Phosphorus: Rice Fertilization and LSU AgCenter Soil Testing Changes

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Topics of Discussion

- Phosphorus
  - Importance
  - Soil forms
  - Rice deficiencies
  - soil testing/plant analysis
  - P fertilization

- LSU AgCenter STPAL
  - Reporting format changes
  - Additional tests added

Why is phosphorus important?

- **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

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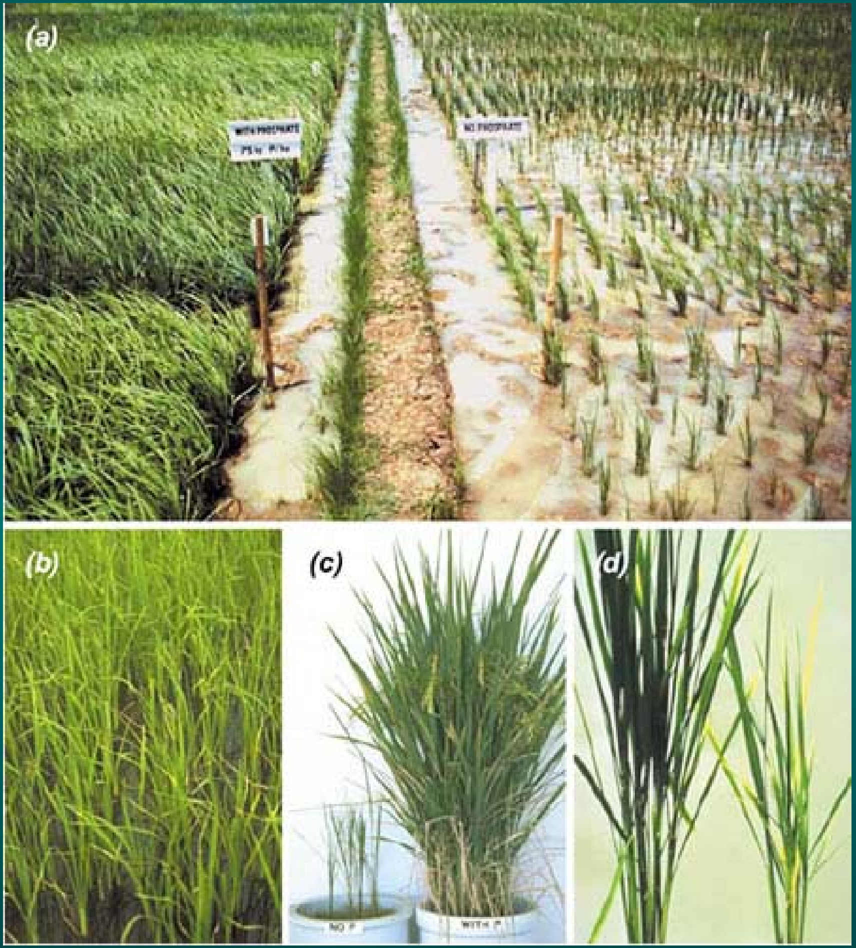
Identifying P deficiencies in rice

- Leaves/stems:
  - "dirty dark green"
  - purplish tint (anthocyanin)
- 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

