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The effect of variable rate nitrogen fertilization based on grid, topography and conventional soil testing on sugarbeet yield, quality and profitability.

Variable rate nitrogen (N) application based on grid soil testing was in its infancy, relative to sugarbeet production, in 1995. In 1996, between 115 and 125,000 acres of sugarbeet production in Minnesota and North Dakota was fertilized using this technology. A major drawback of grid soil testing is the cost associated with sampling and soil analysis. In 1995, Hollands[1] reported on the relationship between soil topography and N level differences. The use of topography and zone soil testing was viewed as a method of reducing the costs associated with grid soil testing, as well as providing the producer with elevation information for drainage purposes. No correlation between the two systems and the conventional soil test and single rate application was available on sugarbeet yield, quality and return.

Objective:

The objective of this trial was to compare variable rate N application based on the grid soil test, zone soil test based on topography and the conventional random soil test and single rate N application for profitable sugarbeet production.

Procedure:

A 50-acre field, in a three-year sugarbeet rotation (sugarbeet, wheat, barley) at the Northwest Experiment Station, was conventionally and grid soil tested in October 1996. Headlands were not included in either sampling or used in the trial. Nitrate-nitrogen (NO_3-N) was determined at the 0-6", 6-24" and 24-48" soil depths. The conventional sampling consisted of 30 probes in a random pattern throughout the field. Twenty grids, 2.5 acres in size, were utilized with the grid sampling. Soil analysis was done at AgVise Soil Testing Lab, Northwood, ND. Mapping was done by Centrol at Twin Valley, MN.

A laser generated field topography was done upon harvest of the barley crop. Based on elevation differences, the field was divided into three zones and the NO_3-N information from the geo referenced grids soil tests points was overlayed to determine if additional sampling was needed. Four additional soil samples were removed from the highest elevation of the field, with three additional samples from the lowest elevations. Three grid points which fell on dividing lines of the three zones were not used in determining nitrogen needs.

The test field was divided into nine strips (RBD with 3 replications/Trt) and N was variable rate and conventionally applied based on the grid soil test, zone soil test based on topography and conventional random soil test on May 13, 1997. As the trial was designed to only look at N fertilization, a broadcast application of 46 lb/A P_2O_5 was applied to the entire field to insure adequate phosphorus availability. The trial was harvested September 24 and 25 with two sugar samples

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[1]Hollands, K. 1995. Relationship of nitrogen and topography. Sugarbeet Research and Extension Reports. 26: 123-128.

removed from each truck load. Samples were analyzed daily at the ACSC quality lab in East Grand Forks, MN.

Results and Discussion:

Grid soil sampling gave an accurate estimate of <u>total</u> soil NO_3-N variability in the 0-4' profile. The test field average with conventional random sampling was 83 lb/A NO_3-N, whereas with grid sampling the level varied between 15 and 169 lb/A (Table 1). The current nitrogen recommendation for a 20-ton sugarbeet crop is 120 lb/A of soil plus added fertilizer nitrogen in the 0-4' soil profile. These guidelines assume a 30 lb level of residual nitrogen in the 2-4' depth that is subtracted from the soil test value, and that 80 percent of the remaining nitrogen is available for the plant growth. Additionally, NO_3-N levels less than 30 lb/A (2-4') were adjusted for by taking 80 percent of the difference less than 30 lb/A and adding this to the surface application. Taking into account these

Table 1. Total NO_3-N in 0-2' and 2-4' Soil Profile by Grid (lb/A)				
14 0-2' <u>3 2-4'</u> 17	11 <u>3</u> 14	72 <u>81</u> 153	68 <u>66</u> 134	91 <u>78</u> 169
12 <u>3</u> 15	25 <u>15</u> 40	39 <u>51</u> 90	21 <u>21</u> 42	11 <u>3</u> 14
17 <u>3</u> 20	70 <u>18</u> 88	77 <u>24</u> 104	20 <u>3</u> 23	19 <u>6</u> 25
14 <u>3</u> 17	85 <u>39</u> 124	52 <u>18</u> 70	44 <u>27</u> 71	85 <u>21</u> 106

Conventional: 83 lbs (0-2':38, 2-4':45)

guidelines, the conventional soil test in this study showed 50 lb/A nitrogen <u>available</u> for the 1997 sugarbeet crop.

Table 2 shows the recommended N level by grid compared to that from the conventional random soil sampling technique.

