When do Plants Require Nutrients

Ray Ward

Ward Laboratories, Inc

Kearney, NE

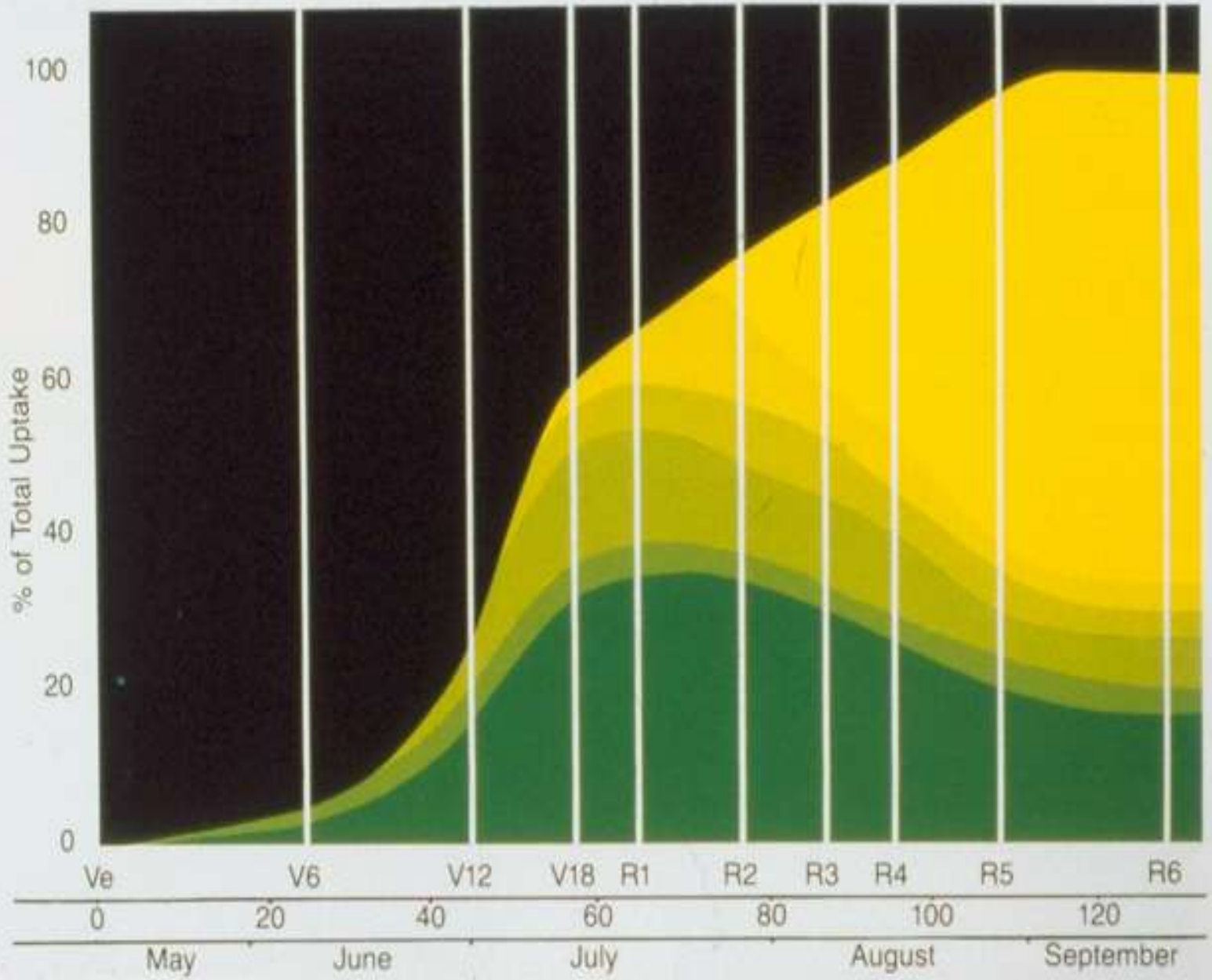
www.wardlab.com

"Guiding Producers Today to Feed the World Tomorrow"