Effect of P deficiency

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

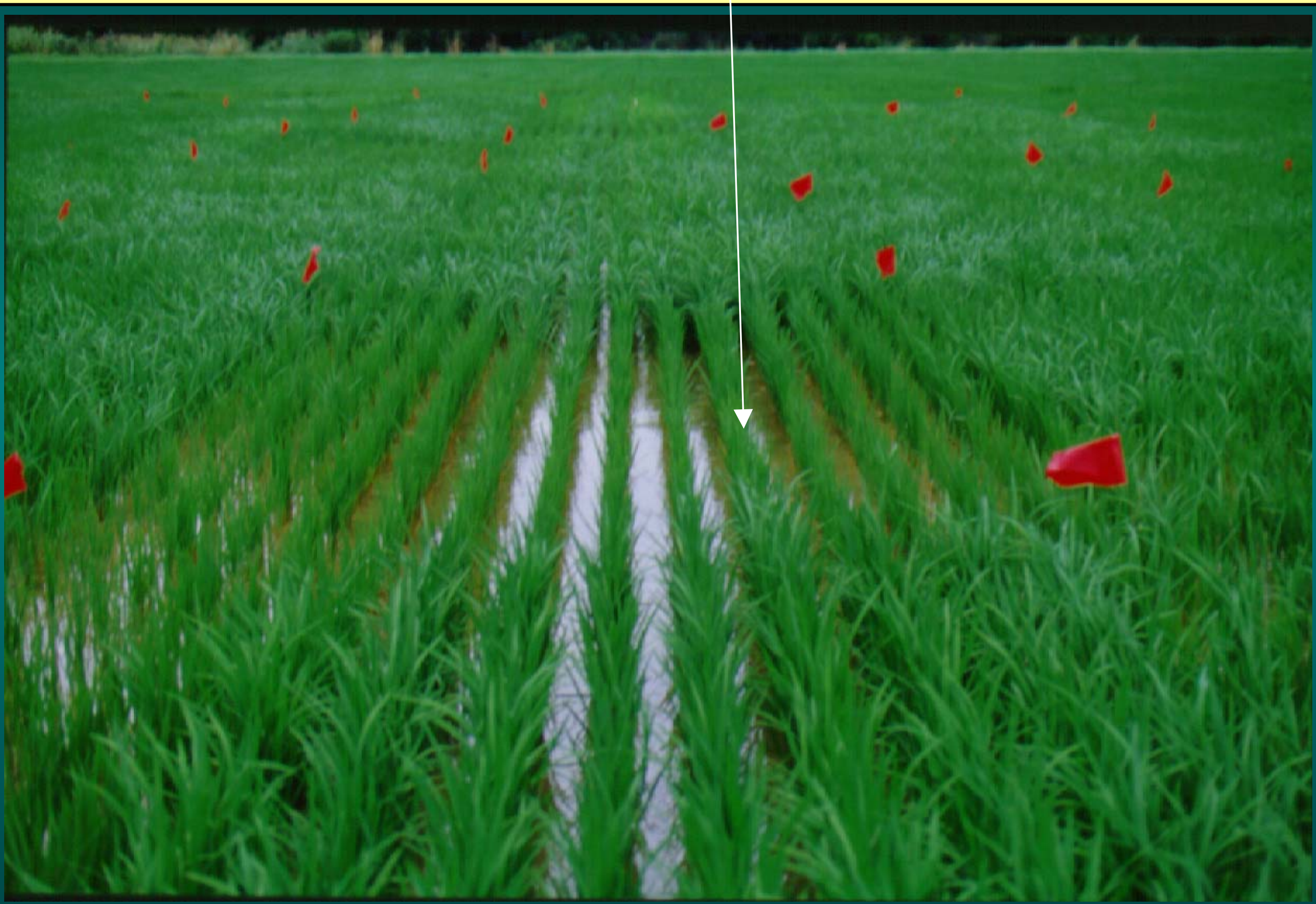
Premature necrosis of rice leaves due to P deficiency