The laser generated topography map of the test field is shown in Figure 1. The highest elevation of the field was 0.25 feet above the benchmark with the lowest elevation of the field 5.1 ft below. The highest elevations are in the NE section of the field with a high ridge running N-S in the center. The three zoned areas for variable rate fertilization are labeled L, M, and H, with L being the lower elevation of the field and H the highest. The $N0_3$-N level in the 0-4' soil profile at the low, medium and high elevation zones were 24, 78, and 152 lb/A respectively. A comparison of the N recommendations by soil sampling methods at geo-referenced grid points is shown in Table 3.

Table 2. N-Recommendations by Grid (lb/A)				
128	131	7	23	0
130	107	56	92	131
124	80	48	122	120
128	28	78	74	42

Conventional: 70 lb/A

Figure 1. Laser Generated Field Topography and Grid Sample Points

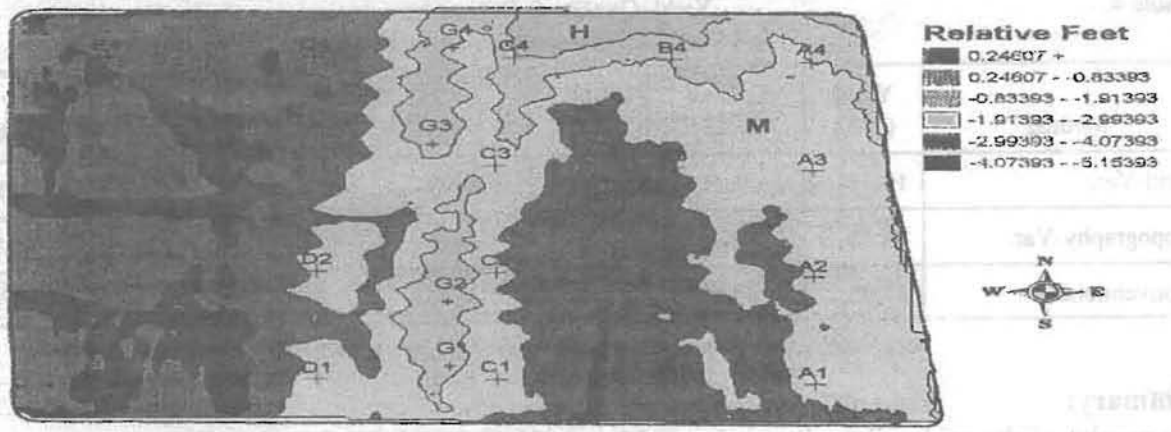

Table 3. Comparison of the N-Recommendations by Soil Sampling Method at Geo-Referenced Grid Points				
128G 114T 70C	131 114 70	7 14 70	23 14 70	0 14 70
130 114 70	107 114 70	56 73 70	92 114 70	131 73 70
125 114 70	80 73 70	48 73 70	122 114 70	120 73 70
128 114 70	28 73 70	78 73 70	74 114 70	42 73 70

G=Grid; T=Topography; C=Conventional

The yield, quality and gross return by the various soil sampling and application methods is shown in Table 4. Grid soil sampling and variable rate N application increased yield by 1.53 ton/A, net sucrose by 0.30 percent and gross return by $91/A compared to the conventional random soil test and single rate fertilizer application. Soil sampling by zone based on topography and variable rate N application increased yield and gross return over the conventional by 1.17 ton/A and $46/A respectively, but did not increase net sucrose percent. Analysis of the individual replications of the trial showed the highest yield and lowest net sucrose percent on the north side of the field and lowest yield, but highest net sucrose percent on the south. This was consistent over all treatments and replications. The northern side of the field had the largest acreage in the higher elevation zone, while the southern side had the least.

Table 4. **Yield, Quality & Return by Soil Sampling & Fertilizer Application**

Method	Yield (T/A)	Sucrose (%)	LM (%)	Rec. Sucrose (lb/A)	(lb/T)	Return ($/T)	($/A)
Grid-Var.	19.51	17.61	1.48	6293	322.7	43.05	839
Topography-Var.	19.15	17.31	1.50	6050	316.1	41.50	794
Conventional	17.98	17.32	1.49	5690	316.6	41.62	748

Summary:

The results of the grid soil testing and variable rate N application, compared to the conventional single soil tests and rate method, are consistent with the data obtained in such comparisons at the Northwest Experiment Station over the past four years. The results from variable rate N application based on topography and zone soil testing are encouraging from a yield and gross return point of view, but discouraging from no improvement in net sucrose percent. An infra-red aerial image of the test field at harvest, that was ground truthed, revealed an area of dense, green canopy extending beyond the medium elevation zone and that by adding an additional zone an increase in net sucrose percent may have resulted.