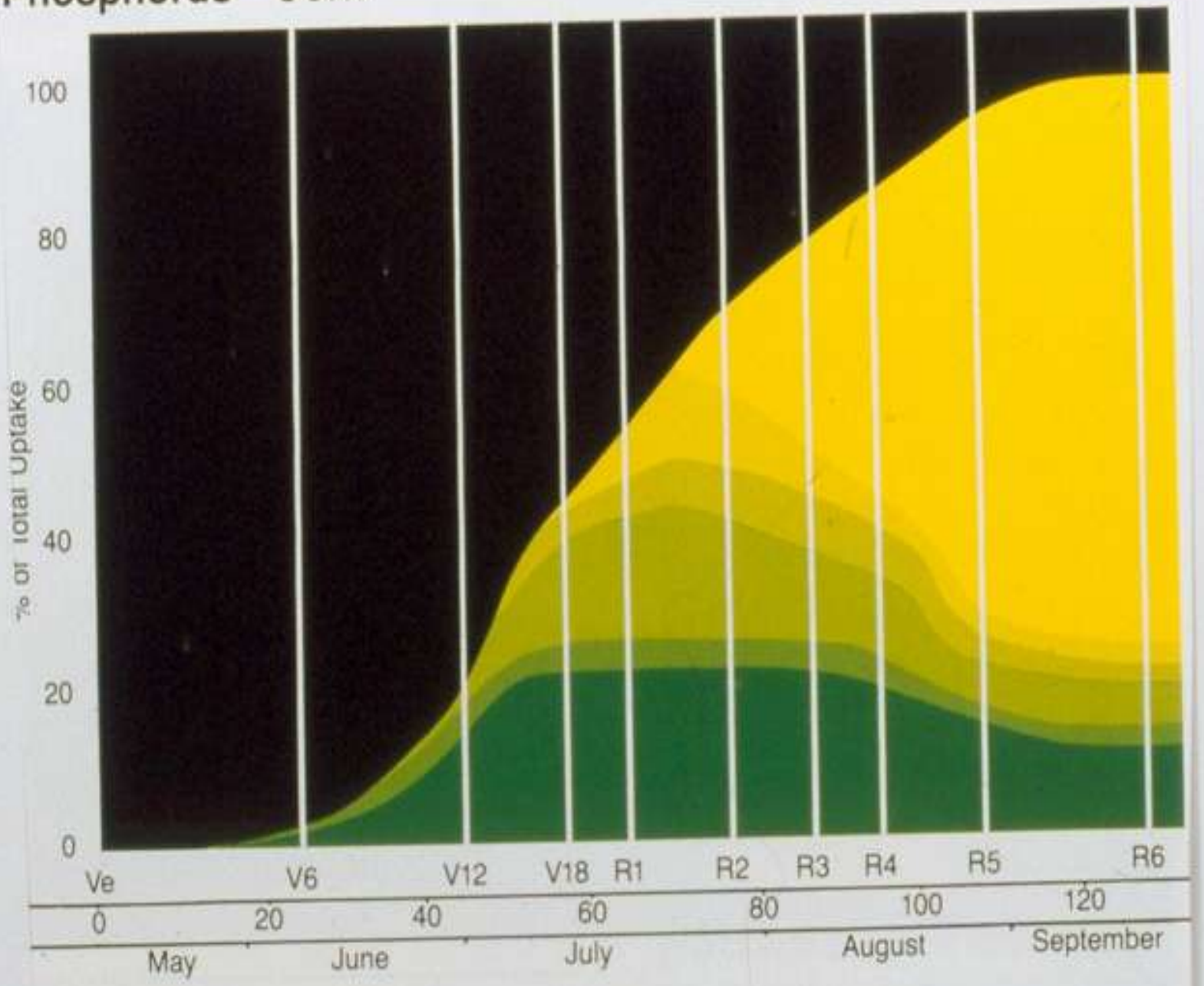
Topics

- Nutrient uptake during crop growth
- Total amount of nutrient mined out of the soil
- Mobile and Immobile soil nutrients
- What is the best soil test level

