# Nutrient Management and Nutrient Cycling

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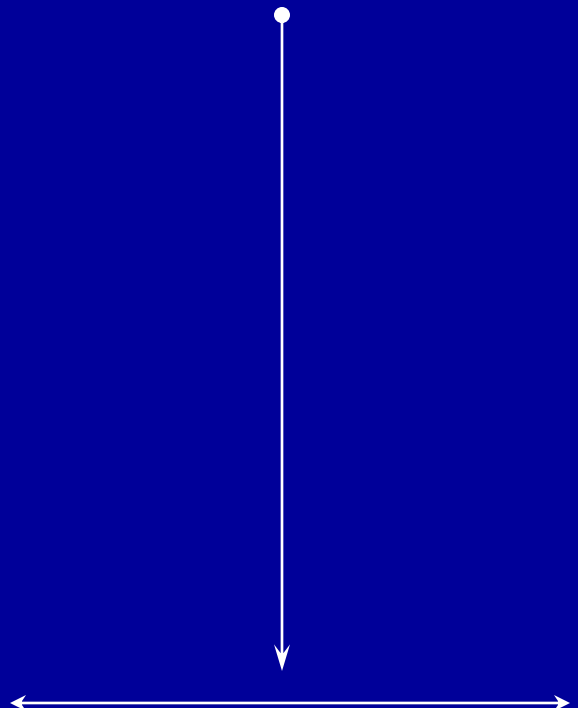
# Fertilizer Recommendations

