Phosphorus Deficiencies in Rice: Causes and Cures

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LSU AgCenter Research & Extension

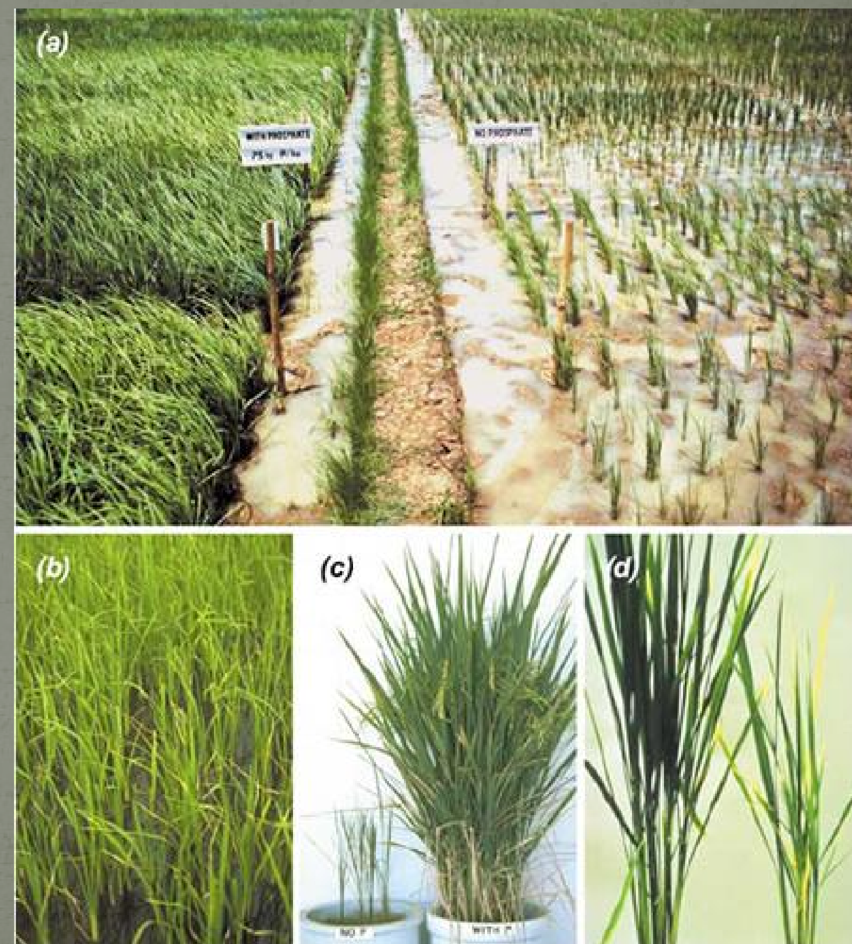
Why is phosphorus important?

- Nucleic acids
- Many metabolic functions w/in plant:
  - Energy storage and transfer
- Has been shown to promote:
  - Increased root growth
  - Early maturity
  - Increased straw strength
  - Crop quality
  - Disease resistance

Identifying P deficiencies in rice

- DIFFICULT
  - Hidden hunger
- Leaves/stems:
  - “dirty dark green”
  - purplish tint (anthocyanin)
- Tillering reduced
- Stunted/small/erect plants
- Slender stalks
- Grow/mature slowly
- death of older leaves

