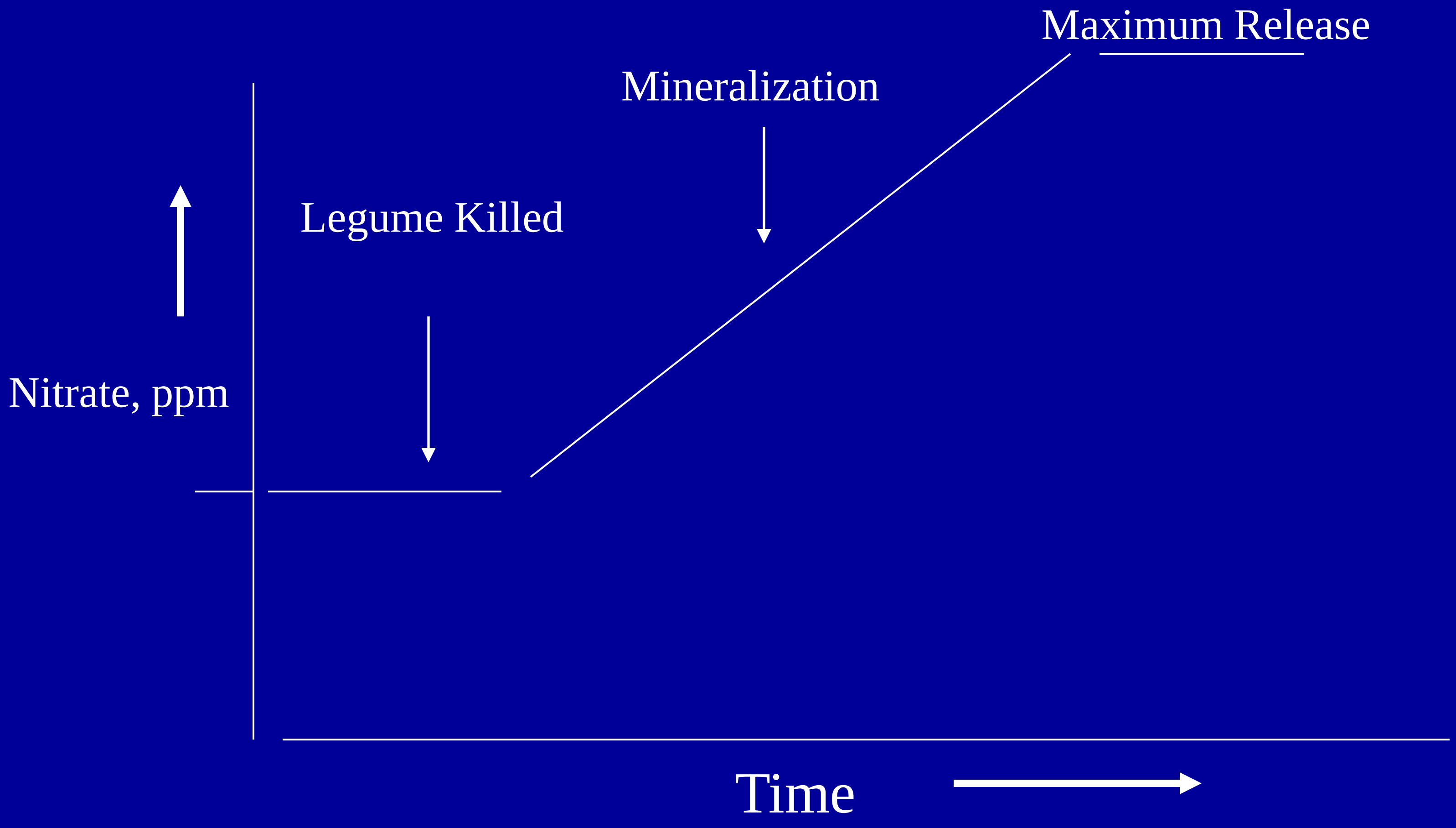
12 inches tall, about 2000 lbs of dry hay @ 18 % protein or 2.9 % N = 58 lbs of N/ton