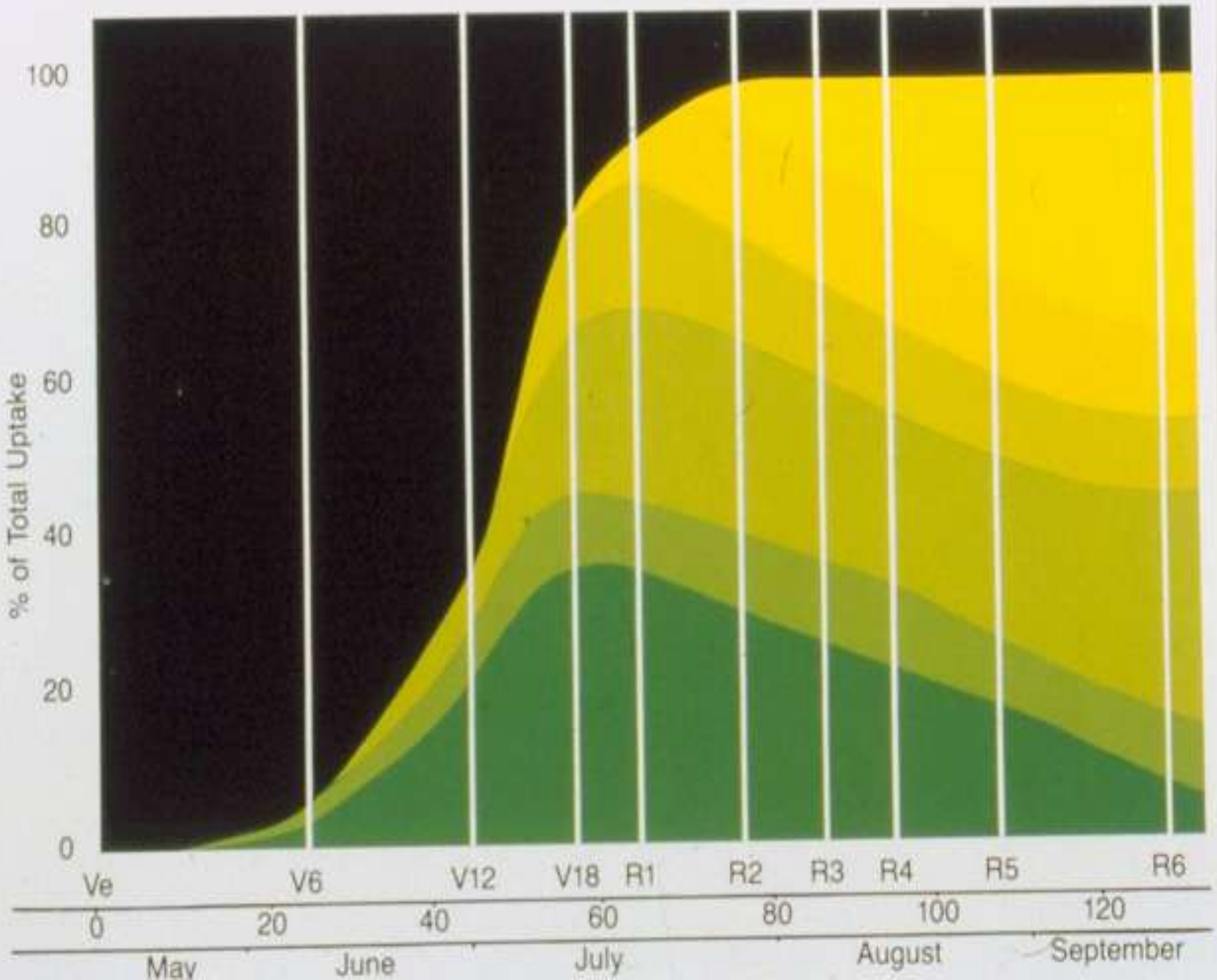
Nitrogen—Corn



Phosphorus—Corn



Potassium—Corn



Corn Growth Stages

Stage	Description
Vegetative	VE through VT
Silking	Pollination
Blister	Ear Development
Milk	"
Dough	"
Dent	
Black Layer	Maturity

Summary of Growth and Nutrient Uptake

Stage	DM	% N	% P	% K
V6	2	5	4	7
V12	17	27	22	35
V18	40	50	47	80
R1	45	65	52	90
R2	60	72	70	100
R4	80	88	82	100
R6	100	100	100	100

Wheat Growth Stages

Description
Crown is visible, tillers develop
Leaf sheaths elongate and form a false stem
Stem elongation. First internode visible
Tip of flag leaf visible (boot stage)
Heading
Flowering
Grain filling begins, lower leaves turn color

Summary of Growth and Nutrient Uptake

Stage	DM	% N	% P	% K
Leaf sheath	5	15	8	6
Jointing	10	32	20	16
Flag leaf	38	70	65	60
Heading	60	78	80	82
Flowering	70	80	88	95
Grain filling	85	81	95	100

WARD Laboratories, Inc.

WARD Laboratories, Inc.

