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Impact of Avail® and JumpStart® on Yield and Phosphorus Uptake of Corn and Winter Wheat in Kansas

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Introduction

- The volatile price of fertilizer within the last five years has created interest to revisit common P fertility questions like fertilizer recommendations and fertilizer efficiency
- Current P recommendations are based on the Mehlich 3 soil test using a critical level of 20 mg kg^{-1}
- Management practices such and banding, stripping or starter applications with or close proximity to the seed are well documented methods of increasing application year P efficiency
- Two products, Avail and JumpStart, are currently being advertised and sold widely in Kansas as tools to enhance P uptake from native P supplies or applied fertilizers. Can enhancement products be a useful tool to achieve greater P efficacy?

Background on Products

- Avail is a product of Specialty Fertilizer Products
  - “a patented technology that surrounds phosphorus fertilizer in a water-soluble ‘shield;’ blocking the bonds of attraction of chemical elements in the soil to the phosphorus” Avail’s uses are covered in US patents 6,525,155 and 6,596,831. Information from these patents confirms that Avail is the Na salt of long chain carbon compounds with a high net negative charge.
- JumpStart is a product of Novozymes Biologicals
  - a seed inoculant containing the fungi *Penicillium bilaii.* The fungus grows on the root system and produces a number of organic compounds that increase the solubility of native and fertilizer P.

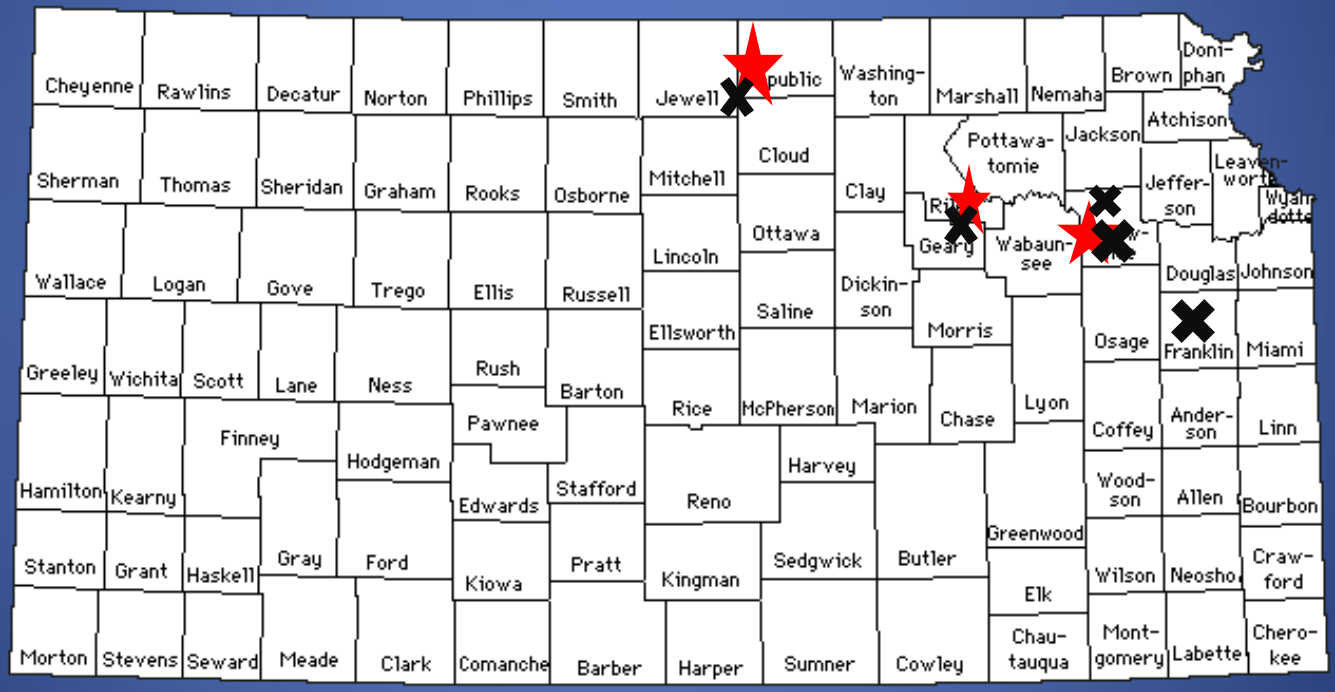
Objectives

- Confirm current P soil test interpretations and fertilizer recommendations;
  - Corn and wheat will respond to P fertilizer at ST < 20 mg kg^{-1}
- Evaluate the potential benefit of using Avail and/or JumpStart with P fertilizer in corn and wheat production