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

Stunted, dead rice plants, caused by P deficiency

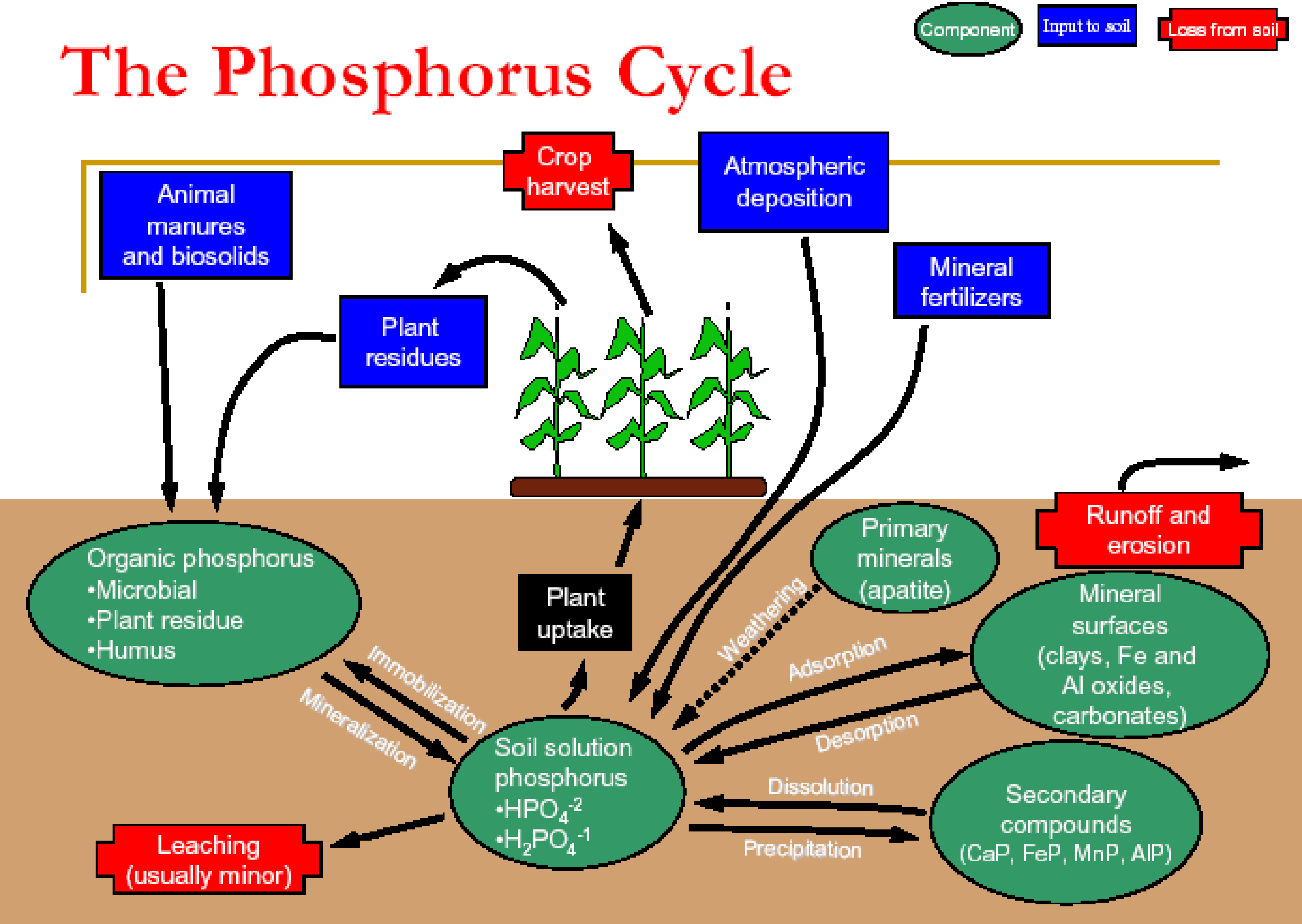
Source: D. M. Brandon

P-deficiency 14 DAF



Source: T. Walker

The Phosphorus Cycle

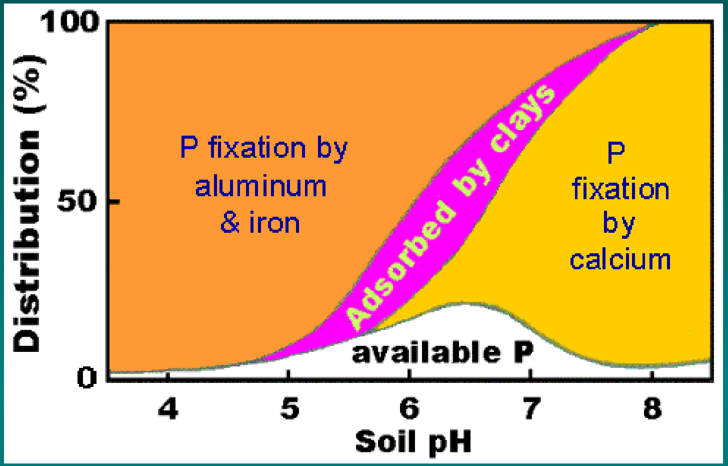


Source: J.J Wang

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 unchanged



Many Soil Test for Phosphorus

- Bray 1
- Bray 2
- Mehlich 1
- Mehlich 2
- Mehlich 3
- AB-DTPA
- Citric Acid
- Morgan
- Lancaster
- Olsen
- Truog