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

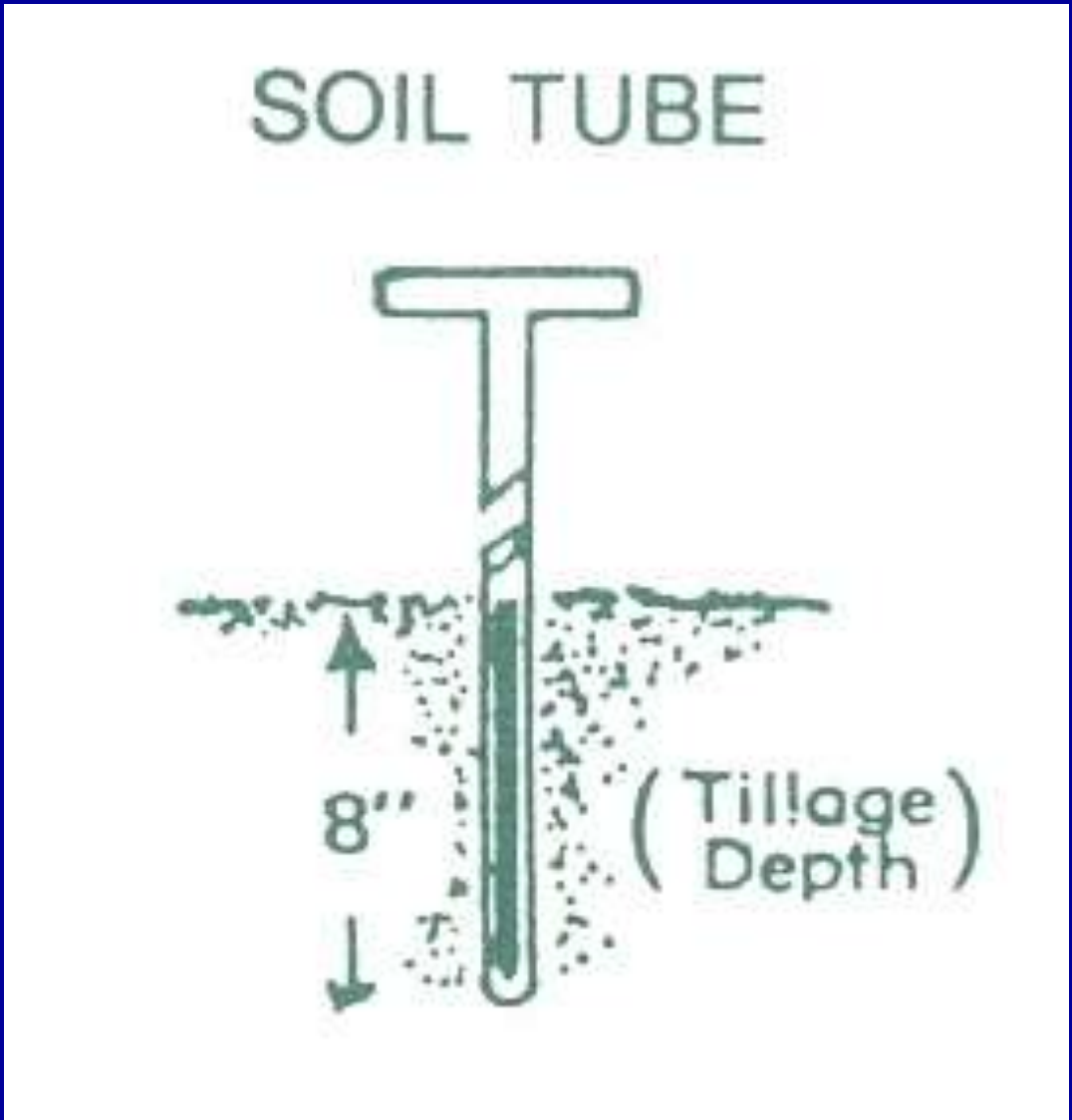


Minimizing Fertilizer reaction with soil

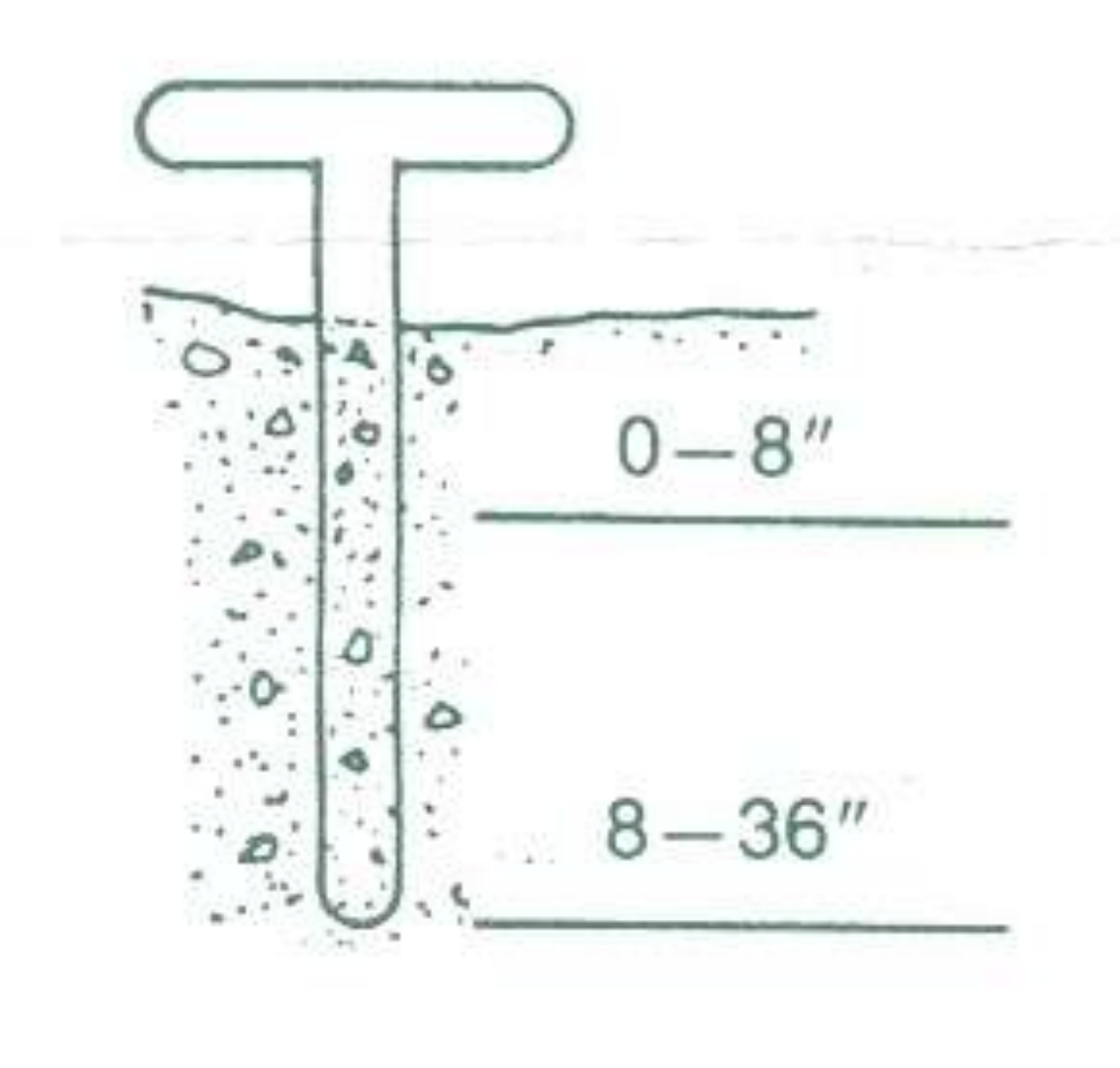
Balance

Maximinzing contact with roots