Corn Studies

- Field trials were established at three sites in 2008 and five sites in 2009
- All sites had low soil test P (Melich III <20g kg^{-1})
- Treatments included:
  - three rates of P in 2008 and 4 in 2009
  - with and without the Avail added to the fertilizer,
  - with and without JumpStart added to the seed
- Treatment effects were measured by
  - Seedling, earleaf and grain P content
  - grain yield and yield components at harvest

Trial Locations



2008

2009

Site Information

Location	Soil Series	Taxonomic Class	pH	O.M.	P	K
				g kg^{-1}	mg kg^{-1}	
ANF (2008)	Kahola silt loam	Fine-silty, mixed, superactive, mesic Cumulic Hapludolls	6.2	2.2	11.3	155
ANF (2009)	Reading silt loam	Fine-silty, mixed, superactive, mesic Pachic Argiudolls	7.7		13.0	
KRV (2008)	Eudora silt loam	Coarse-silty, mixed, superactive, mesic Fluventic Hapludolls	6.6	0.9	15.3	111
KRV (2009)			7.0		15.0	
NCE (2008)	Crete silt loam	Fine, smectitic, mesic Pachic Argiustolls	6.5	2.7	11.5	532
NCE (2009)			6.3	2.7	14.0	
ECE (2009)	Woodson silt loam	Fine, smectitic, thermic Abruptic Argiaquolls	6.0		11.0	
HKS (2009)	Rossville silt loam	Fine-silty, mixed, superactive, mesic Cumulic Hapludolls	6.9		12.5	

Effect of P Application on Seedling P Uptake (mg P plant^{-1})

P kg/ha	Agron Farm8	NCE Field8	Agron Farm9	KRV Field9	NCE Field9	ECE Field9	HKS Farm9
0	23.4	20.9	14.1	10.0	8.33	13.0	12.3
4.9	-	-	13.5	10.3	8.52	12.9	11.9
9.8	29.1	25.8	13.6	12.0	8.17	12.4	11.0
19.8	24.8	22.5	15.1	11.0	9.37	13.2	11.8
0 vs P	NS	0.031	NS	NS	NS	NS	NS
Low vs hi	NS	NS	0.47	NS	NS	NS	NS

Effect of P Product on Seedling P Uptake (mg P plant^{-1})

Prod	Agron Farm8	NCE Field8	Agron Farm9	KRV Field9	NCE Field9	ECE Field9	HKS Farm9
None	27.2	23.6	14.1	11.1	8.69	12.8	11.6
Avail	25.9	22.7	14.2	10.9	8.52	12.6	11.8
JumpS	26.8	22.3	13.5	10.8	9.2	12.8	-
AV + JS	27.0	23.4	13.7	11.1	8.74	13.7	-
Av vs 0	NS	NS	NS	NS	NS	NS	NS
JS vs 0	NS	NS	NS	NS	NS	NS	-
Av+JS vs 0	NS	NS	NS	NS	NS	NS	-

Effect of P Application on Corn Yield, 2008 (bu ac^{-1})

P kg/ha	Agron Farm	NCE Field	KRV Field
0	195.2	196.8	217.6
4.9	-	-	-
9.8	168	216	217.6
19.8	196.8	222.4	241.6
SE	8.98	6.51	15.2
0 vs P	NS	0.003	NS
Low vs hi	NS	NS	NS

Effect of P Product on Corn Yield, 2008 (bu ac^{-1})

Prod	Agron Farm	NCE Field	KRV Field
None	209.6	217.6	209.6
Avail	222.4	216	222.4
JumpS	208	209.6	208
AV + JS	216	217.6	216
SE	8.98	6.51	15.2
Av vs 0	NS	NS	NS
JS vs 0	NS	NS	NS
Av+JS vs 0	NS	NS	NS