- Soil Testing
- Plant Analysis

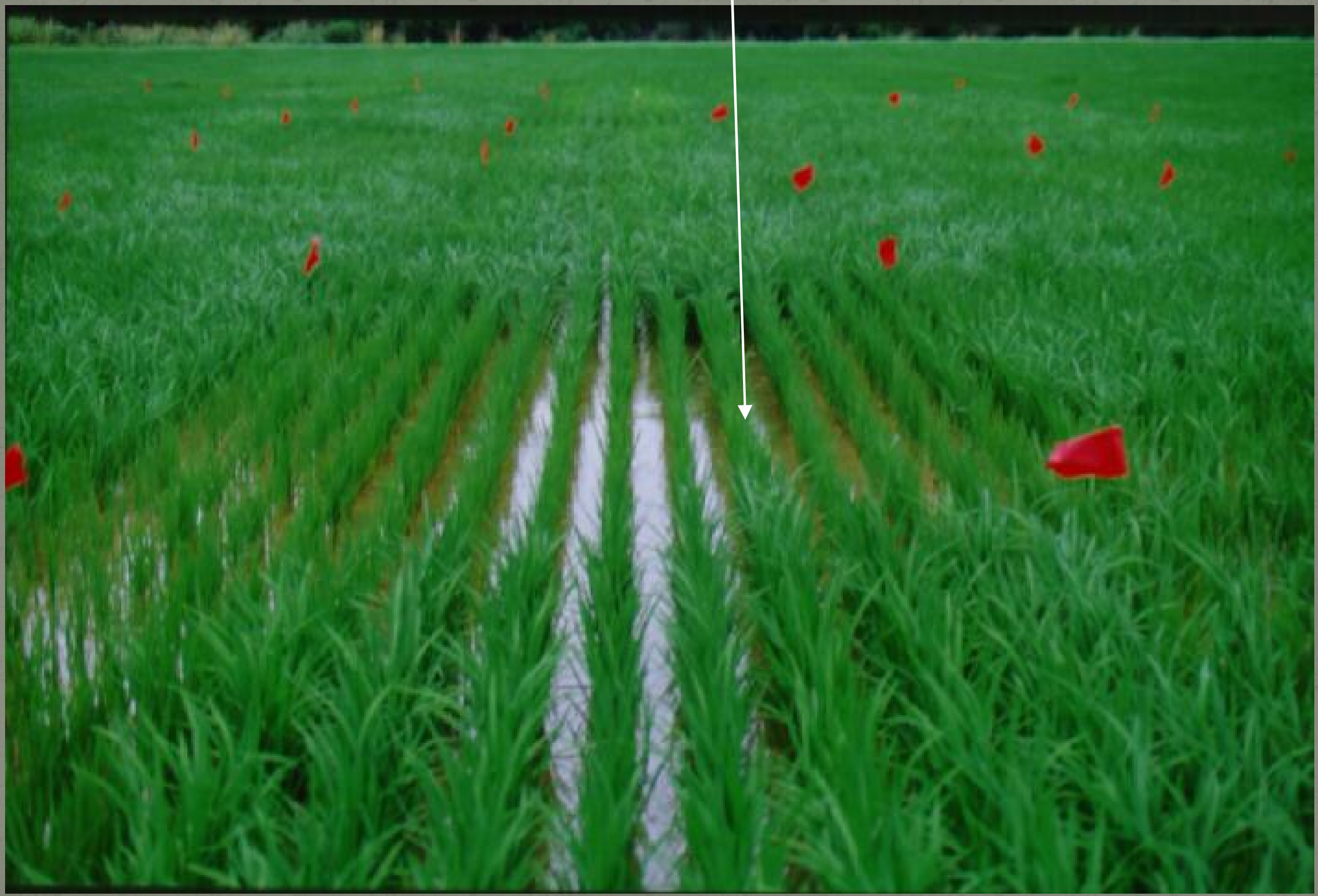


Source: Crop, Soil, and Water Sciences Division at IRRI

Rice - P

P-deficiency 14 DAF