If left on the soil it will be available for the next crop

If Legume is Grazed, there will be about 46 lbs of N remaining for the next crop

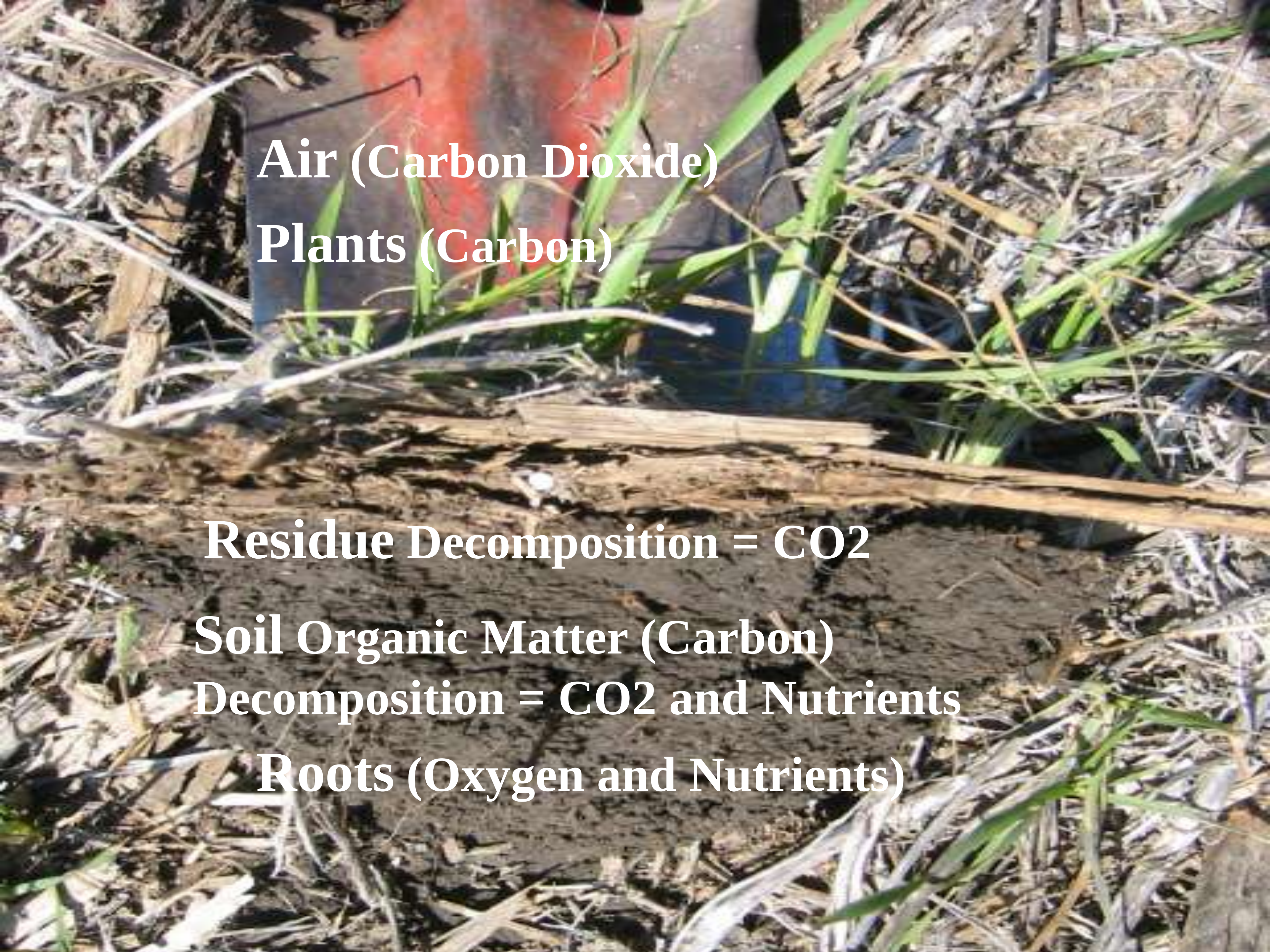
Nitrogen Tie-up or Nitrogen Release

- Legume Cover Crop C:N = 13.8



Estimated N Release Time

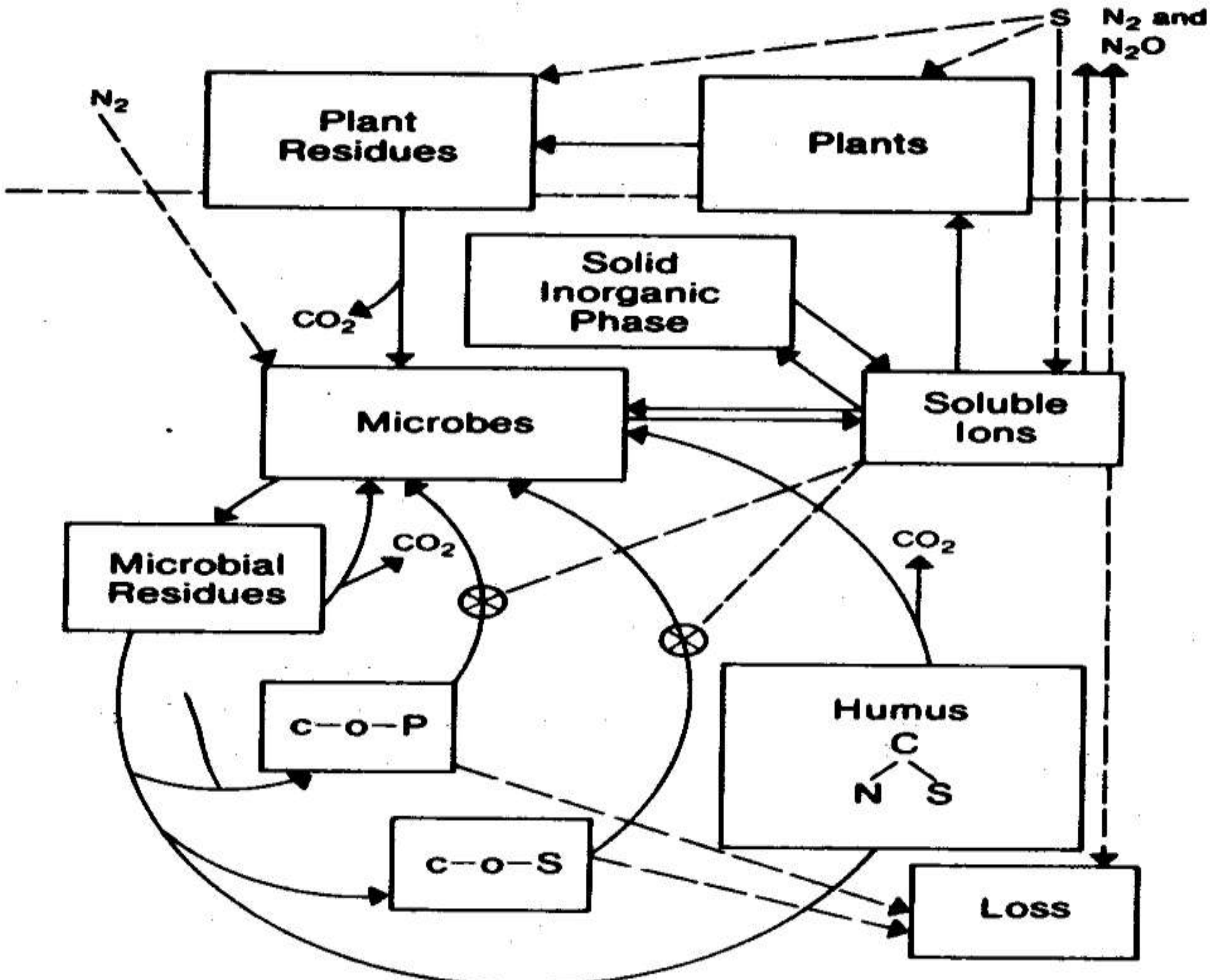
% Protein	% N	C:N ratio	Release time
22	3.5	11:1	Very quickly
18	2.9	14:1	Early summer
13	2.1	20:1	Late summer
8	1.3	23:1	Late summer and next crop
4	0.6	70:1	2 or more years from now


Air (Carbon Dioxide)
Plants (Carbon)
Residue Decomposition = CO2
Soil Organic Matter (Carbon)
Decomposition = CO2 and Nutrients
Roots (Oxygen and Nutrients)

No. 1 Environmental Enemy in Production Agriculture

Intensive Tillage

The Carbon Cycle



Carbon/Organic Matter

- Organic Matter is about 58 % C
- Ratio becomes 170 OM : 10 N : 1.4 S
- 1 % OM in 8 inches of Soil is 24,000 lbs/A
- This Quantity of OM Holds About 1400 lbs of N and 200 lbs of S per Acre.