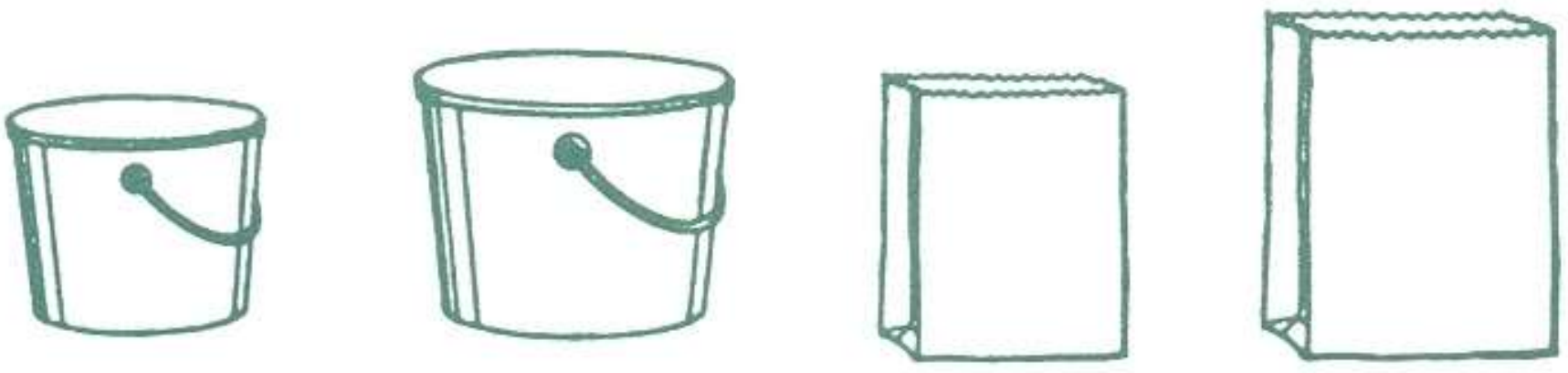
# Soil Sample for Fertility



# Top and Subsoil Sampling



# Clean Buckets and Sample Bags



Top Soil 8”

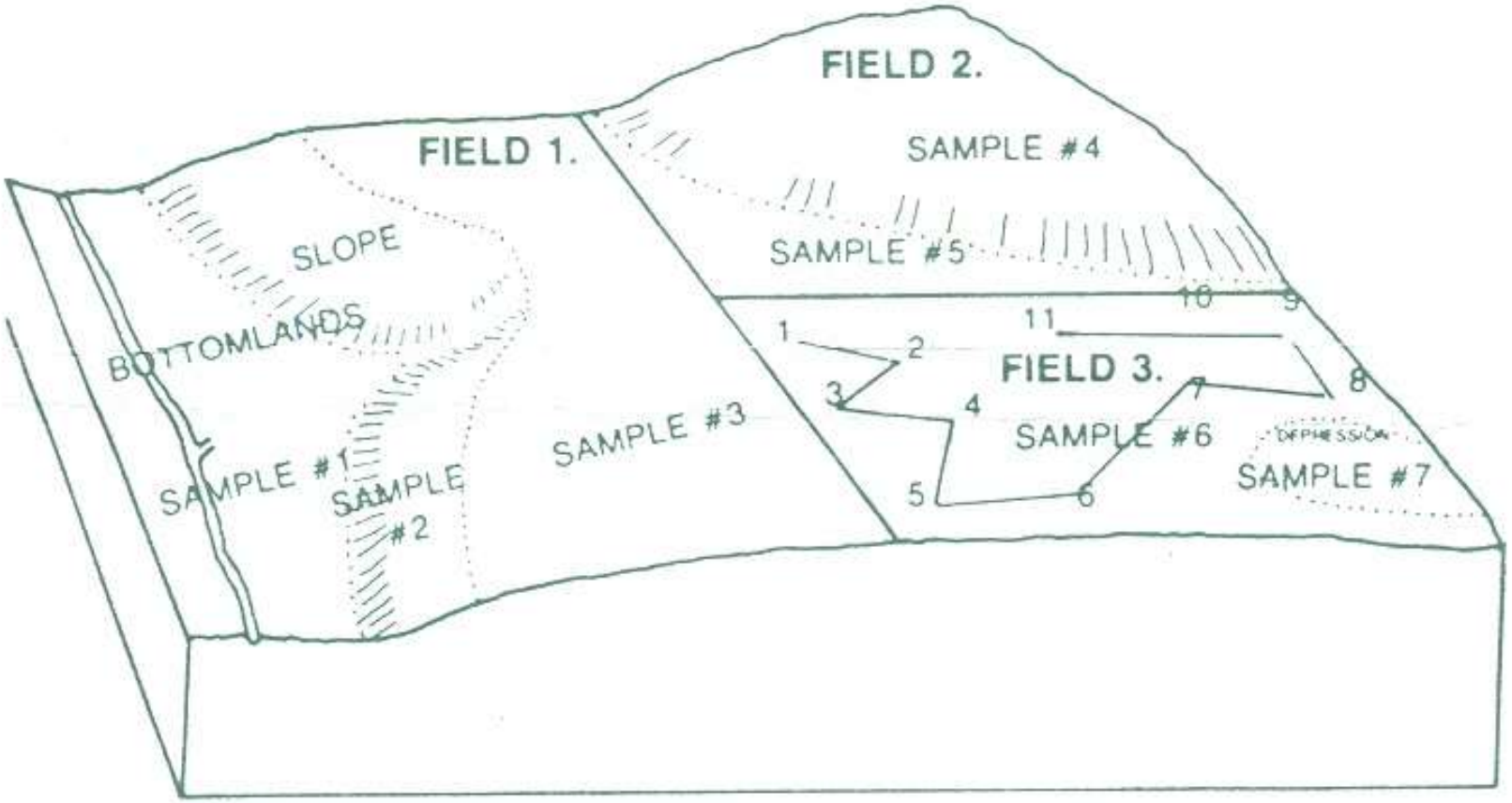
Sub Soil 8-36”