Each method estimates available P however…
- concentrations/soil test P values differ
- Must be calibrated with Louisiana soils

Know where your soil test P value came from

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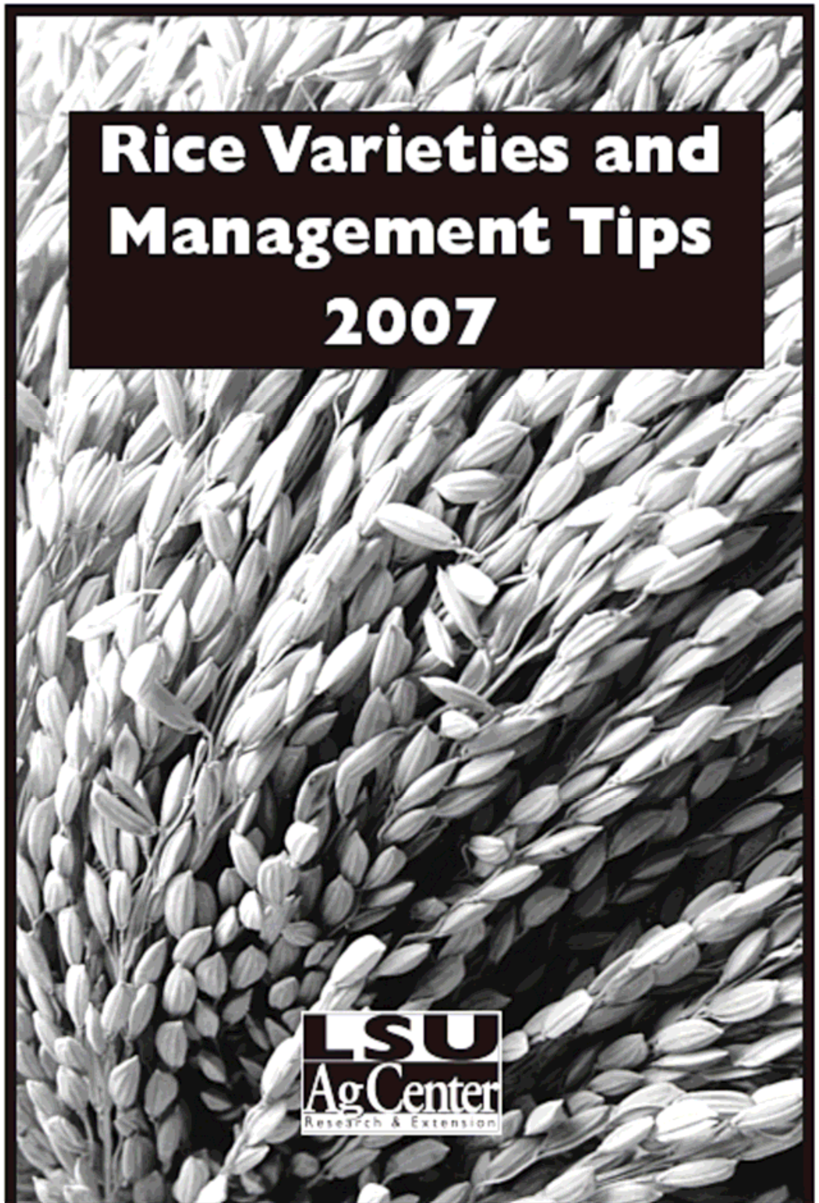
Soil Testing for Phosphorus

- LSU Soil Testing and Plant Analysis Lab
  - Changed to the Mehlich III soil test on August 19, 2005
    - Multi-element extraction
    - Rice plant essential nutrients effected: P, K, Zn, S, Fe



LSU AgCenter Soil Testing

For those of you who use the LSU AgCenter Soil Testing and Plant Analysis Laboratory, you may have noticed a major decline in your soil test phosphorus results. Do not be alarmed. This decline was not a mistake made by the laboratory but simply a change in the chemical extraction method used by the laboratory. The Mehlich III soil test extraction was adopted by the laboratory on August 19, 2005, replacing the Bray II phosphorus extraction. In general, the Mehlich III soil test phosphorus level will be approximately one-half of the phosphorus extracted by Bray II and is also dependent on the calcium content of the soil. One of the many reasons for the change was to provide consistency between soil testing procedures used by land-grant soil testing laboratories. Currently, soil test calibration studies are being conducted on the major rice-producing soils across the state in an effort to validate and improve phosphorus fertilizer recommendations for improved rice varieties.