Effect of P Application on Corn Yield, 2009 (bu ac^{-1})

P kg/ha	Agron Farm	NCE Field	KRV Field	ECE Field	Hooks Farm
0	217.6	192	230.4	77.92	232
4.9	220.8	211.2	227.2	68	227.2
9.8	214.4	216	233.6	89.28	209.6
19.8	198.4	225.6	230.4	71.2	224
SE	9.5	7.1	6.0	9.7	10.4
0 vs P	NS	<0.001	NS	NS	NS
Low vs hi	NS	<0.001	NS	NS	NS

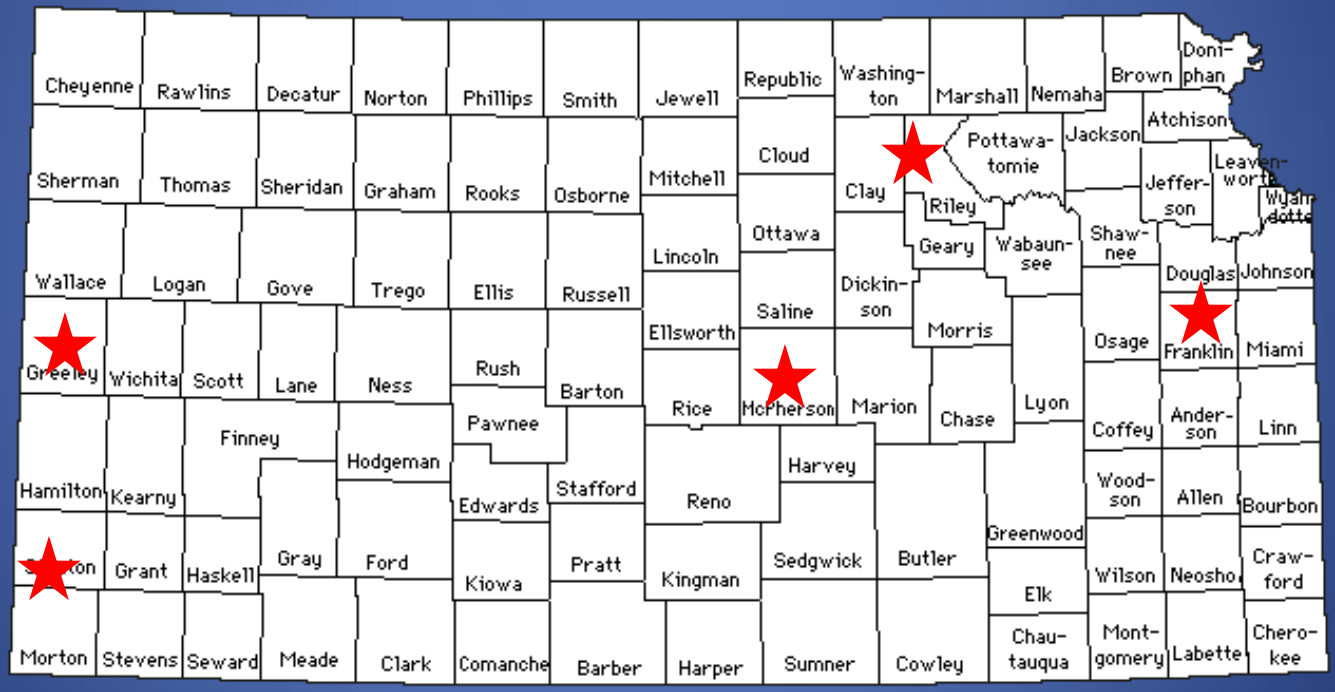
Effect of P Product on Corn Yield, 2009 (bu ac^{-1})

Prod	Agron Farm	KRV Field	NCE Field	ECE Field	HKS Farm
None	211.2	230.4	217.6	76.2	220.8
Avail	217.6	230.4	212.8	92.2	217.6
JumpS	209.6	225.6	219.2	84.3	-
AV + JS	198.4	236.8	208	87.0	-
SE	9.5	7.1	6.0	9.7	10.4
Av vs 0	NS	NS	NS	NS	NS
JS vs 0	NS	NS	NS	NS	-
Av+JS vs 0	NS	NS	(.019)	NS	-