Source T. M. Walker

P-deficiency 14 DAF



Source: T. Walker

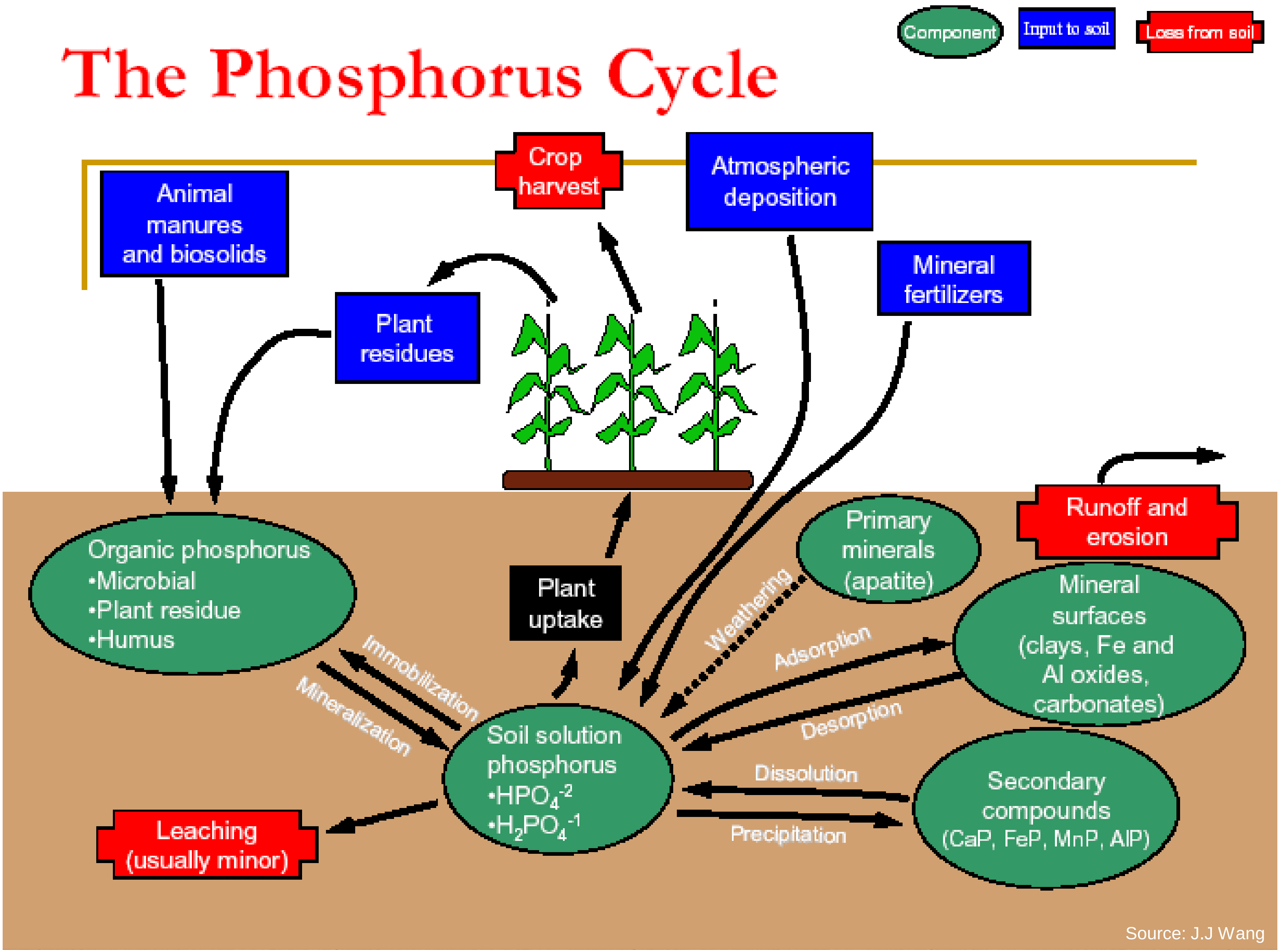
Stunted, dead rice plants, caused by P deficiency