Nutrient Mining, lbs/Bu WHEAT

Nutrient	lb/bu	60 bu/A
Nitrogen, N	1.2	72
Phosphorus, P2O5	0.52	31
Potassium, K2O	0.26	16
Sulfur, S	0.12	7
Zinc, Zn	0.003	0.18

Nutrient Mining, lbs/Bu WHEAT

Nutrient	lb/bu	60 bu/A
Chloride	0.07	4.2
Manganese	0.002	0.12
Copper	0.0007	0.04
Boron	0.001	0.06
Molybdenum	0.0004	0.02
Zinc, Zn	0.002	0.12

Nutrient Mining, lbs/Bu
CORN

Nutrient	lb/bu	200 bu/A
Nitrogen, N	0.75	150
Phosphorus, P2O5	0.33	66
Potassium, K2O	0.23	46
Sulfur, S	0.09	18
Zinc, Zn	0.001	0.2

Nutrient Mining, lbs/Bu
CORN

Nutrient	lb/bu	200 bu/A
Chloride	0.024	4.8
Manganese	0.0006	0.12
Iron	0.0012	0.24
Copper	0.0004	0.08
Boron	0.0006	0.12
Molybdenum	0.00001	0.002

Crop Nutrient Mining, lbs/bu
SOYBEAN

Nutrient	lb/bu	60 bu/A
Nitrogen, N	3.6	216
Phosphorus, P2O5	0.77	46
Potassium, K2O	1.2	72
Sulfur, S	0.18	11
Zinc, Zn	0.003	0.18

Crop Nutrient Mining, lbs/bu
SOYBEAN

Nutrient	lb/bu	60 bu/A
Chloride	0.016	1.0
Iron	0.005	0.3
Manganese	0.002	0.12
Copper	0.001	0.06
Boron	0.0006	0.04
Molybdenum	0.00001	0.0006