Sulfur Cycle

Loss: Plant and animal uptake and removal

Loss: Leaching

Loss: Lack of Oxygen

Gain: Plant and animal residue

Gain: Sulfur from the atmosphere (less as the atmosphere is cleaned up)

Gain: From fertilizer

Gain: Mineralization and oxidation

No-Till Sulfur Deficiency

- Most of the Sulfur in the soil is held in the organic matter portion of the soil
- The idea is the build soil organic matter to improve soil quality and health and increase soil productivity
- C : N : S ratio
- 100C : 10N : 1.4S

Phosphorus Cycle

- Total P (OM and Minerals)= ~920 ppm P2O5
  - However, only a very small of this P is available for plant uptake
  - Some Microbes can dissolve this P but it is very slow
  - Added P from fertilizer or manure is needed for soils testing low in P

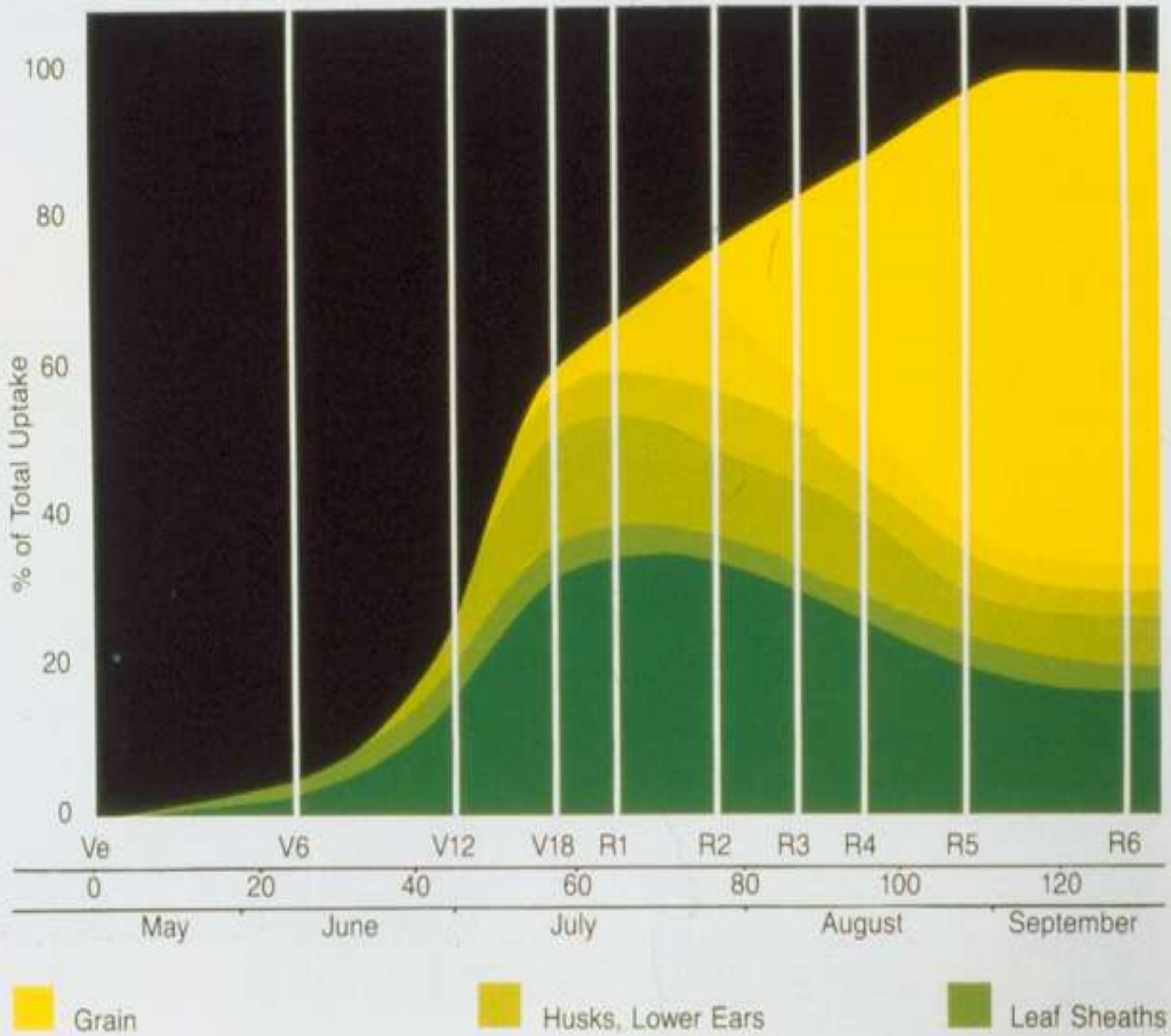
Phosphorus Cycle

- P is attached to soil calcium, iron, and aluminum. The P that is on the edge of the soil crystals diffuses into the soil solution for plant uptake. It is called “surface phosphorus”.
- Available P is measured by soil test. Olsen P, Bray P-1, and Mehlich P-3 measure available P