Wheat Studies

- Two different studies were conducted the 2008-2009 crop year
  - Two replicated field studies consisting of:
    - three rates of P
    - with and without the addition of Avail to the fertilizer
    - with and without JumpStart to the seed
    - With both Avail and JumpStart
  - Three replicated field consisting of:
    - Three rates of P
    - With and without the addition of Avail to the fertilizer
  - Non-replicated trials were conducted with the JumpStart seed treatment as part of county wheat variety demonstrations

Replicated Trial Locations with Wheat



Site Information

Location	Soil Series	Taxonomic Class	pH	O.M.	P	K
				g kg^{-1}	mg kg^{-1}	
Franklin County	Woodson silt loam	Fine, smectitic, thermic Abruptic Argiaquolls	6.7	30	23	165
Greeley County	Ulysses silt loam	Fine-silty, mixed, superactive, mesic Aridic Haplustolls	6.4	14	63	
McPherson County	Crete silt loam	Fine, smectitic, mesic Pachic Argiustolls	4.7		19	
Riley County	Tully silty clay loam	Fine, mixed, superactive, mesic Pachic Argiustolls	5.9		6	
Stanton County	Richfield silt loam	Fine, smectitic, mesic Aridic Argiustolls	7.6		15	

- Franklin and Greeley County locations above critical level
- Riley County location P applied below recommended rates

Effect of P Application on Flagleaf P (g P kg^{-1})

P kg/ha	Riley	WARC	Stanton
0	1.63	2.13	2.36
9.8	1.74	2.13	2.38
19.6	1.81	2.43	2.24
0 vs P	0.007	0.028	NS
Low vs hi	0.47	0.049	NS

No P added

40 lbs P_2O_5 added

Effect of P Product on Flagleaf P (g P kg^{-1})

P kg/ha	Riley	WARC	Stanton
0	1.63	2.13	2.36
Avail	1.74	2.13	2.38
JumpStart	1.81	2.43	2.24
JS + Avail	1.76	-	2.21
0 vs Avail	NS	NS	NS
0 vs JS	NS	-	NS
0 vs JS+AV	NS	-	NS

Effect of P Application on Wheat Yield, 2009 (bu ac^{-1})

P kg/ha	Riley	WARC	Stanton	McPherson	ECES
0	17.1	26.6	39.3	62.7	65.7
9.8	26.0	23.9	40.0	64.8	67.7
19.8	30.5	25.4	43.4	67.8	67.5
SE	2.0	4.7	2.2	2.0	1.8
0 vs P	<0.001	NS	NS	NS	NS
Low vs hi	<0.001	NS	NS	NS	NS

Effect of P Product on Wheat Yield, 2009 (bu ac^{-1})

Prod	Riley	WARC	Stanton	McPherson	ECES
None	28.2	24.6	41.6	66.3	67.6
Avail	30.9	27.2	43.9	68.8	68.3
JumpS	26.0	NA	41.6	NA	NA
AV + JS	26.8	NA	40.1	NA	NA
SE	2.0	4.7	2.2	2.0	1.8
Av vs 0	NS	NS	NS	NS	NS
JS vs 0	NS	NA	NS	NA	NA
Av+JS vs 0	NS	NA	NS	NA	NA

Jumpstart county summary

- Trials were conducted with the JumpStart seed treatment as part of county wheat variety demonstrations
- Using each test location as a replication
- Overall, JumpStart failed to enhance yields in 18 of the 20 comparisons

	P kg ha^{-1}	Yield bu ac^{-1}
Non Treated	0	62.58
JumpStart Treated	0	59.21
SE		2.5
Contrast		0.0039

Conclusions on Corn

- 2008 and 2009 Excellent corn yields were observed
- Despite locations having ST P below the critical value, only one site, NCEF, responded to P fertilization in both years
- No response to either product was seen at any location or year were a response to P fertilizer was observed

