VARIABLE RATE N APPLICATION ON WHEAT AFTER SUGARBEETS – "PUTTING RESEARCH INTO PRACTICE"

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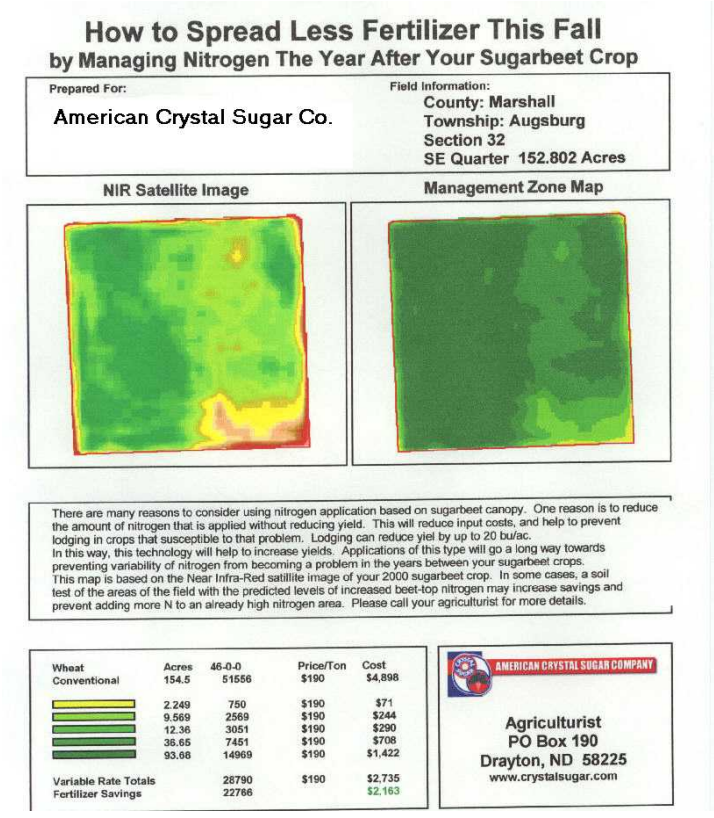
INTRODUCTION

American Crystal Sugar Company has been promoting variable rate nitrogen application using satellite imagery of beet canopies since 1999. This program is based on the research of Dr. John Moraghan, North Dakota State University and Dr. Larry Smith, University of Minnesota, Northwest Research and Outreach Center, Crookston. Many growers adopted this program for the 2001 crop year. Nearly 50,000 acres were VRT spread using zone management, in all districts. However, grower skepticism surfaced concerning potential adverse effects of reduced N use on wheat yield, protein and test weight. This caused concern with many growers and prompted the American Crystal Precision Farming Team to devise a plan to resolve the problem and provide answers to shareholder concerns. Our goal is to continually increase the number of acres involved in this program.

OBJECTIVES

1) To determine if a variable rate application of nitrogen using beet top imagery adversely affects yield, protein or test weight in wheat following sugarbeets. 2) Maximize field uniformity in all crops. 3) Increase sugar content and lower loss to molasses in subsequent beet crops. 4) Lower on farm nitrogen costs. 5) Less lodging of small grains.

MATERIALS AND METHODS



How to Spread Less Fertilizer This Fall
by Managing Nitrogen The Year After Your Sugarbeet Crop

Prepared For:
American Crystal Sugar Co.

Field Information:
County: Marshall
Township: Augsburg
Section 32
SE Quarter 152.802 Acres

NIR Satellite Image

Management Zone Map

There are many reasons to consider using nitrogen application based on sugarbeet canopy. One reason is to reduce the amount of nitrogen that is applied without reducing yield. This will reduce input costs, and help to prevent lodging in crops that susceptible to that problem. Lodging can reduce yiel by up to 20 bu/ac.
In this way, this technology will help to increase yields. Applications of this type will go a long way towards preventing variability of nitrogen from becoming a problem in the years between your sugarbeet crops.
This map is based on the Near Infra-Red satillite image of your 2000 sugarbeet crop. In some cases, a soil test of the areas of the field with the predicted levels of increased beet-top nitrogen may increase savings and prevent adding more N to an already high nitrogen area. Please call your agriculturist for more details.

Wheat	Acres	46-0-0	Price/Ton	Cost
Conventional	154.5	51556	$190	$4,898
	2.249	750	$190	$71
	9.569	2569	$190	$244
	12.36	3051	$190	$290
	36.65	7451	$190	$708
	93.66	14969	$190	$1,422
Variable Rate Totals		28790	$190	$2,735
Fertilizer Savings		22766		$2,163

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Growers of American Crystal Sugar Company are provided with satellite images of their sugarbeet crop in September of each year. This printed sheet (left) provides the grower with the satellite image, a management zone map, as well as a fertilizer cost savings spreadsheet. If the grower decides to go ahead and spread nitrogen based upon the management zones, they contact their Agriculturist to discuss yield goals and other special requirements. The Agriculturist and grower agree on the N credits to assign to each management zone. The Agriculturist then places the order over the Internet with Precision Partners, giving instructions on which company and type of VRT machine will do the N spreading. Precision Partners then makes a zone spread map and delivers the file to the respective fertilizer company to have the field VRT spread. The process can be completed in a day or two.