The Mehlich III soil test is a multi-element extraction. Therefore, it is not only replacing the Bray II soil test for phosphorus, it is also replacing other soil tests previously used by the laboratory. Of the nutrients important to rice, potassium (K), zinc (Zn) and sulfur (S) will be affected. The following tables can be used to evaluate the fertility status of you soil. Generally, if your soil test results fall into the very low, low or medium categories, fertilizer applications would be recommended to increase rice yields.

Table A. Soil test S and Zn ratings based on the Mehlich III soil test for all soil types and textures.

Nutrient	Low	Medium	High
		ppm	
S	<12	12–16	>16
Zn	<1.00	1.00–2.25	>2.25

Table B. Soil test K ratings based on the Mehlich III soil test.

Soil Type	Texture	Very Low	Low	Medium	High	Very High
Alluvial				ppm		
	clay, silty clay	<114	114–182	183–227	228–273	>273
	clay loam, silty clay loam	<91	91–136	137–182	183–205	>205
	loam and silt loam	<57	57–91	92–136	137–159	>159
	sandy loam	<45	45–80	81–114	115–136	>136
Upland						
	clay, silty clay	<114	114–182	183–227	228–250	>250
	clay loam, silty clay loam	<57	57–102	103–148	149–170	>170
	loam and silt loam	<57	57–91	92–136	137–159	>159
	sandy loam	<45	45–80	81–114	115–136	>136

Current LSU Recommendations

- Multiple linear regression equation used for P
  - Bray II-P = -33.97 + 1.56 (M3-P) + 0.033 (M3-Ca)
- Must be calibrated for Louisiana soils! – Rice

Soil Test Level	Soil test P (Bray II)	Fertilizer Recommendation lbs P_2O_5/A
	---ppm---	
VL	<20	60
L	20 - 40	40
M	41 - 60	20
H	61 - 80	0
VH	>80	0

Don't be alarmed…

Soil Test Results

2005

Element	Value	Centipede
pH	6.19	High
Phosphorus, ppm	169.58	Very High
Potassium, ppm	52.36	Low
Calcium, ppm	767.92	Low
Magnesium, ppm	113.21	Medium
Sodium, ppm	19.55	Optimum

Soil Test Results

2007

Element (Mehlich3)	Value	Rice
pH (1:1 Water)	6.04	High
Phosphorus, ppm	87.23	Very High
Potassium, ppm	272.87	Very High
Calcium, ppm	1,037.23	Medium
Magnesium, ppm	388.09	Very High
Sodium, ppm	416.17	Excessive
Sulfur, ppm	82.13	High
Copper, ppm	1.34	High
Zinc, ppm	17.18	High

Extractants used for soil P test in southern rice producing states

- **Arkansas: Mehlich 3**
  - prev. lower soil: solution ratio
- **Louisiana: Mehlich 3**
  - prev. Bray 2
- **Mississippi: Mehlich 3**
  - Currently Lancaster
- **Texas: Mehlich 3**
  - prev. NH_4OAc-EDTA

Bulletin 190C and Fact Sheet, 2005

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When should you fertilize with P?

1. Soil test

2. Altered by land-forming
   - especially where deep cuts were made

http://www.swep.com.au/Filtration.JPG

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
   - Y-leaf:
     - CL between 0.14 and 0.27% @ mid-tillering
     - CL between 0.18 and 0.29% @ PI
4. If needed, apply salvage P application

What P sources are available?

