Wheat Yield and Protein as Influenced by In-Furrow (down the tube) Phosphorus, Potassium and Coated Urea (ESN)

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Research Questions

The soils of northern Minnesota are variable, in large part due to the activity of glaciers during the last ice age. These soils, which were influenced by the activity of glacial Lake Agassiz, have pH levels that range from 7.8 to 8.4. As soil pH levels increase from 7 to the mid-8's, the availability of certain essential elements necessary for plant growth and development is restricted and nutrient uptake by plant roots is hindered. As an example, research trials with phosphorus suggests plant roots have a limited time, in the cold soils of early spring, to utilize applied phosphorus as these soil factors reduce phosphorus availability for uptake by plant roots in high pH soils.

Recent research at the U of MN Magnusson Research Farm has suggested an improvement in wheat development, growth, and yield from phosphorus applied a 2X rate compared to the standard rate of phosphorus applied in-furrow. It is also theorized that broadcast applications of additional phosphorus on these high ph soils may have added benefit to not only the present wheat crop but the subsequent crop of soybeans. An increase in uptake of early season phosphate by wheat roots is theorized to improve plant growth and development which may lead to increased wheat yields, improved quality, and ultimately profitability.

A new formulation of nitrogen called ESN (environmentally sensitive nitrogen) is a time released coated urea product with improved seed safety compared to other forms nitrogen. This coated urea can be applied in-furrow at nitrogen rates up to three times the current safe rate of urea. The polymer coated, time released formulation supplies nitrogen to the crop throughout the entire growing season and reduces nitrogen loss through volatilization, denitrification, and leaching.

Phosphorus and ESN applied in-furrow at planting time have the potential to increase wheat growth, development and yields. Small plot and large on-farm research trials will be designed to provide scientific data to provide answers to these research questions in the spring wheat production systems in northern Minnesota's environmental conditions.

Results

See tables on page 60 and 61

Application/Use

The rationale for this research is to compare the standard phosphate starter with and without ESN and a 2X rate of phosphorus fertilizer starter program in spring wheat. The elevated phosphorus levels may improve early season wheat growth and development in the high pH soils of northern MN. A coated urea product may offer the potential to improve wheat yield and quality (protein), especially if the product is not released into the soil solution until later in the plant developmental stages of the spring wheat.

Material and Methods

Treatment applications, data collection, data analysis and summaries will be conducted by the University of Minnesota to insure unbiased, scientifically valid research results. This fertility research integrates small plot replicated trials with large, replicated on-farm trials. The Magnusson Research Farm (located 6 miles northwest of Roseau, MN) will be the site for the small plot replicated research trials. The Magnusson Research Farm is a 40 acre site that was gifted to the University of Minnesota to conduct agricultural research that will have a positive impact on crops produced in the area. The Farm is the northern most research site in Minnesota with unique environmental conditions that make this an attractive location for crop research. Results of this field research will be summarized for potential publication in regional publications (e.g. Prairie Grains Magazine) and scientific journals. Research findings from the large on-farm trials and the small plot trials will be presented at regional and local wheat growers meetings.

The experimental design for the small plot research was a randomized complete block with 4 replications. Spring wheat was seeded with and without a starter fertilizer. The starter fertilizer was applied down the tube with the seed. These small plots were managed similar to area wheat production fields. Flag leaves were collected for tissue analysis. Plots were harvested for yield with a small plot combine with sub-samples from each plot for wheat seed quality assessments.

The small plot fertility trial had 13 fertility treatments plus a control (no starter fertilizer) treatment for a total of 14 treatments replicated four times for a total of 56 individual plots. Total nitrogen application equaled 140# nitrogen for all plots.