Top Soil Bag

Subsoil Bag

USE PLASTIC PAILS

# Field & Zone Sampling



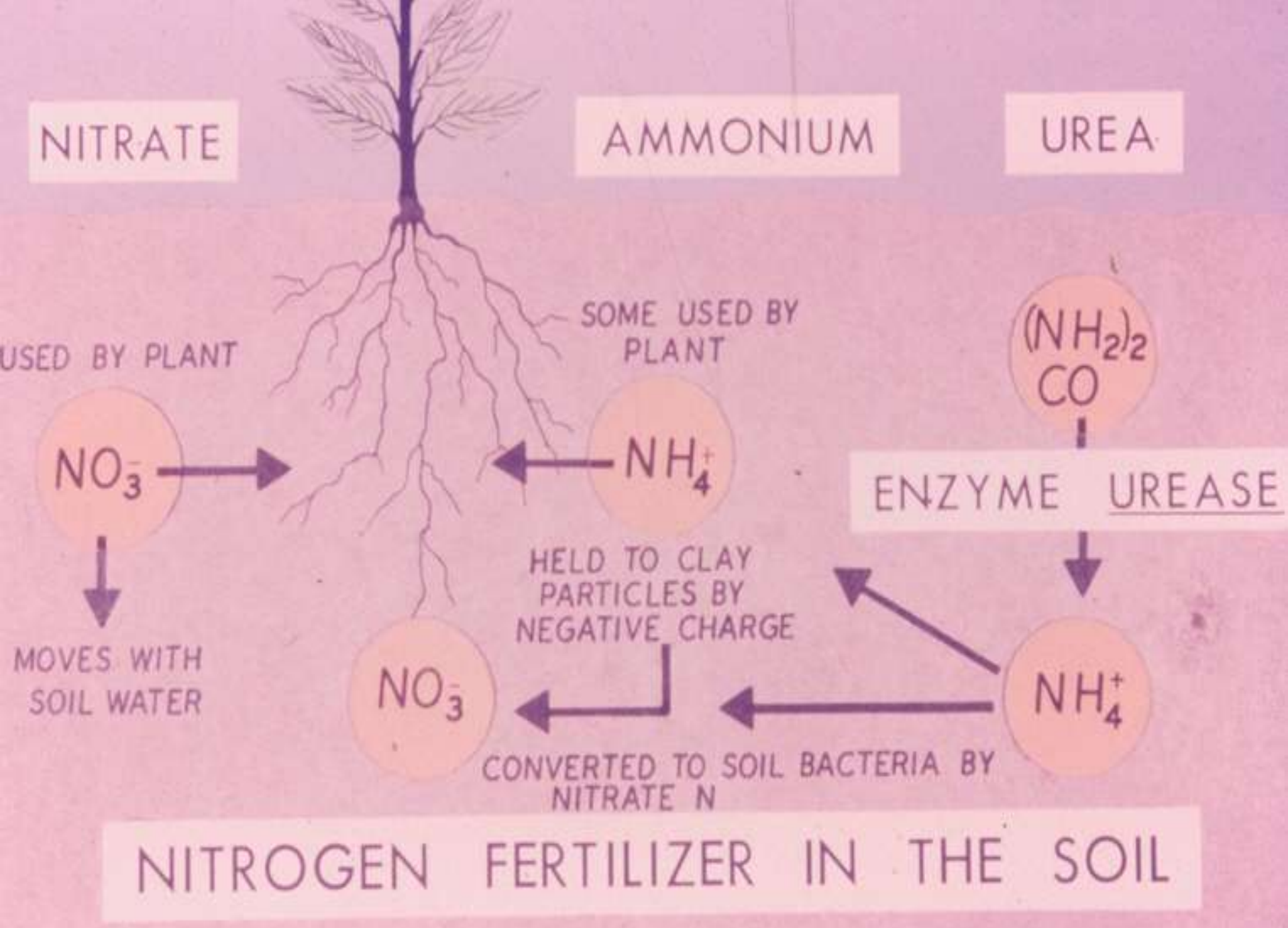
# Grid Sampling

– 1 2 3 4 5 6 7 8

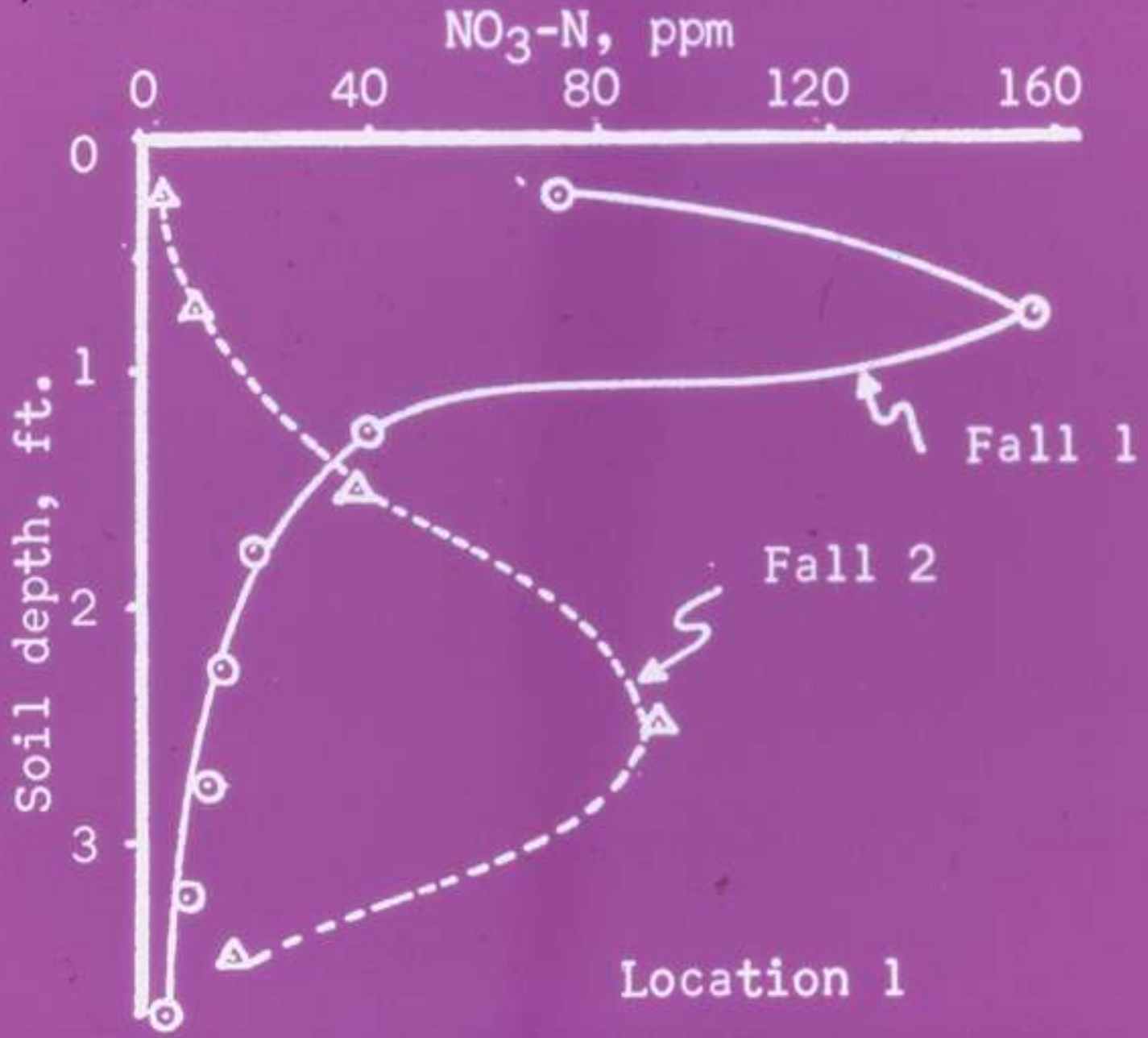
– 9 10 11 12 13 14 15 16

– 17 18 19 20 21 22 23 24

– 25 26 27 28 29 30 31 32




# NITROGEN FERTILIZER IN THE SOIL


$NO_3$-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

# Iowa Pre-sidedress Nitrate Test

- N recommendation, lbs of N/A = (25 – soil nitrate (ppm)) * 8

# 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 |

# Nitrogen Application – Kansas Milo, bu per acre

| N Rate Lbs N/A | Application Method | Riley County | Greenwood County |
|---|---|---|---|
| 0 | | 59 | 63 |
| 100 | Broadcast | 124 | 85 |
| 100 | Dribble | 133 | 83 |
| 100 | Knife | 137 | 91 |

# No Till Nitrogen Application
# Missouri 9 Site Years 1988-1990

| N rate | Average Yield |
|---|---|
| lbs N/A | Bu/A |
| 0 | 80 |
| 60 | 102 |
| 120 | 121 |
| 180 | 134 |

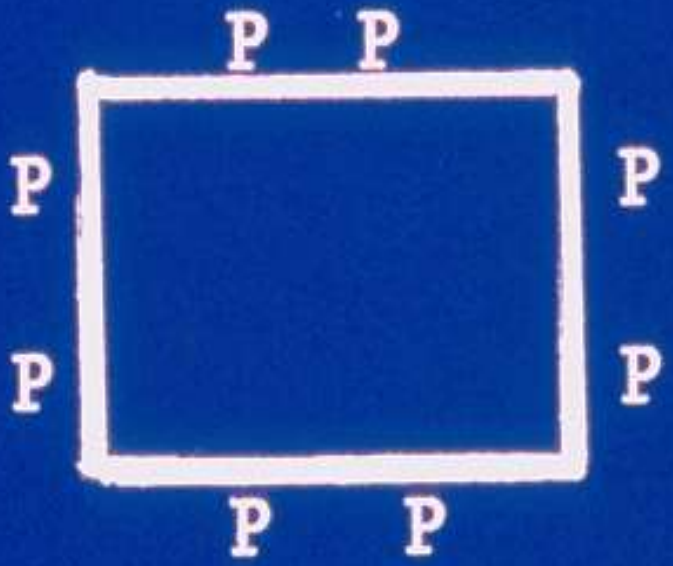
| N Products | Continuous Corn | Corn-Soybean Rotation |
|---|---|---|
| | Yield, Bu/A | |
| AN 34% N | 113 | 149 |
| Urea 46% N | 100 | 142 |
| UAN 32% N | 91 | 132 |
| UANS 32% N 5% S | 91 | 135 |

# UREA

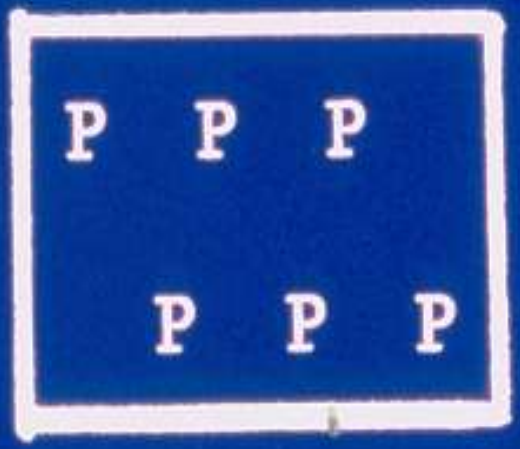
- Urease breaks urea down to ammonia and $CO_2$
- Need about ½ inch of moisture to get urea in the soil
- Do not apply urea when residue is moist and it is forecast to get hot and windy