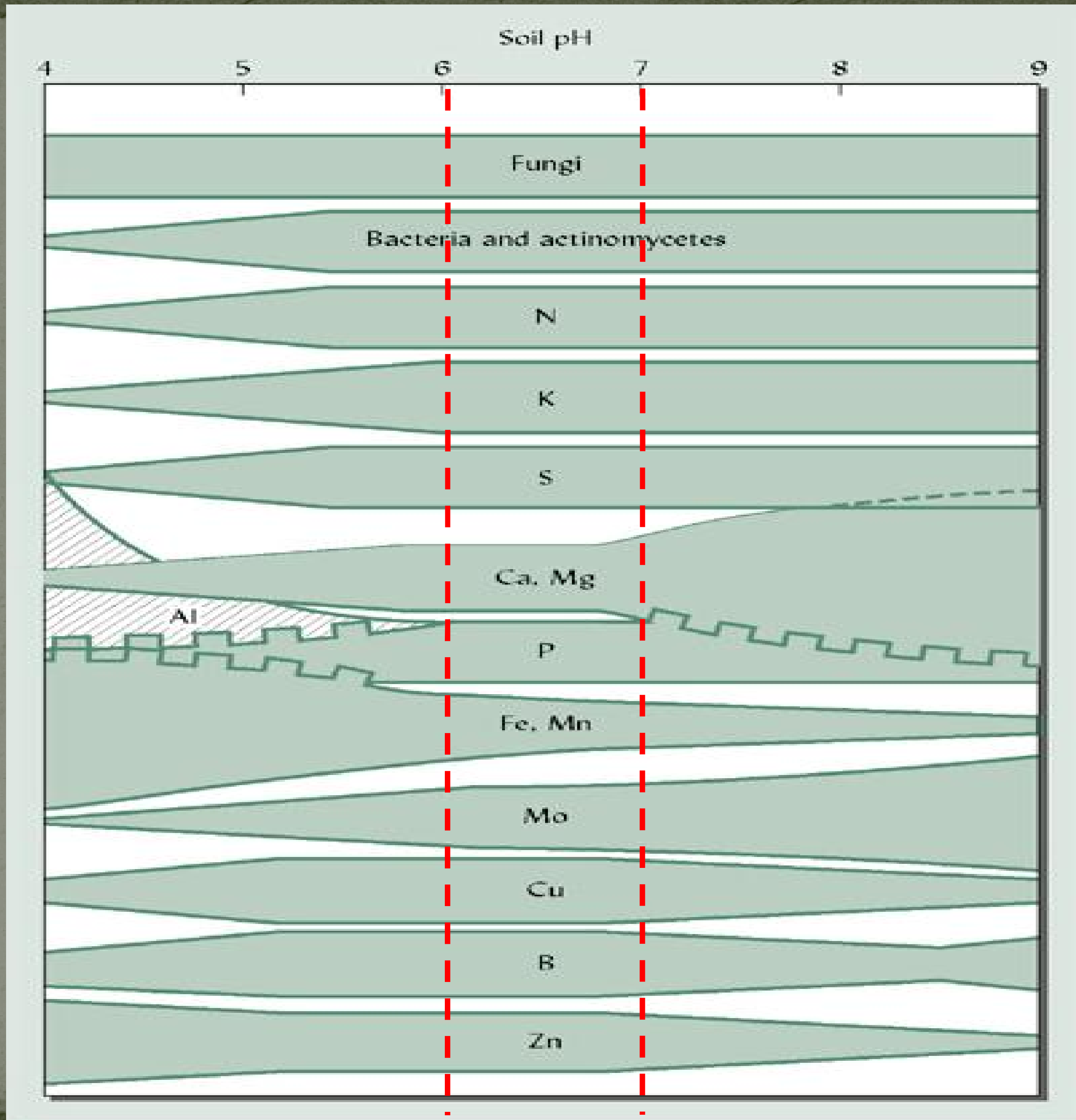
Source: D. M. Brandon

Premature necrosis of rice leaves due to P deficiency

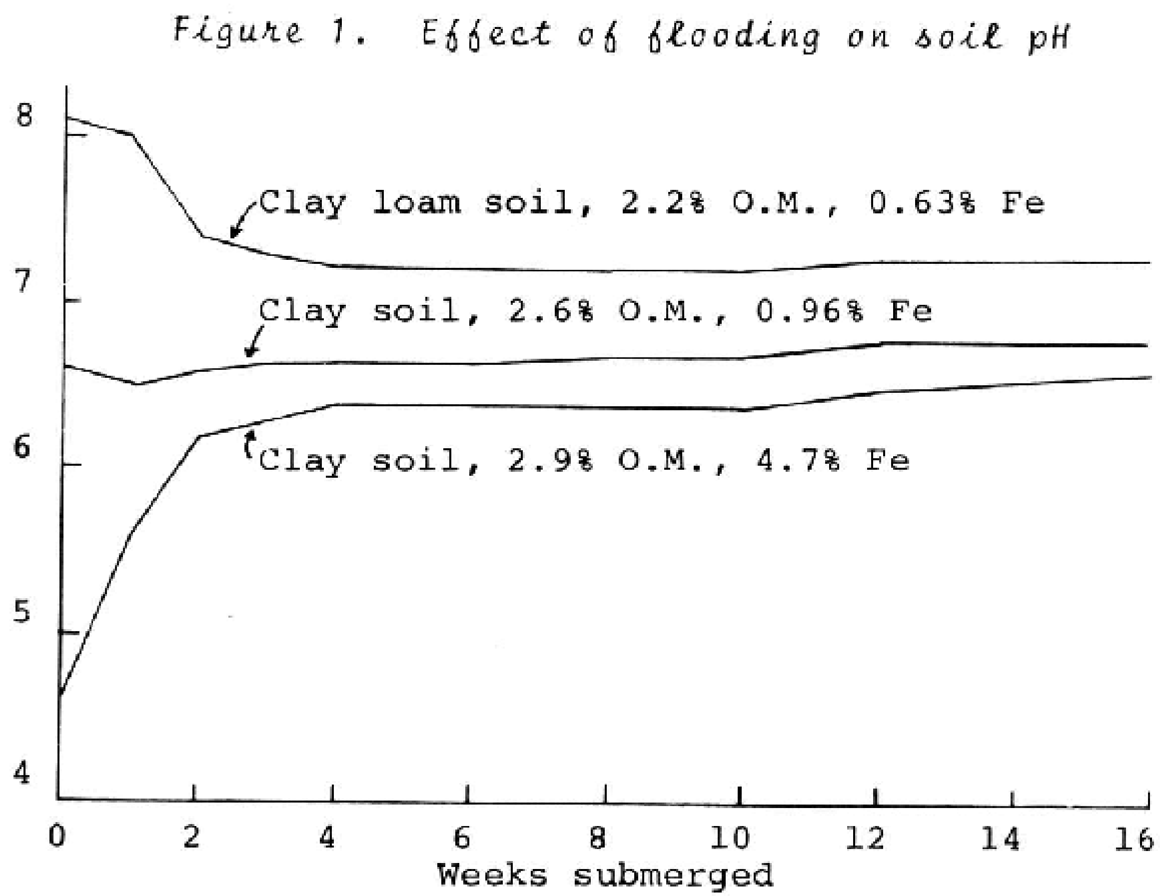
Source: B.R. Wells, B.A. Huey, R.J. Norman, S. Helms

The Phosphorus Cycle




Soil pH
4
5
6
7
8
9
Fungi
Bacteria and actinomycetes
N
K
S
Ca, Mg
Al
P
Fe, Mn
Mo
Cu
B
Zn