Treatment list:

No added P or K	MES 10 + K (9-30-30-7) - In-furrow
Standard P & K (9-30-30) - Broadcast	MES 10 (2x) + K (18-60-30-14) - In-furrow
Standard P & K (9-30-30) - In-furrow	Standard P & K + AMS (9-30-30-7) - In-furrow
Elevated P & K (18-60-60 - Broadcast	MES 10 + K + ESN (39-30-30-7) - In-furrow
Elevated P & K (18-60-60) - In-furrow	Standard P & K + ESN (39-30-30) - In-furrow
Elevated P normal K (18-60-30) - In-furrow	Standard P & K + ESN (69-30-30) - In-furrow
Elevated P normal K (13-45-30) - In-furrow	Elevated P normal K + ESN (39-60-30) - In-furrow

Data collected: Background soil fertility, plant vigor ratings, crop color rating, chlorophyll meter ratings (taken at jointing and flag leaf stages of wheat development), flag leaf tissue test, crop yield, and crop quality parameters (test weight, protein).

The on-farm trials were conducted at 2 Roseau area locations . Location 1 is located northwest of Roseau on Rice Farms. Location 2 is located west of Roseau on Magnusson Farms. Field trial design will be a randomized complete block design with three replications at each site. The on-farm cooperators selected to participate in this research utilize new technologies and advanced management practices to maximize wheat yields such as seed treatments, aggressive fertility rates, and fungicide treatments. Each site will have two treatments replicated three times (six strips). Each site had a standard in-furrow application of 6-30-30. An added treatment of 12-60-0 was applied by University of Minnesota personel prior to final seedbed preparation

Total applied nitrogen will be the same for each treatment based on the producer's specific yield goal for wheat. Plot size will be one pass of the air seeder feet wide by 500 feet long to accommodate the production practices and the farmer cooperators equipment.

Economic Benefit to a Typical 500 Acre Wheat Enterprise

At location 2 where P_2O_5 levels were low, a significant wheat yield advantage was realized. A significantly higher soil P_2O_5 level was measured in soil post-harvest indicating an accumulation of phosphorous in the soil is possible for future crop use.

Related Research

Minnesota Turf Seed Council has on-going fertility research program in perennial ryegrass. Minnesota Agricultural Fertilizer Research and Education Council funded fertility research in wheat in 2012. Minnesota Soybean Research and Promotion Council funded fertility research in soybean in 2014.

Recommended Future Research

Research should be repeated during the second year of the grant to validate first year results

2014 Phosphorous Application to Spring Wheat
Location 1=Rice Farm-3 mi. North and 5 mi. west of Roseau Variety - Linkert

					Test wt.		
	Yield-Bu./acre *		% Protein		#/bushel		
Treatment	Loc.1	Loc.2	Loc.1	Loc.2	Loc.1	Loc.2	
Standard In Furrow (7-30-30)	66.7	74.1	13.8	14.7	62	63.5	
Standard In Furrow (7-30-30)+13-60-0	66.7	82.5	14.1	14.5	62	63.5	
broadcast prior to spring tillage							
LSD @5% level	NS	4.6	NS	NS	NS	1	
CV	4	5	3	4	32	31	

Experimental Design: RCB w/3reps Plots size=70' x 600' Broadcast application of MAP(7-30-0) prior to
*Assume 63#/bu @12.5% moisture **Objectives:** Wheat yields in 2014 and soybean in 2015
phosphorus is feasible in high PH soils