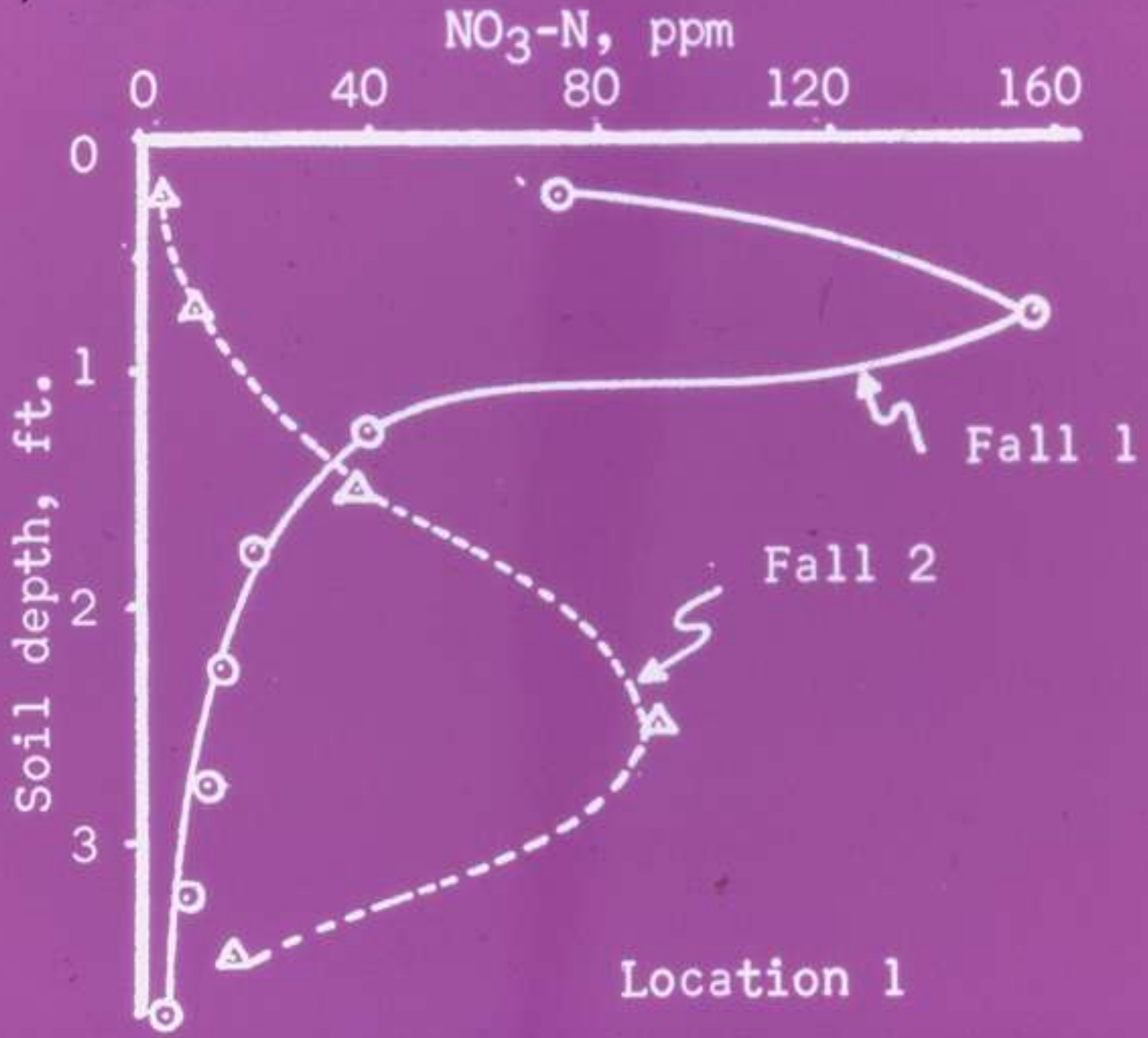
Soil Nutrients

Mobile Nutrients

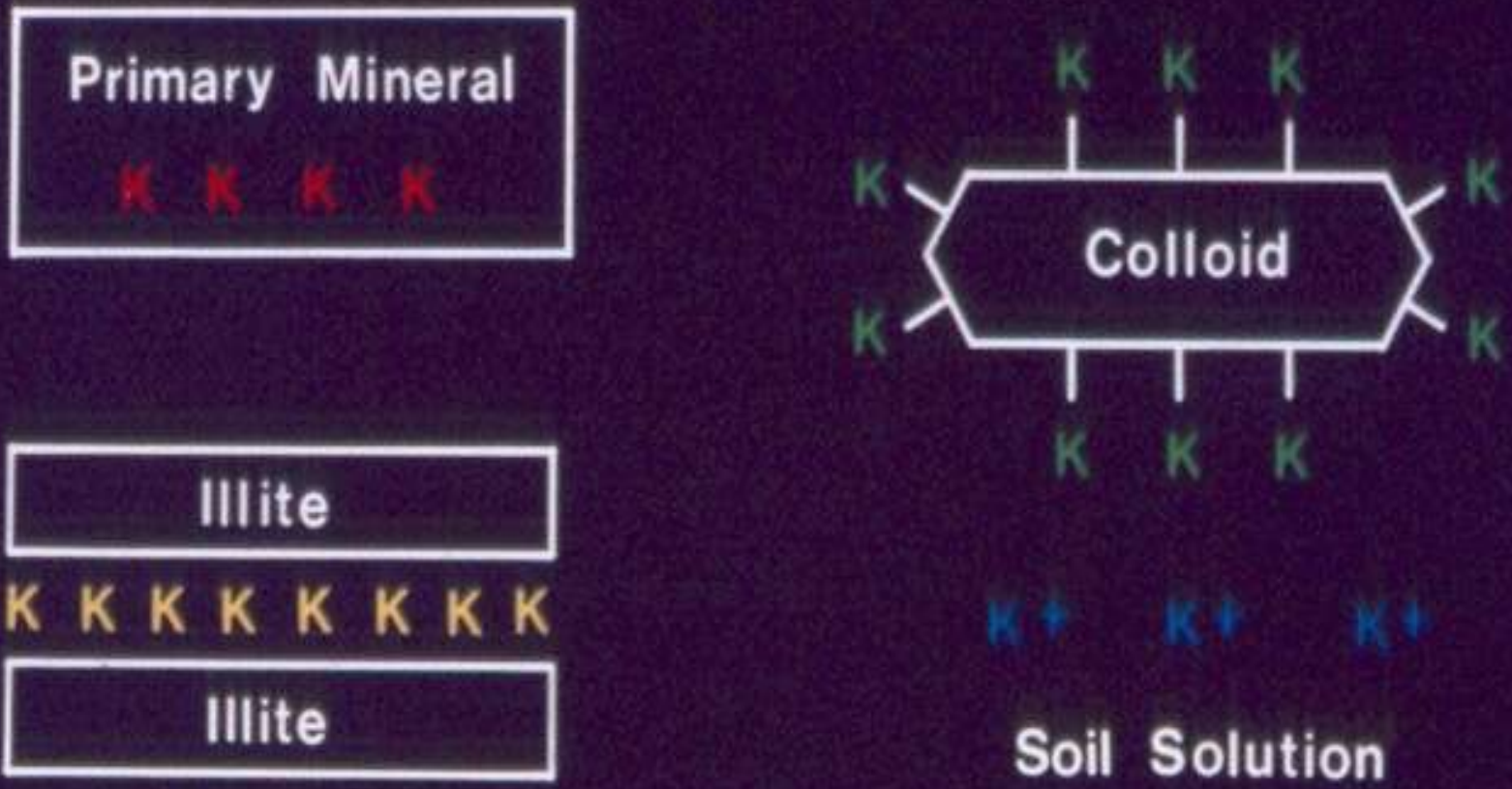
- Nutrients that are soluble in the soil
- Nitrate, Sulfate, and Chloride