- Triple super phosphate (TSP)
  - 0-46-0
  - $256.50 / ton (September 06)
  - $0.28 / lb P_2O_5
  - @ 60 lb rate: $16.8 / A

- Diammonium phosphate (DAP)
  - 18-46-0
  - $297.50 / ton (September 06)
  - $0.32 / lb P_2O_5
  - @ 60 lb rate: $19.2 / A
  - 10.8 lb N / A
    - ($0.22 lb / N as compared to $0.32 for urea N)
    - Good starter fertilizer

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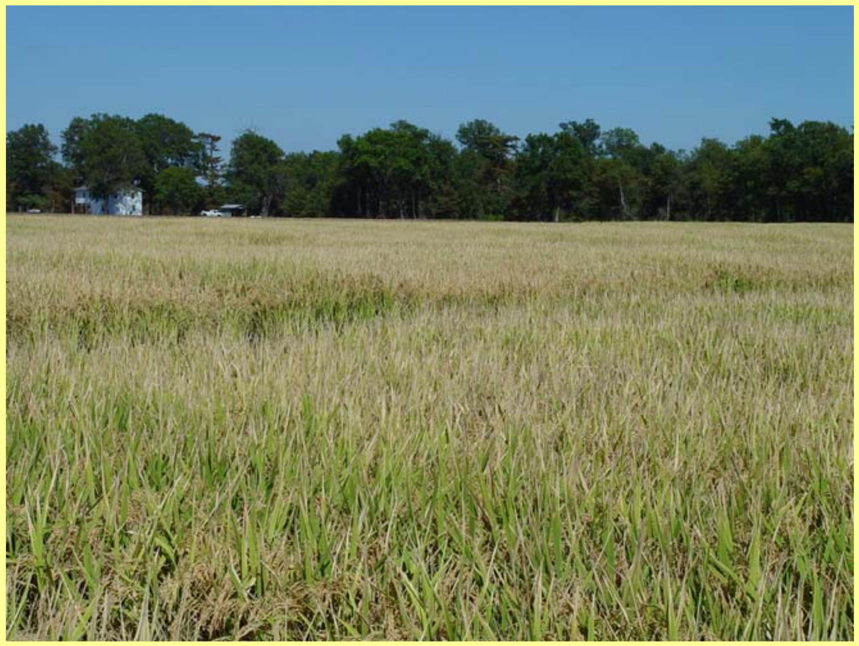
Does the timing of P applications make a difference?

- 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
- DAP - good starter



Other Changes at LSU AgCenter STPAL

LSU AgCenter STPAL Changes

- 2 reporting formats
  - Traditional format
  - Excel format
    - CSV (comma delimited)
    - Importable into GIS software
    - Variable rate recommendations
- Optional test
  - Tabs in the spreadsheet

- Additional tests added
  - Sum of bases (Mehlich 3)
  - CEC (texture derived)

Est. completion date - June

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Questions

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- Dr. Jim Wang
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- Rodney Henderson
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Major extractants for soil P

- Bray 1 (1945): 0.025 M HCl + 0.03 M NH_4F
- Bray 2 (1945): 0.1 M HCl + 0.03 M NH_4F
- Mehlich 1 (1953): 0.05 M HCl + 0.0125 M H_2SO_4
- Mehlich 3 (1984): 0.2 M CH_3COOH + 0.25 M NH_4NO_3 + 0.015 M NH_4F + 0.013 M HNO_3 + 0.001 M EDTA

Soil Testing Modes of action

1. Acid dissolution
   – HCl, HNO3, H2SO4
2. Anion exchange
   – Acetate, bicarbonate, citrate, lactate, sulfate
3. Cation complexation
4. Cation hydrolysis
   – High ph, hydroxyl anion (OH) dissolves portion of Fe- and Al-P by hydrolysis.