# Solid Phase Phosphorus

## Adsorbed




## Fixed



# Nutrient Uptake and Root Structure

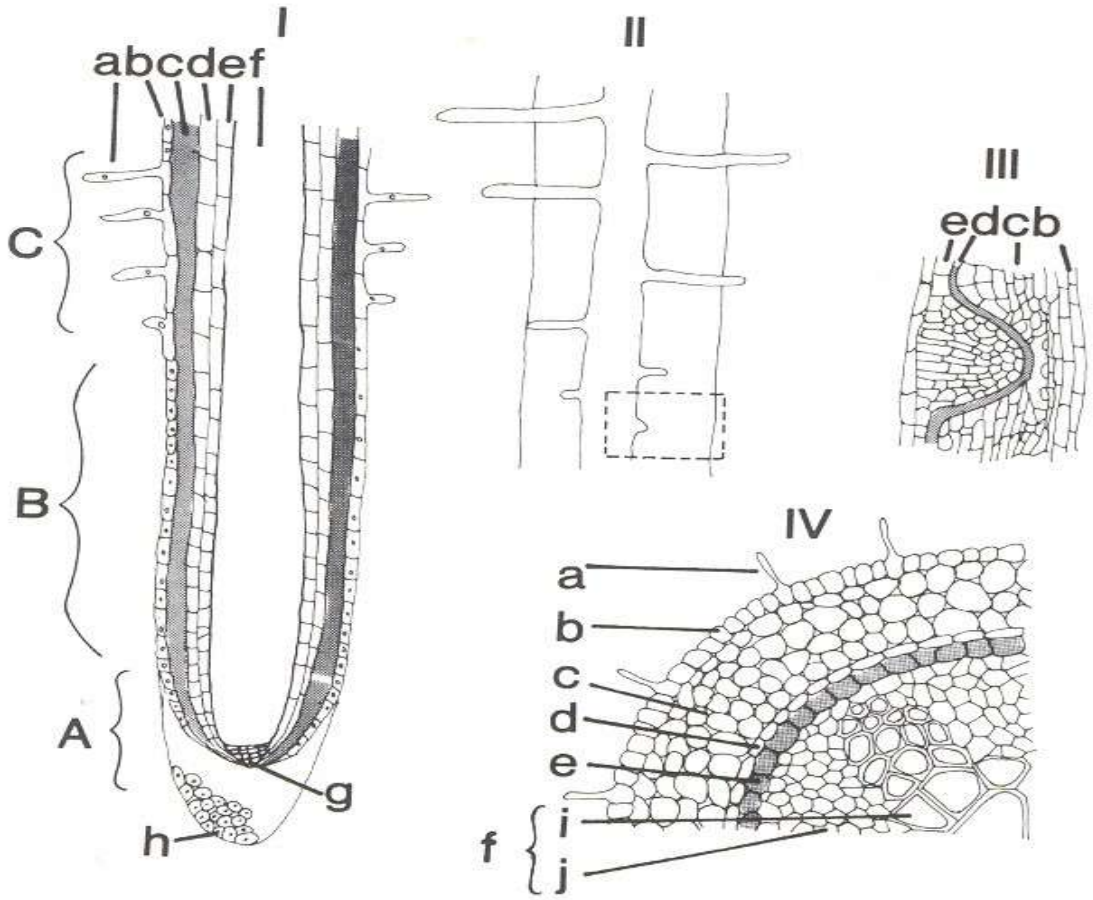


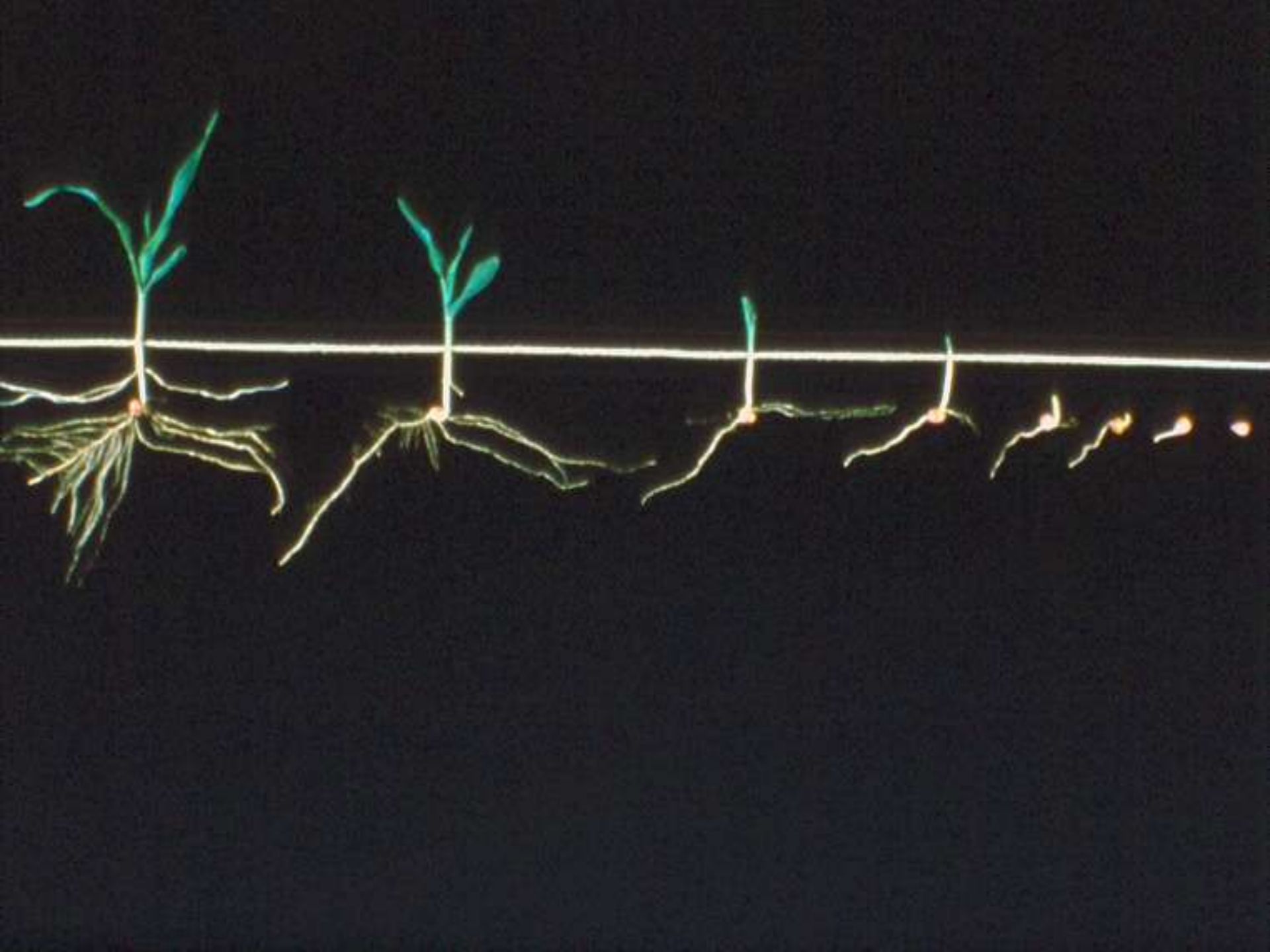

**Fig. 10.2.** Longitudinal section of herbaceous dicot root. *I.* Root tip with regions of cell division (*A*), elongation (*B*), and maturation (differentiation) (*C*). *II.* Section of mature root with lateral roots in varying stages of development. *III.* Meristem of a lateral root arising from the 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*).