Figure

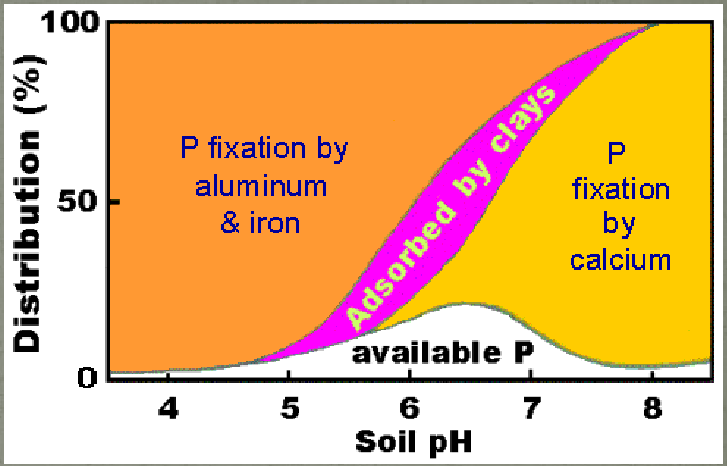


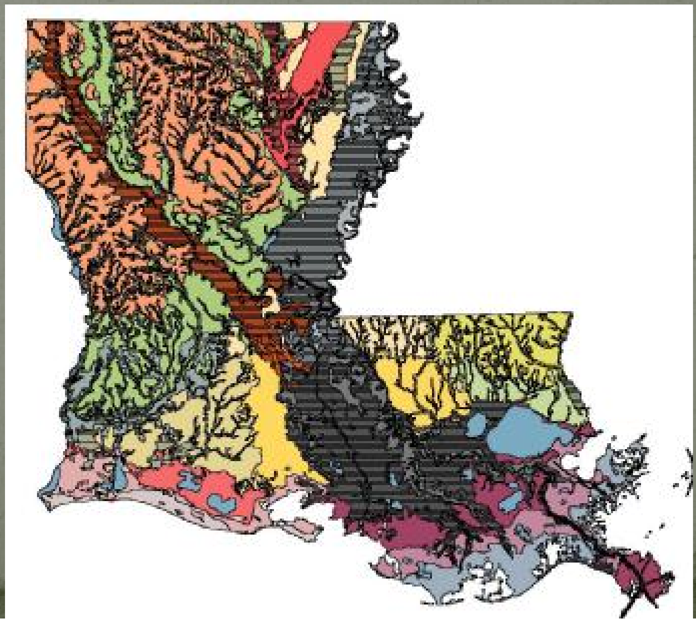
Taken from The Chemistry of Submerged Soils
Ponnamperuma, Advances in Agronomy, 1972

Phosphorus availability in rice soils

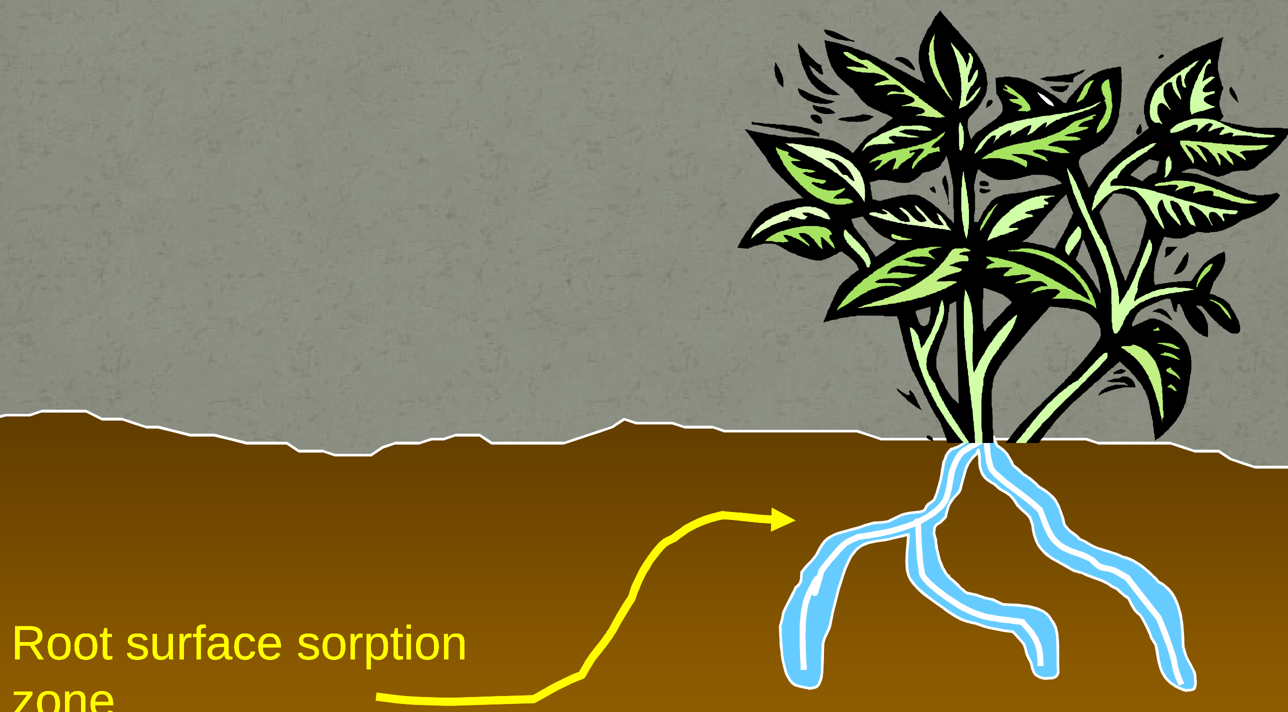
- Acid soils:
  - Fe and Al-P
  - Permanent flood
    - ↑pH
    - ↑ P availability