Conclusions on Wheat

- A range of yields were observed in 2009
- Significant responses to P were obtained at Riley County for both tissue P content and grain yield and WARC for tissue P content
- No responses to JumpStart or Avail were observed at any of the locations in all trials during 2008-2009 crop year

Recommendations to Producers

- JumpStart showed no increase in P response when fertilizer P was added. In corn trials, there were few observed increases in P uptake, and no increases in grain yield. In replicated wheat trials, there were no observed increases in P uptake or grain yield; additional strip trials showed an overall negative response with the JumpStart seed treatment.
- The Avail trials resulted in few positive results. There was no grain yield response to the use of this product at the P responsive sites for corn and wheat. Overall, this product did not prove to be an effective method of increasing P uptake or yield with broadcasted MAP fertilizer.

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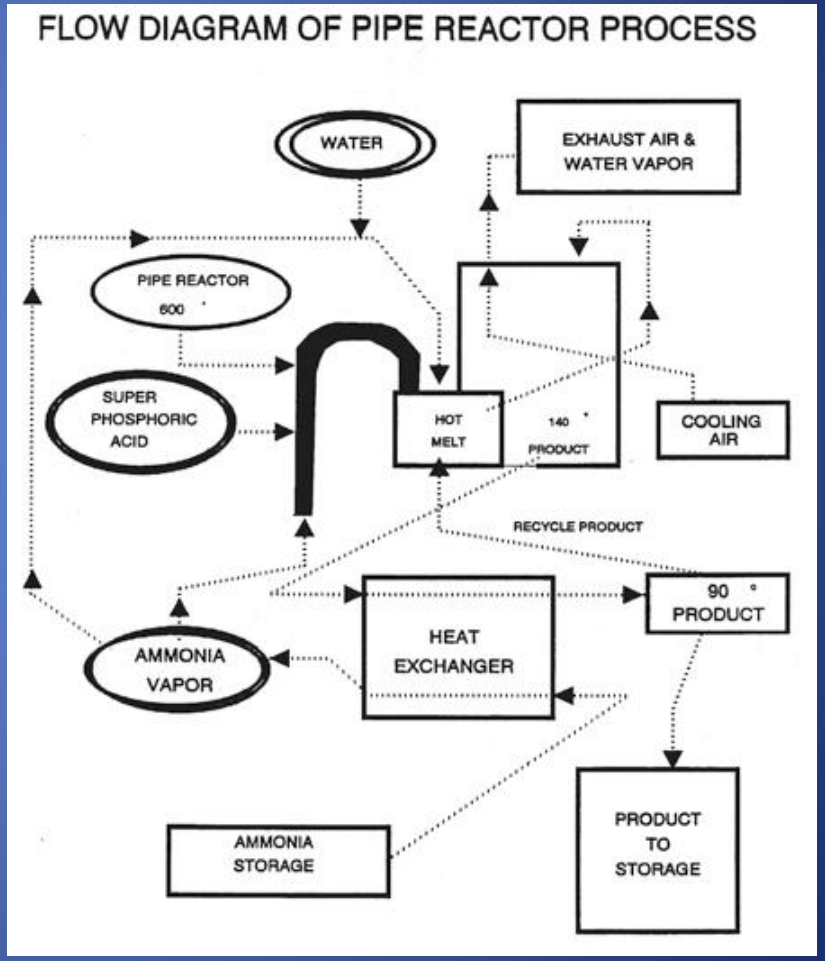
Common questions about P fertilizers

What does the Plant want?

- There are two forms of P that plants are able to take up, $H_2PO_4^-$ or HPO_4^{-2}.
- Formulas of common P fertilizers
  - DAP (18-46-0) $(NH_4)_2HPO_4$
  - MAP (11-52-0) $(NH_4)H_2PO_4$
  - APP (10-34-0) H_2O $(NH_4)_3PO_4$

10-34-0 ‘White Acid’ v. ‘Black Acid’

- Acid ‘color’ just refers to the method of which the Super Phosphoric Acid (SPA) is produced.
- No matter the input SPA the result is 10-34-0 a mix of poly and ortho



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Questions?