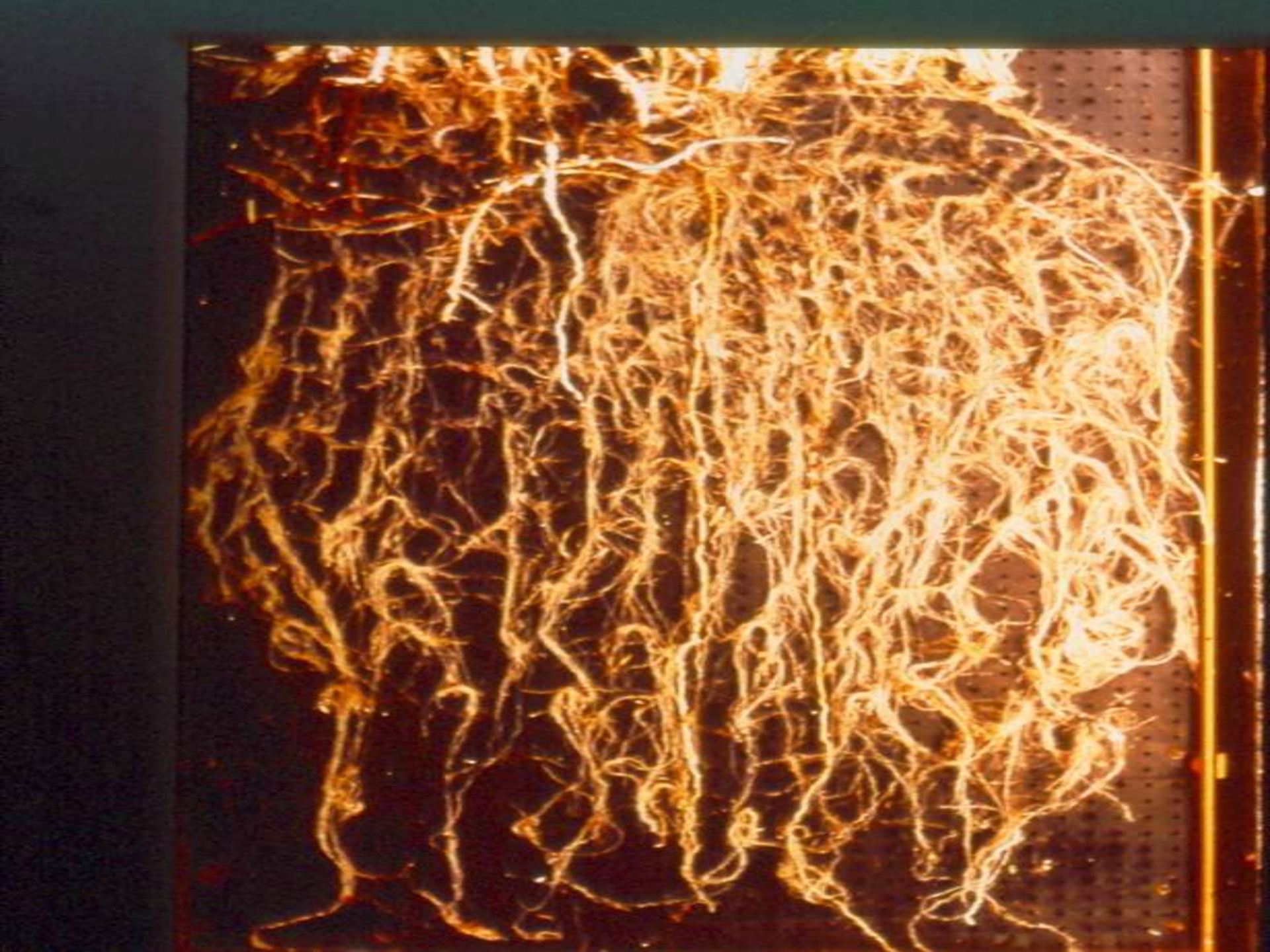
# Factors Affecting Active Uptake

Oxygen

Temperature

Ion Interference





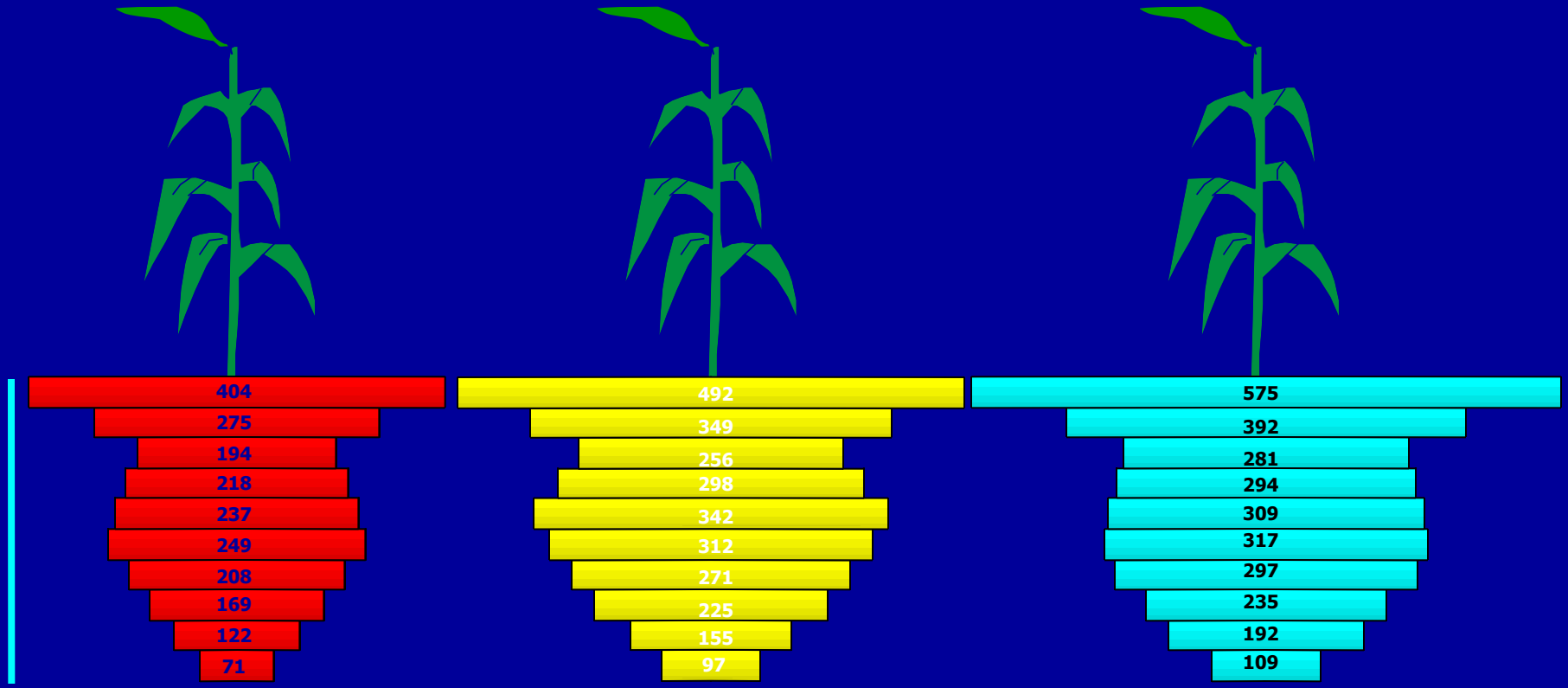

General view of the research plots (Ponta Grossa - PR)


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)




| 2148 cm/0,8 m² | 2798 cm/0,8 m² | 3001 cm/0,8 m² |
|---|---|---|
| 100% | 130% | 140% |