- Calcareous soils:
    - Ca-P
  - Permanent flood
    - ↓pH
    - P availability slightly increased



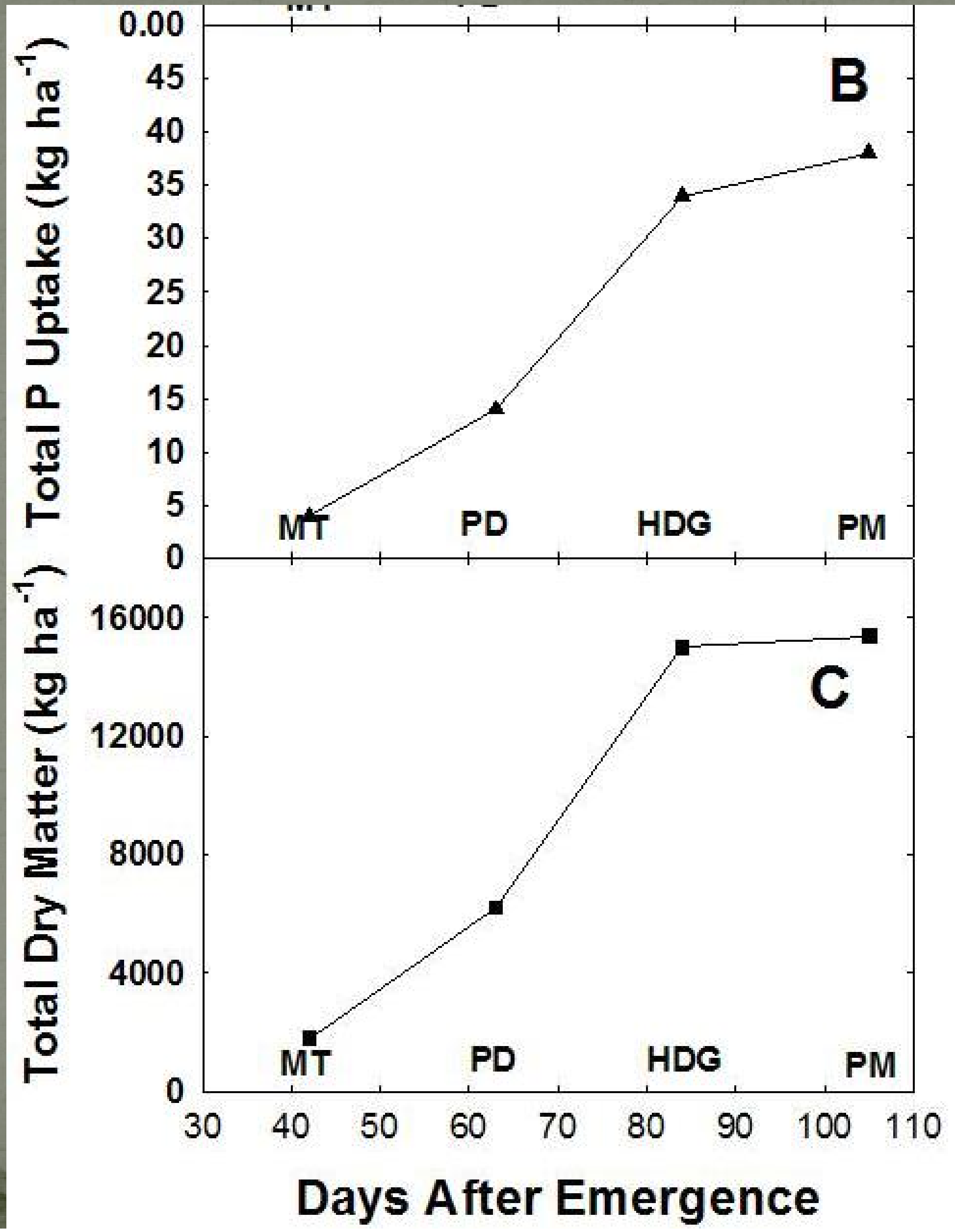


Phosphorus uptake



“How little does P actually move? If the P in a loamy soil is more than ¼” from a root, it will not move close enough to be taken up by the root.” *Soil Fertility Manual*, IPNI

When does rice take up P



Does the timing of P applications make a difference?