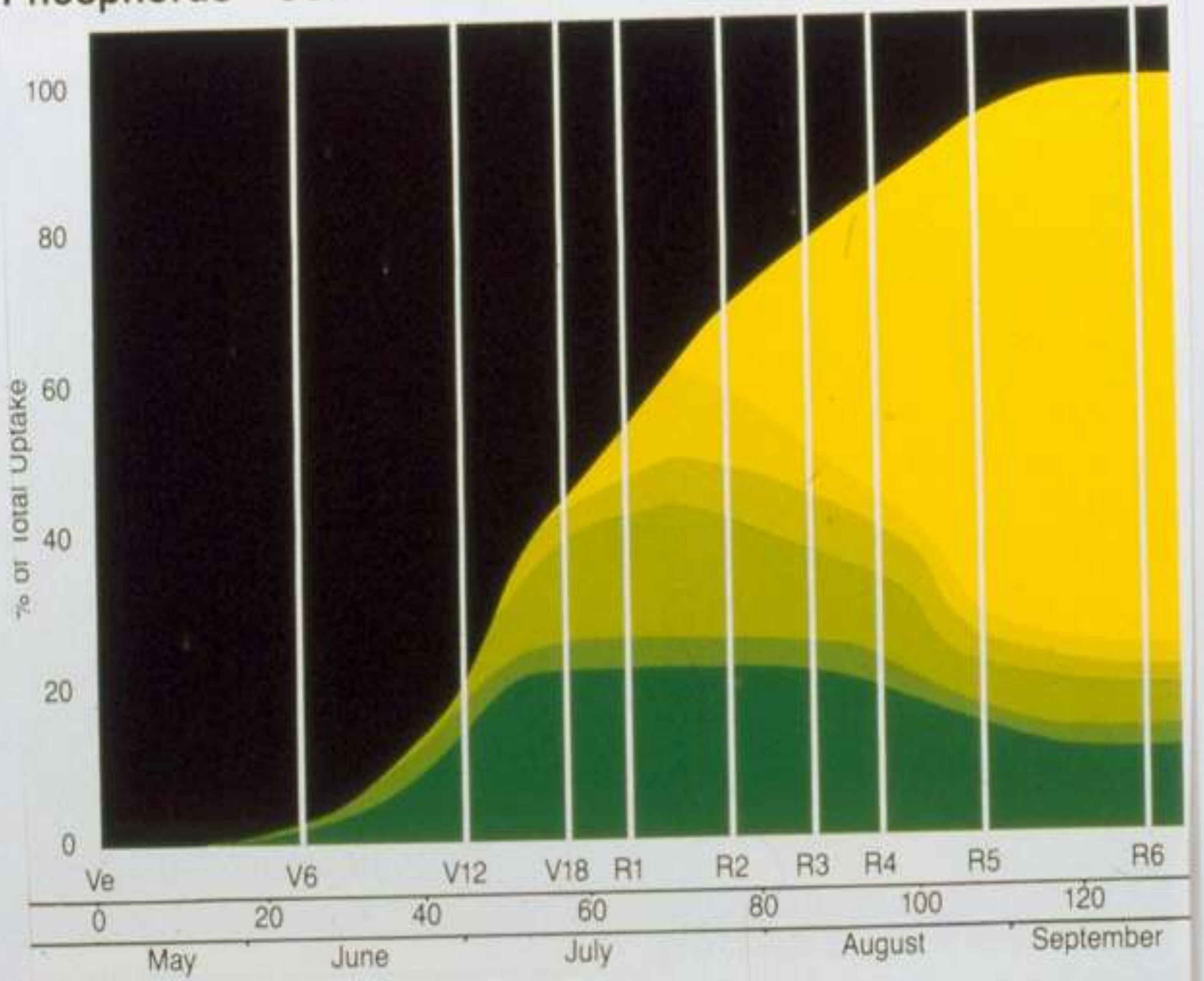
Phosphorus Forms

- P in solution, H2PO4 and HPO4
  - Very low water solubility, 0.01 to 1 ppm P
- Mycorrhizal hyphae bring P to the plant root
- Some P is used by the microbes for their life process
- Calcium (high pH) or Aluminum/Iron (low pH) bound
- Organic P (about ½ of total P)

Nitrogen—Corn



Phosphorus—Corn



Potassium—Corn