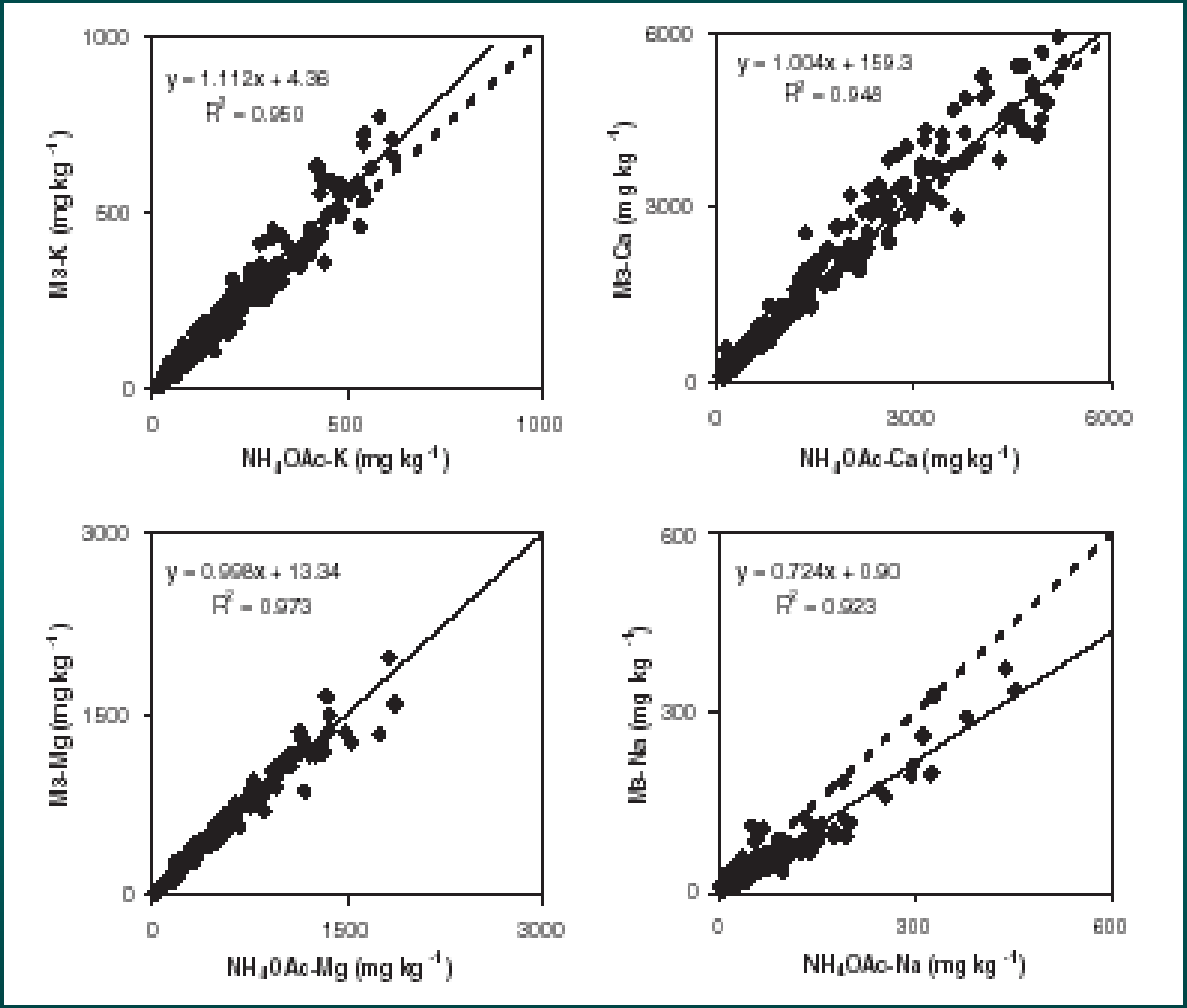
Major extractants for soil P

- Morgan (1941): 0.72 M NaOAc + 0.52 M CH_3COOH, pH 4.8
- Modified Morgan (1969): 0.62 M NaOAc + 1.25 M CH_3COOH, pH 4.8
- Lancaster (1980): first 0.05 M HCl, then with 0.037 M NH_4F + 0.03 M $AlCl_3$ + 1.58 M CH_3COOH + 0.187 M $CH_2(COOH)_2$ + 0.125 M $CH_2CH(COOH)_2$, pH 4.0

Major extractants for soil P

- Modified Kewlona (1987): 0.5 M CH_3COOH + 0.015 M NH_4F, pH 3.0
- Olsen (1954): 0.5 M NaHCO3, pH 8.5
- Soltanpour or AB-DTPA (1977): 1 M NH_4HCO_3 + 0.005 M DTPA, pH 7.5

Conversion from NH_4OAc to M3 for K, Ca, Mg and Na



J.J. Wang, D.L. Harrell, R.E. Henderson, and P.F. Bell (2004)