- Not as important as N
  - Pre-flood as effective as pre-plant applications
  - Pre-flood apps can actually save money

- For soils with severe P def.
  - Splitting 50% pre-plant and 50% pre-flood have been utilized successfully

TABLE 3.4.7. Influence of P Application Timing on Rice Grain Yields

Time of P Application	Rice Grain Yield (kg/ha)			
	Davis Farm		Wimpy Farm	
	1997	1998	1997	1998
Control	6372	7222	7665	6953
Preemerge	7656	7561	8196	6760
Preflood	7204	7868	8579	7011
Postflood (7 days)	7914	7839	9416	6873
Panicle differentiation	6612	7420	8198	6713
$LSD_{0.05}$	806	512	574	n.s.
Soil test P (kg/ha)	10	17	28	20
Soil pH	7.6	6.8	8.0	7.7

Source: Data from Wilson et al. (1999).

Can I cut back (skip) on P fertilizer?

- Base P fertilizer decisions on recent soil test results.

- Apply at recommended rates :
  - 0 - 60 lb/A P_2O_5

A 7000 lb/A rice crop takes up 60 lb/A P_2O_5. (grain ≈ 42 lb/A; straw ≈18 lb/A)

What should I do when I see plant deficiency symptoms?

Make sure P is the problem: Plant analysis

1. Sample both healthy and deficient rice plants
2. Send to LSU AgCenter STPAL
3. Review laboratory results:
   - Whole plant:
   - <0.15% @ mid-tillering

4. If needed, apply salvage P application

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What P sources are available?

- Triple super phosphate (TSP)
  - 0-46-0
  - $455 / ton
  - $0.49 / lb P_2O_5
  - @ 60 lb rate: $29.40 / A

- Diammonium phosphate (DAP)
  - 18-46-0
  - $492 / ton
  - $0.53 / lb P_2O_5
  - @ 60 lb rate: $31.80 / A

  - Plus 10.8 lb N / A
    - ($0.22 lb / N as compared to $0.47 for urea N)
    - Good starter fertilizer

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Prices based on prices quoted on 2/10/2010, Crowley, LA