American Crystal Sugar Company's Agronomy Department decided it was necessary to provide growers with field research results regarding this issue. Wheat sampling was conducted on 24 fields throughout all 5 districts of the ACSC growing region. Each Agriculturist cooperated with a grower who used beet top imagery to variable rate apply nitrogen following sugarbeets. Prior to planting spring wheat, urea was applied variable rate according to management zones set up with the use of satellite images of the previous year's sugarbeet canopy. Nitrogen management zones were created based upon plant canopy

density of the beet crop. For most fields nitrogen credits were assigned to the zones using 80, 60, 40, 20 and 0 lbs./ac of nitrogen, based upon previous research of Dr. Moraghan and Dr. Smith. An 80 lbs./ac nitrogen credit was given to the dark green areas of the field with the heaviest canopy. Nitrogen credits were reduced down to a 0 lbs./ac credit given to the yellow areas of least canopy.

Wheat sampling within these fields was conducted on 3 nitrogen management zones, 80,40, and 0 lbs./ac N credit. GPS guidance was utilized to ensure that samples were taken from the correct zone. The samples were collected from each of the test fields when the standing grain reached physiological maturity. A PVC frame measuring 3 feet square was used to maintain a constant area of sampling, which was placed on the ground in the standing grain. A hand trimmer was then used to cut the grain a few inches below the head within this PVC frame. The wheat was gleaned from the square area and placed in a canvas sample bag. Each bag was tagged according to zone, area, sample number and marked with GPS coordinates from the sample location. Three sub-samples were taken around each GPS coordinate. A total of 36 samples were taken from each field, 12 from each management zone, based on recommendations of Dr. J. Goos, North Dakota State University and Dr. J. Wiersma of the University of Minnesota, Northwest Research and Outreach Center, Crookston.

After all samples were collected from the field, the sample bags were placed in a heated aeration bin to be dried to the appropriate harvest moisture content. The samples were then thrashed using a test plot combine. Each sample was processed to determine bushels/acre, test weight, and protein percentage. Protein was determined at Northern Grain Co., Glyndon, Mn. All data was compiled and statistically analyzed to determine treatment differences. The SAS program was used with the experimental design procedure being a RCBD with locations used as blocks.

The following is a chart (Table 1) showing each Agriculturists field by variety, yield goal chosen, lbs. of nitrogen per bushel of yield goal, soil test and starter fertilizer if available, and nitrogen credits given to each zone selected by the grower.

TABLE 1. CULTURAL PRACTICE INFORMATION on fields selected for the 2001 ACSC N credit study.

AGRICULTURIST	VARIETY	YIELD GOAL	POUNDS of N/BU	SOIL TEST	STARTER FERTILIZER	N CREDIT ZONES
		(bu/ac)		(lbs./ac)	(lbs./ac)	(lbs./ac)
Casey Bryl	Ingot	50	2.5	15	0	80,60,40,20,0
Chad Wardner	HJ98	60	2.5	0	0	80,60,40,20,0
Cody Kritzberger	Ingot	55	2.5	0	0	80,60,40,20,0
Cory Kritzberger	Dandy	60	2.5	0	9	60,30,0
Curt Meyer	Forge	60	2.5	0	0	80,60,40,20,0
Dan Bernhardson	Ingot	50	3	0	13	80,60,40,20,0
Donna Aafedt	Alsen	60	2.5	0	27	80,60,40,20,0
Greg Richards	Oxen	50	2.5	15	13	80,60,40,20,0
Jack Call	Ingot	60	2.5	67	15	80,40,20
Jeff Sveen	Mercury	70	2.5	0	4	80,60,40,20,0
John Halland	Oxen	65	2.5	0	8	60,20,0
John Prigge	HJ98	60	2.5	9	0	80,40,0
Kelly Sharpe	Gunner	64	2.5	38	18	80,60,40,20,0
Kirk Johnson	Oxen	65	2.5	9	10	80,60,40,20,0
Marc Connely	Oxen	60	2	0	0	80,60,40,20,0
Maureen O'Leary	Dandy	60	2.5	0	7	80,40,0
Neil Boeddeker	Oxen	60	2.5	0	15	70,40,0
Nick Arends	Ingot	60	2.5	0	12	80,60,40,20,0
Tim Kenyon	Parshall	60	2.5	37	0	80,60,40,20,0
Tim Leshuk	2375	40	2.5	0	12	80,60,40,20,0
Tom Herman	Dandy	60	2.5	0	0	80,60,40,20,0
Tom Zidon	Ingot	70	2.5	20	18	80,60,40,20,0
Tyler Grove	Ingot	60	2.5	10	15	80,60,40,20,0
Roger Sellnow	AC Barry	60	2.5	0	0	70,40,0

RESULTS

For the Red River Valley summary (Table 2) zone C received the entire 150 lbs./acre of nitrogen, zone B received 110 to 120 lbs./acre, and zone A received 70 to 80 lbs./acre of nitrogen. Yield, test weight, and protein content were not significantly different between zones for the Red River Valley data summary. All three yield factors were remarkably similar indicating that the nitrogen credits assigned to zones A, B, and C were correct. Mineralization of nitrogen from beet tops occurred rapidly and supplied sufficient nitrogen to meet the wheat crop needs in the same manner in each zone.