2014 Wheat Fertility Trial Magnusson Research Farm--Samson Wheat Broadcast urea added to all treatment

						RCI [3]		Vigor [4]		
TRT#	Trts	App*	Yield ** Bu./acre	Yield % of mean	% Protein	3-Jul	8-Jul	3-Jul	8-Jul	
1	0-0-0	NONE	96	86	14.1	256	336	7	6	
2	9-30-30	B	111	101	13.3	374	451	8	7.8	
3	9-30-30	I	108	97	13	370	456	8.3	8.3	
4	18-60-60	B	109	98	12.9	404	448	8.3	8.3	
5	18-60-60	I	115	104	12.9	375	473	8.5	9	
6	18-60-30	B	112	101	12.9	390	454	8.8	8.3	
7	18-60-30	I	112	101	12.8	385	456	8.3	9	
8	13-45-30	I	108	97	13.1	389	461	8.3	8.5	
9	9-30-30-7s	B	104	94	12.6	387	466	8.5	8.3	
10	18-60-30-14s	I	120	108	12.8	427	488	8.5	9	
11	9-30-30-7s	I	113	102	13	412	472	8	8.5	
12	39-30-301	I	108	98	13.8	341	401	7.5	7.5	
13	69-30-302	I	115	103	14.4	369	426	8	7.8	
14	39-60-301	I	119	107	13.4	422	467	8.8	8.8	
	LSD @5% level		9	7	0.8	61	44	1	1	
	CV		6	6	4	11	7	9	8	

App*= Application method: I - In furrow and B - broadcast. Yield**-corrected to 12% moisture.
number -more chlorophyll. [4] Vigor=9-best plant vigor Test wts./Bushel =62.5#(all treatments within .3#/bu.)
Soil test results- Post harvest-2014 P_2O_5= treatments 1 & 3= 6ppm; treatment 5= 6.5ppm

Location 2=Magnusson Farms-1mi.west and 1 mile north of Roseau Variety-Samson

	Soil test ppm - P_2O_5						Tissue tests at anthesis			
	Spring		post harvest		RCI		phosphorus		potassium	
	Loc.1	Loc.2	loc.1	loc.2	Loc.1	Loc.2	Loc.1	Loc.2	loc.1	loc.2
	9.5	4	7	2.7	306	791	0.27	0.27	2.2	1.6
	9.5	4	9.7	4	319	801	0.28	0.28	2.5	1.5
	NS	NS	NS	NS	NS	NS				
	2	1	10	1	9	1				

final seed bed tillage to both locations with 12' Gandy drop spreader.
Compare 2015 soybean yield where additional fertilizer was applied to determine if 'stockpiling ' of

application to equal 140#/ac. total added nitrogen

	Heading	Tissue sampling data - 7/22 (anthesis)									
	Date	B	Ca	Fe	Mg	Mn	N	P	K	S	Zn
	21	3.8	0.6	83	0.32	25	4.1	0.29	1.68	0.38	17
	21	4	0.7	99	0.42	28	4.1	0.29	1.83	0.35	16
	21	4.5	0.6	90	0.34	28	3.9	0.3	1.73	0.33	15
	21	4	0.6	102	0.34	29	3.9	0.3	1.73	0.33	15
	22	4.3	0.6	99	0.37	34	4	0.3	1.91	0.3	15
	21	3.5	0.7	97	0.34	29	4	0.3	1.8	0.33	16
	22	3.8	0.7	106	0.4	39	4	0.3	1.72	0.34	15
	21	4.3	0.6	95	0.38	34	4	0.3	1.74	0.33	15
	21	4	0.6	97	0.36	29	4	0.29	1.76	0.31	15
	23	4.8	0.8	116	0.46	41	4.1	0.32	2.1	0.35	16
	22	3.8	0.6	101	0.34	32	3.9	0.3	1.9	0.31	15
	21	4	0.7	95	0.34	28	4	0.31	1.72	0.35	16
	21	4.5	0.7	100	0.37	32	4.1	0.31	1.71	0.36	16
	21	4.5	0.7	100	0.43	38	4.1	0.32	1.89	0.31	16
	1	1	0.1	15	0.07	8	0.2	0.02	0.35	0.05	1.7
	2	17	10	11	13	18	4	6	14	11	8

[1] ESN applied in furrow 30#N/acre [2] ESN applied in furrow 60#N/acre [3] RCI=Relative chlorophyll index- higher
Mean Yields = 111 Bu./acre planted 6/4/2014 Soil test results- Spring 2014 P_2O_5= 4ppm SO_4=5ppm NO_3=34#/acre