New composite fertilizer available

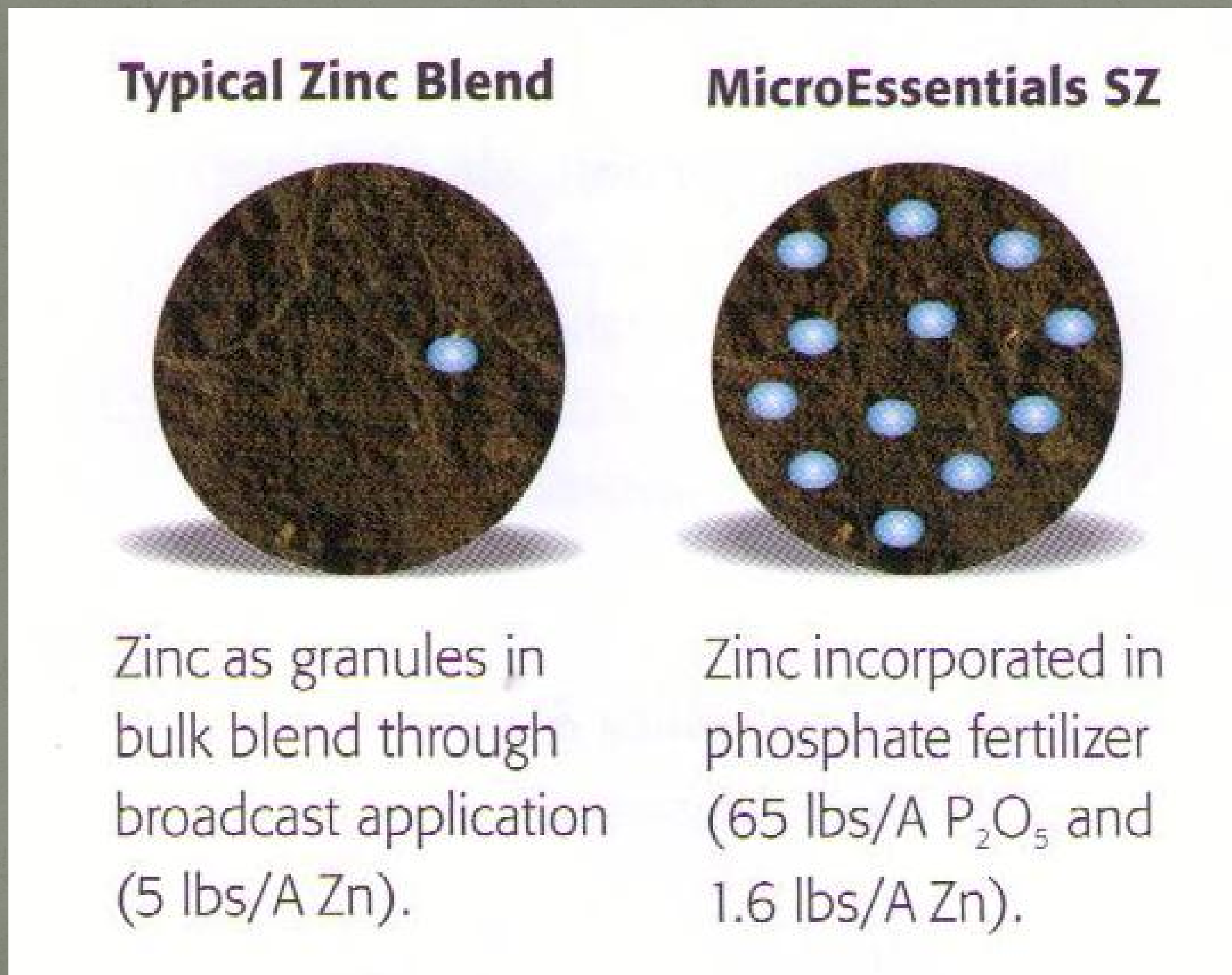
MicroEssentials™ SZ

- 12% N
- 40% P_2O_5
- 10% S
- 1% Zn

Backscattered electron cross sectional image of MicroEssentials SZ

Granules showing sulfur distribution in white.

Distribution of S and Zn the advantage



Cost comparison

MicroEssentials™ SZ	DAP
– 12% N	– 18% N
– 40% P_2O_5	– 46% P
– 10% S	
– 1% Zn	
– Cost ≈ \$422/ton	– Cost ≈ \$492/ton
– 20 lb Zn, 200 lb S	

Polymer coating

- charge

Ca, Fe, Mg, Al…

Trial ID: 7405

Location: Drew

Crop Code				ORYSA
Crop Variety				CL161
Part Rated				GRAIN
Rating Data Type				YIELD
Rating Unit				LB/A
Rating Date				16/Sep/05
Trt No.	Treatment Name	Rate	Rate Unit	
01	UTC			6978.2 b
02	10-34-0			7538.3 a
03	10-34-0 0.5% AVAIL v/v			7461.2 a
04	10-34-0 1.0% AVAIL v/v			7504.1 a
05	10-34-0 1.5% AVAIL v/v			7312.8 a
LSD (P=.05)				280.40
Standard Deviation				181.99
CV				2.47
Grand Mean				7358.92
Replicate F				4.237
Replicate Prob(F)				0.0294
Treatment F				6.364
Treatment Prob(F)				0.0055

Means followed by same letter do not significantly differ (P=.05, LSD)

6 site years…
no response

Table 2. Soybean seed yield as affected by P source and P application rate for a P fertilization trial in Poinsett County, AR.

P Fertilizer Source	P application rate (lb P_2O_5/acre)				Source mean
	0	50	100	150	
	Bushels/acre (13% moisture)				
UTC	58.6†	--	--	--	58.6
Polymer MAP	--	63.6	65.2	65.3	64.6
MAP	--	63.9	65.6	73.5	67.3
Rate Mean	**58.6**	**63.7**	**65.4**	**69.4**	--
C.V., %			8.0		
Source P-value, 0.1149		Rate P-value, 0.0564		Interaction P-value, 0.1332	

† *n* = 12, yields averaged across two controls that received 0 or 30 lb N/acre as urea.

Rice: 2 yr 2 loc …no response

Response of Rice Yields to Phosphorus Fertilizer Rates and Polymer Coating

David J. Dunn and **Gene Stevens,** Missouri Agricultural Experiment Station, Delta Research Center, University of Missouri, Portageville 63873

Table 2. Effect of phosphorus rate using triple super phosphate (TSP) and polymer coating on rice yield and net return averaged across years at Qulin, MO.

P rate (P_2O_5, lb/acre)	**Yield** (bu/acre)*		**Net return** ($/acre)	
	TSP	TSP + polymer	TSP	TSP + polymer
0	134 d	—	603 c	—
25	143 c	150 ab	637 b	668 a
50	149 bc	151 ab	658 ab	666 a
100	154 a	154 a	668 a	665 a

* Yield values followed by the same letter were not significantly different at the *P* = 0.1 level.

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