Immobile Nutrients

- Nutrients that are attached to soil particles
- CEC and other surfaces
- Phosphorus, Potassium, Calcium, Magnesium, Zinc, Iron, Manganese, Copper, Boron, and Molybdenum


NO_3-N, ppm
0
40
80
120
160
Soil depth, ft.
0
1
2
3
Fall 1
Fall 2
Location 1

FOUR FORMS OF K



Timing of Fertilizer Application

Mobile Nutrients

If excess rainfall, the mobile nutrients can move below the root zone. Improve efficiency of the mobile nutrients

Best to split apply nitrogen and sulfate.

Apply some with the pre-plant/pre-emerge herbicide, apply some with the starter, and side-dress/top-dress rest of it.

Sulfur Deficiency - Corn

Chloride Deficiency

Timing of Fertilizer Application

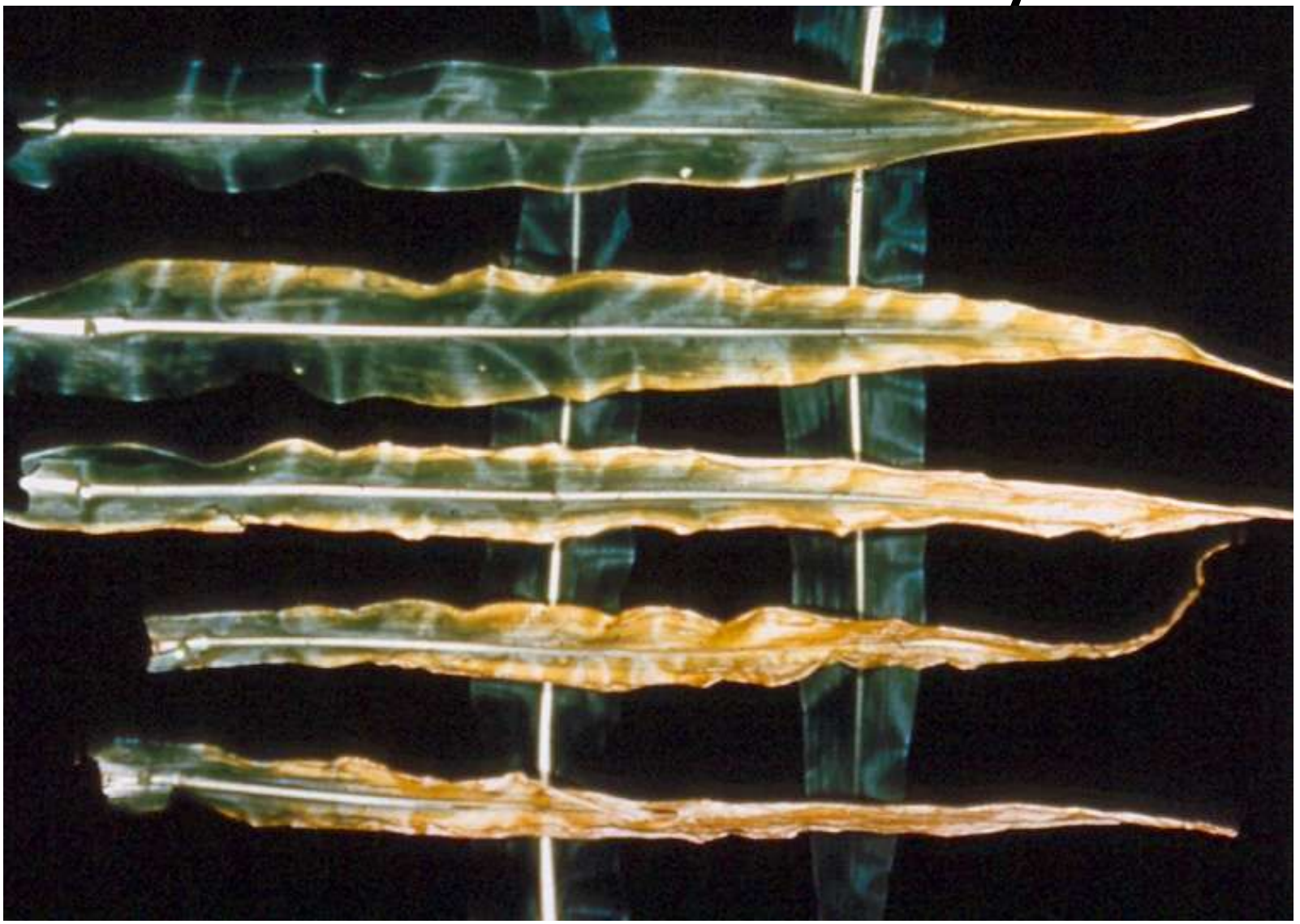
Immobile Nutrients

- Apply before planting
- Apply at seeding
- Applications after crop emergence may be helpful, but are more likely be used next year.