# Phosphorus Recommendations

$P_2O_5$ lbs/A =

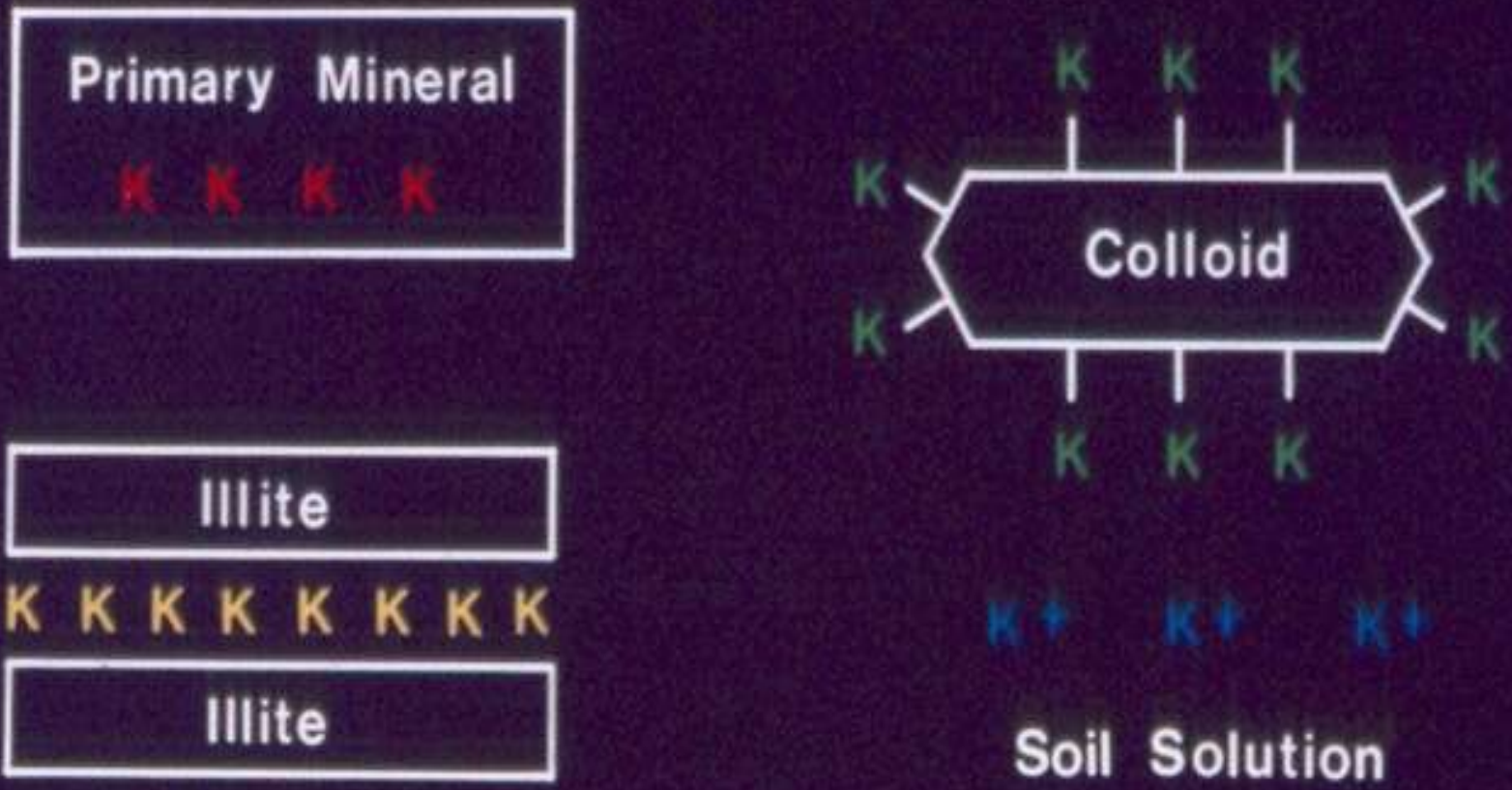
exp [intercept – (slope * ppm P)]

+ 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 Recommendations for Corn

| Yield Goal | Sulfate soil test, ppm SO4-S | | |
|---|---|---|---|
| Bu/A | 6 | 9 | 12 |
| 100 | 8 | 0 | 0 |
| 125 | 14 | 6 | 0 |
| 150 | 19 | 11 | 4 |
| 175 | 25 | 17 | 10 |

# 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.

# Manganese Soil Test, DTPA Extractable

| Soil Test Value | Rating |
|---|---|
| 0-0.5 | Very Low |
| 0.6-1.0 | Low |
| 1.1-1.5 | Medium |
| 1.6-4.0 | High |
| 4.1+ | Very High |

# Manganese Recommendations

- Foliar Treatment if deficiency is diagnosed with Plant Analysis
  - Manganese 0.5 to 1.0 lb Mn/A in 20 gallon water/A
  - Possible soil treatment of 25 to 50 lbs of manganese sulfate per acre.

# Copper Soil Test (DTPA) and Recommendations

| | | |
|---|---|---|
| 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 |

# Boron Soil Test and Recommendations

| | | |
|---|---|---|
| 0 – 0.25 | Low | 0.5 – 3.0 |
| 0.26 – 0.50 | Medium | 0.0 – 1.7 |
| 0.51 + | High | 0 |

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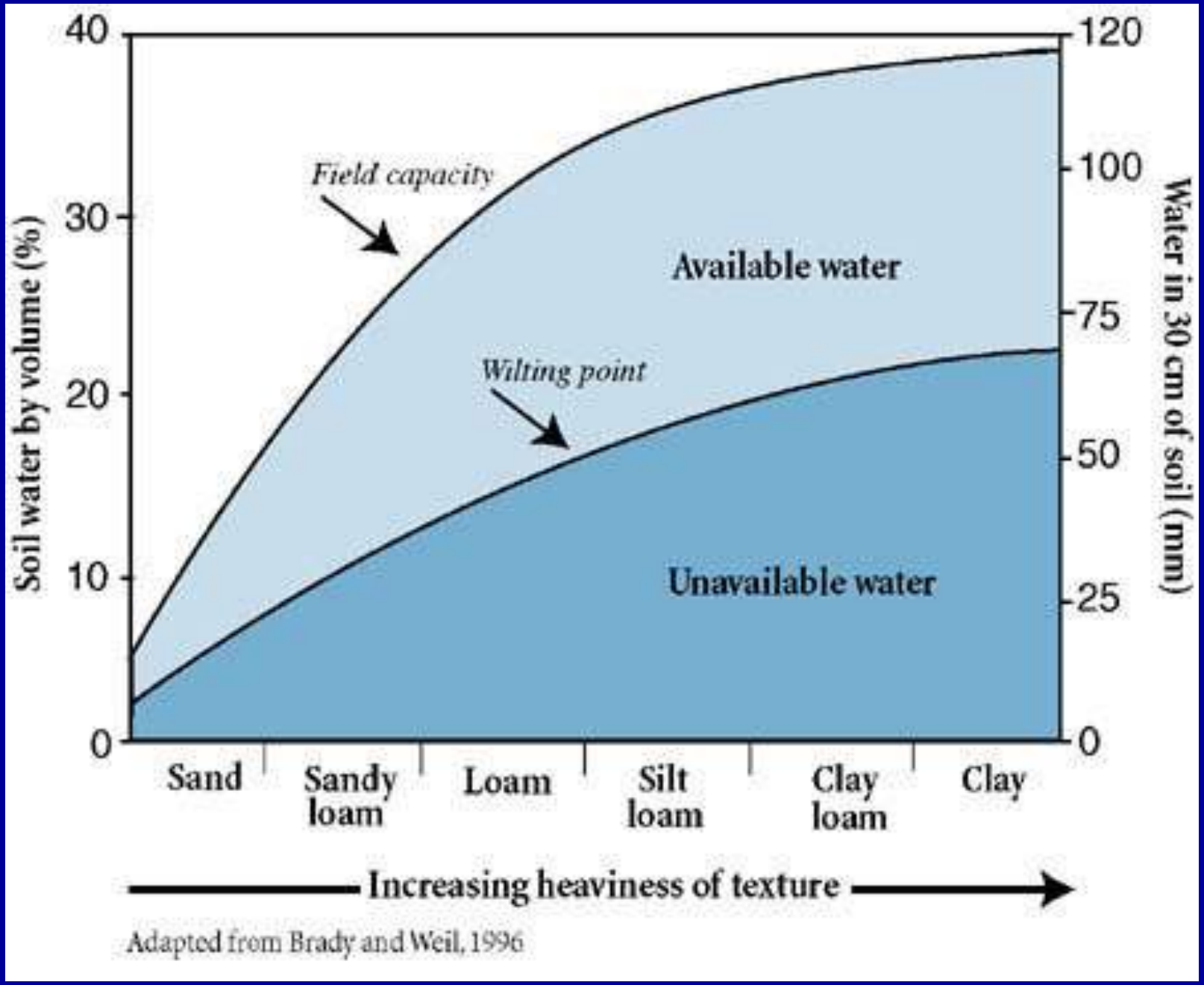
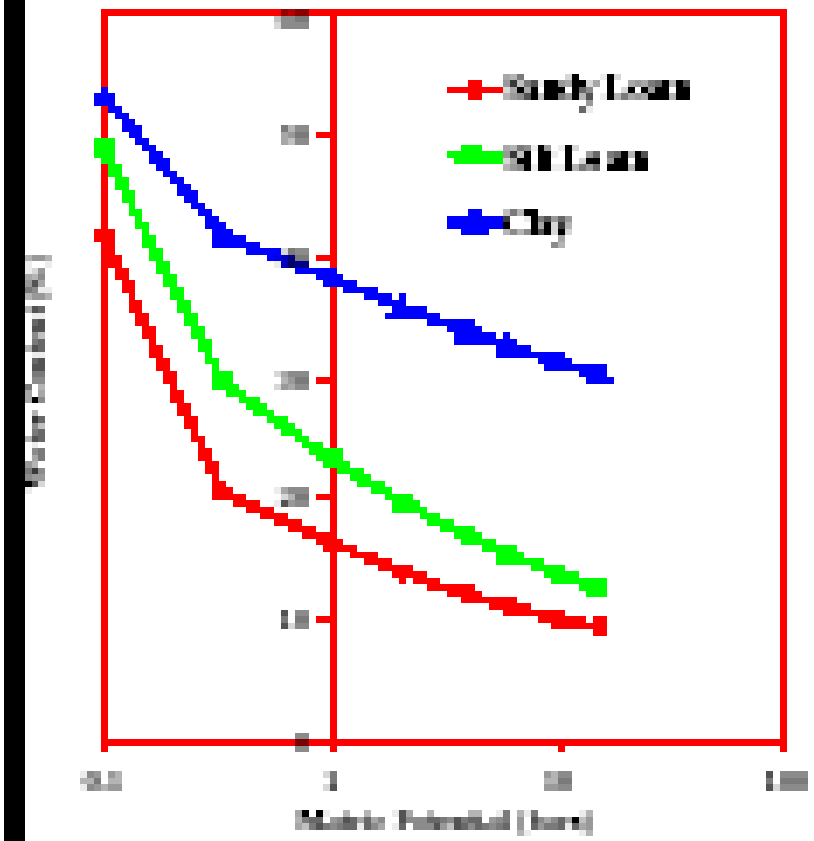
# Chloride Soil Tests and Chloride Recommendations