TABLE 2. RED RIVER VALLEY WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	56.2 a	59.7 a	12.9 a
B	55.1 a	59.6 a	12.8 a
C	55.9 a	59.5 a	12.7 a

*Numbers followed by the same letter do not differ significantly at P = 0.05

Crookston and Hillsboro field summaries were similar to those for the Red River Valley as a whole. No significant differences in yield, test weight or protein were observed. (Tables 3 and 4)

TABLE 3. HILLSBORO FACTORY DISTRICT WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	44.7 a	58.9 a	12.9 a
B	43.9 a	58.8 a	12.7 a
C	46.8 a	59.1 a	13.1 a

*Numbers followed by the same letter do not differ significantly at P = 0.05

TABLE 4. CROOKSTON FACTORY DISTRICT WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	61.6 a	60.4 a	12.6 a
B	60.5 a	59.9 a	12.8 a
C	60.5 a	60.2 a	12.4 a

*Numbers followed by the same letter do not differ significantly at P = 0.05

The Moorhead field summary (Table 5) showed no differences in test weight and protein between the three zones. Yield in bushels per acre was significantly higher for zone A where an 80 lbs. nitrogen credit was given for the beet tops. This may have occurred because the fertilizer applied for the yield goal, chosen by the grower, may have been too low for yields achievable under 2001 weather conditions in the Moorhead area. Zone A yields may have been higher because the 80 lbs./acre nitrogen credit given to zone A areas of the field is usually somewhat conservative. Actual nitrogen measured in beet tops from zone A areas has frequently been more than 100 lbs./acre. The 80 lbs./acre credit is probably still a good choice to use. If the 80 lbs./acre credit had greatly underestimated available

nitrogen to the wheat crop then protein content should have been increased and this did not occur for the Moorhead factory field summary.

TABLE 5. MOORHEAD FACTORY DISTRICT WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	56.7 b	60.3 a	13.2 a
B	52.7 a	60.1 a	13.0 a
C	52.4 a	60.1 a	13.1 a

*Numbers followed by the same letter do not differ significantly at P = 0.05

In the East Grand Forks field summary (Table 6) significant differences were observed in both test weight and protein. Test weight in zone B was significantly different than zones A and C. Protein in zone C was significantly higher than zone B. However, the difference was relatively small and may have been due to slightly over fertilizing zone C based on yield goals chosen, and influences of weather patterns in this district.

TABLE 6. EAST GRAND FORKS FACTORY DISTRICT WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	58.1 a	59.8 a	12.3 a
B	59.7 a	60.5 b	12.0 a
C	62.5 a	59.7 a	12.7 b

*Numbers followed by the same letter do not differ significantly at P = 0.05

In the Drayton field summary (Table 7) protein in zone C was significantly lower than zones B and A. Yield and test weight showed no significant differences. Protein in zone C may be lower because conservative nitrogen credits given in zone A & B provided sufficient nitrogen above that required to maximize yield and thus increased protein.

TABLE 7. DRAYTON FACTORY DISTRICT WHEAT YIELD AND QUALITY

ZONE	YIELD*	TEST WEIGHT*	PROTEIN*
	bu/ac	lbs.	%
A	58.4 a	59.2 a	13.2 a
B	57.5 a	58.9 a	13.4 a
C	56.2 a	58.6 a	12.3 b

*Numbers followed by the same letter do not differ significantly at P = 0.05

CONCLUSION

This research indicates the program is successful in giving the proper nitrogen credits to maintain a high yielding excellent quality wheat crop. Data also suggests beet tops are mineralizing nitrogen and its becoming available in early spring for the following wheat crop. Research by Dr. John Moraghan, Dr. Larry Smith, and Dr. Dave Franzen indicates a heavy, green beet canopy can supply nitrogen to a wheat crop comparable to a 150 lbs./acre application

of urea or anhydrous ammonia. However, normal field variability will always exist. American Crystal Sugar Company's goal is to reduce field variability, on farm input costs, and environmental concerns, while simultaneously maximizing revenue per acre by increasing future sugar content. Producers should feel very comfortable using these guidelines to successfully grow wheat following sugarbeets. Two other benefits of this program are the environmental impact and economic savings to the grower. ACSC growers reduced actual nitrogen application by 2,000 tons over 50,000 acres, in 2001. These benefits reward growers who continue good stewardship of the land and reduced their input costs by approximately $500,000.

Agriculturists and growers can use these results or yield monitor results from beet top nitrogen credit managed fields to determine if different yield goals might be necessary for different management zones within a field. Some variability in the data from individual factory districts may have been influenced by the variety of wheat planted and its yielding ability, as well as local variability in weather patterns.

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