Phosphorus deficiency

Phosphorus Deficiency

Potassium Deficiency



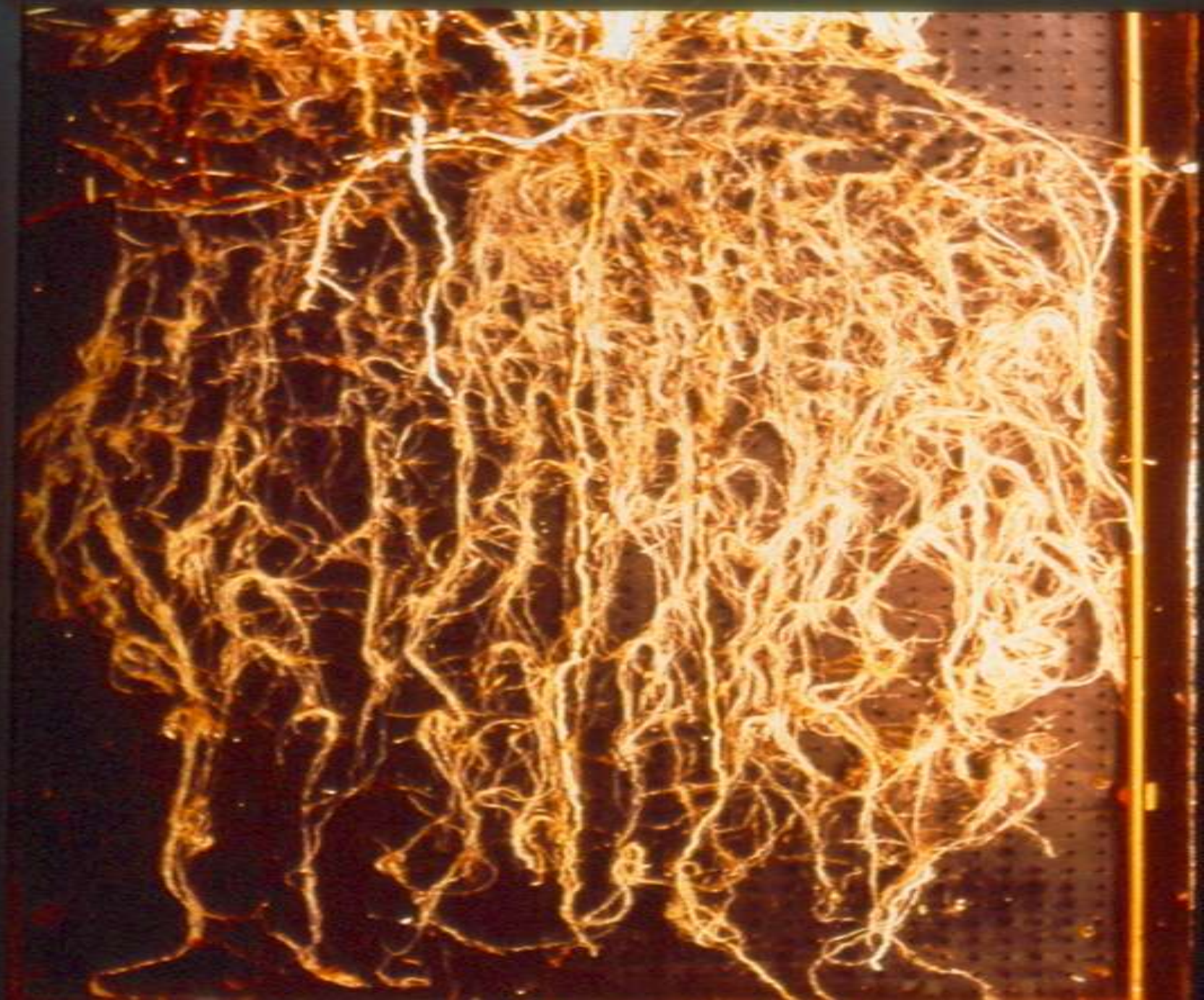
Zinc Deficiency

Iron Chlorosis

WARD Laboratories, Inc.

WARD Laboratories, Inc.

WARD Laboratories, Inc.



Which Interpretation is Correct?

- Depends on the Plant Nutrient
  - Mobile Nutrients like nitrate have to be managed annually
  - Immobile nutrients like phosphate and potash can be built up and maintained
- Depends on Land Tenure
  - Short term land leases dictate using the sufficiency approach
- Limited Resources
  - Cannot afford to build soil tests or fertilizer prices are high

Where are the Biggest Yields?

- Observations over the years I have concluded the best yields come from high-testing soils.
- Research in Canada with small grains has shown higher yields planted into high-testing soils than annual applications of fertilizer on low testing soils.
- Rothamsted Experiment station has demonstrated that yields were higher on high testing soils.

Crops and Soils, ASA

University of Minnesota, Corn

Application			Three-year	Corn Yield, bu/A
Method	Lb P2O5/acre		Low-P Soil	High-P Soil
None	0		148.0	192.8
Pop-up	25 (low) 20 (high)		158.1	191.6
Deep Band	25	20	157.7	196.4
Broadcast	25	20	166.4	196.2
Deep and Pop-up	50	40	171.5	189.0
Pop-up	50	40	165.7	194.5
Deep Band	50	40	166.0	186.4
Broadcast	50	40	167.0	190.2

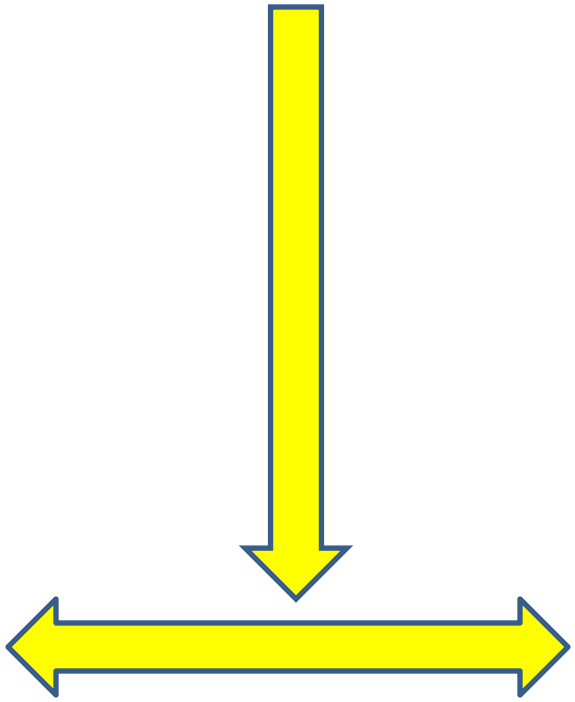
Best Soil Test Level

- Mobile Nutrients
  - Nitrate: Less than 5 ppm NO3-N in the soil at the end of the growing season.
  - Sulfate: Like to have in the 12-16 ppm SO4-S at the end of the season.
  - Chloride: Greater than 6 ppm Cl at the end of the growing season.

Best Soil Test Level

- Immobile soil nutrients
  - Phosphorus: 25 to 35 ppm P at the end of the growing season.
  - Potassium: greater than 200 ppm K.
  - Zinc: greater than 1.0 ppm Zn.
  - Copper: greater than 0.20 ppm Cu.
  - Boron: greater than 0.50 ppm B.

The Best Placement Method



Minimizing Fertilizer reaction with soil

Balance

Maximizing contact with roots