| | |
|---|---|
| < 4 ppm Cl | 20 lbs/A |
| 4 – 6 ppm Cl | 10 lbs/A |
| > 6 ppm Cl | 0 lbs/A |




Adapted from Brady and Weil, 1996

# Soil as a Reservoir




| Soil Type | A.W.C. (in/ft) | Extractable Water (in/4ft) |
|---|---|---|
| Silty Clay Loam | 1.6 | 6.4 |
| Silt Loam | 2.0 | 8.0 |
| Fine Sandy Loam | 1.8 | 7.2 |
| Sandy Loam | 1.4 | 5.6 |
| Fine Sands | 1.0 | 4.0 |

# WATER USE AND CROP YIELD

| CROP | INCHES FOR FIRST BUSHEL | YIELD PER IN. |
|---|---|---|
| WHEAT | 10.0 | 4.6 |
| MILO | 6.9 | 9.4 |
| CORN | 10.9 | 13.3 |
| SOYBEAN | 9.0 | 4.5 |
| SUNFLOWER | 5.4 | 150 |

KSU 2003

# Crop Water Use

| Crop | Inches of water for first bushel | Yield per Inch |
|---|---|---|
| Corn | 9.1 | 10.4 |
| Soybeans | 3.7 | 3.0 |
| Wheat | 5.2 | 4.7 |
| Millet | 3.5 | 237 lbs |
| Sunflower | 6.9 | 151 lbs |
| Canola | 6.2 | 171 lb |

Akron CO

# CRETE SOIL
# BUSHELS PER ACRE

| YEAR | CORN | BEANS | WHEAT |
|---|---|---|---|
| 1994 | | | 46 |
| 1995 | 66 | | 29 |
| 1996 | 108 | 36 | |
| 1997 | 85 | | |
| 1998 | | 30 | |
| 1999 | | | 64 |
| 2000 | 96 | | |
| 2001 | | 25 | |
| 2002 | | | 49 |
| AVER | 89 | 30 | 47 |

WARD FARM

# MUIR SILT LOAM
# BUSHELS PER ACRE

| YEAR | CORN | SOYBEANS |
|---|---|---|
| 1994 | | 67 |
| 1995 | 143 | |
| 1996 | 160 | |
| 1997 | | 45 |
| 1998 | 147 | |
| 1999 | 145 | |
| 2000 | | 40 |
| 2001 | 137 | |
| 2002 | 97 | |
| AVERAGE | 138 | 51 |

# MUIR SILT LOAM
# PERMEABILITY, INCHES/HR

| DEPTH | INCHES PER HOUR |
|---|---|
| 0-12” | 0.6 - 2.0 |
| 12-24” | 0.6 - 2.0 |
| 24-36” | 0.6 - 2.0 |

## 3 HR RAINFALL, POTENTIAL INCHES OF INTAKE

| | |
|---|---|
| 0-12” | 1.8 – 6.0 |
| 12-24” | 1.8 – 6.0 |
| 24-36” | 1.8 – 6.0 |
| | 5.4 – 18.0 |

# CRETE SILTY CLAY LOAM
# PERMEABILITY, INCHES/HR

| DEPTH | INCHES/HR |
|---|---|
| 0-12” | 0.2 – 0.6 |
| 12-24” | 0.06 – 0.6 |
| 24-36” | 0.06 – 0.6 |

3 HR RAINFALL, POTENTIAL

| | INCHES OF INTAKE |
|---|---|
| 0-12” | 0.6 – 1.8 |
| 12-24” | 0.18 – 1.8 |
| 24-36” | 0.18 – 1.8 |
| | 0.96 – 5.4 |

# INCHES AVAILABLE WATER

## CRETE SILTY CLAY LOAM

| DEPTH | INCHES OF WATER |
|---|---|
| 0-12” | 2.52 – 2.76 |
| 12-24” | 1.44 – 2.40 |
| 24-36” | 1.44 – 2.40 |
| 36-48” | 2.16 – 2.64 |
| | 7.56 – 10.16 |

# INCHES AVAILABLE WATER

## MUIR SILT LOAM

| DEPTH | INCHES OF WATER |
|---|---|
| 0-12” | 2.40 – 2.76 |
| 12-24” | 2.40 – 2.76 |
| 24-36” | 2.16 – 2.64 |
| 36-48” | 2.16 – 2.64 |
| | 9.12 – 10.80 |

# INCHES AVAILABLE WATER

## THURMAN LOAMY FINE SAND

| DEPTH | INCHES OF WATER |
|---|---|
| 0-12” | 1.20 – 1.44 |
| 12-24” | 1.20 – 1.44 |
| 24-36” | 0.72 – 1.32 |
| 36-48” | 0.72 – 1.32 |
| | 3.84 – 5.52 |

SOIL MOISTURE LOSS

½ TO ¾ INCH PER TILLAGE OPERATION

TILLING FOR A GROWING SEASON … WATER LOSS IS 2 – 2 ½ INCHES OF WATER

SOIL MOISTURE SAVINGS

RESIDUE 1 – 4 INCHES OF WATER INCREASE FROM STANDING