DEVELOPMENT OF A MODEL FOR PREDICTION OF ORGANIC MATTER ZONES

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Introduction:

Organic matter (Om) varies in the Southern Minnesota Beet Sugar Cooperative growing area. Nitrogen management in sugarbeets is essential to maximizing yield and quality of the crop.

Methods and Materials:

Research in 2003-2006, in cooperation with Dr. John Lamb, University Of Minnesota, St. Paul determined that levels of organic matter can influence the sugar percent and purity of the sugarbeet. A study was initiated in 2006 to determine the influence that Om has on nitrogen mineralization and if Om can be successfully predicted across the growing area. Research conducted in cooperation with Dr. John Lamb, University Of Minnesota, St. Paul and Dr. Albert Simms NW Research & Outreach Center, University of Minnesota, Crookston determined that Om level can influence mineralization of Nitrogen. The data shows that nitrogen mineralized throughout the production season has a good correlation (R^2 0.79) to Om levels.
Satellite imagery of bare soil was investigated for development of a model for prediction of organic matter variance within a field. It was assumed the color of the soil on a greyscale would correlate to Om. With the assistance of Dr. Dan Humberg, South Dakota State University, Brookings, SD, Landsat 5 satellite imagery was used. Multiple combinations of the wavelength bands pixel values from multiple years were compared to geo-referenced soil samples. Bands with the highest correlations to actual organic matter were used for the model. As organic matter tends to follow elevation, elevation was added to the model. Dr. Richard Horsley, Department of Plant Sciences, NDSU, Fargo, ND conducted analysis of the data and produced an algorithm used to define the Om zones. The completed model utilizes elevation data along with three different wavelength bands and correction factors to produce the final product. The model for predicting Om zones was incorporated in mapping software that was used to process a predicted Om map using the model. There are a maximum of 5 zones numbered 2 thru 6. The predicted zone number does not predict the actual Om, but rather delineates Om zones are delineated as 0-3%, 3-4%, 4-5%, 5-6% and 6% and greater. Soil samples were compared to the zones to test accuracy of the model for prediction of Om zones. A statistical significance of 0.048 and a R^2 of 0.882 was achieved using 258 samples from 5 fields in the growing area. In 2009 a pilot program was designed to test if the model would influence sugarbeet yield and quality on a whole field basis. The test was initiated in the 2010 growing season. Six fields were used for the test. Each organic matter zone was soil sampled to a 48 inch depth and nitrogen was adjusted to a given level to adjust for predicted Om mineralization. If Om ranged from 0-3%, N was adjusted to 120 lbs., 3-4% was adjusted to 110 lbs. N, 4-5% 100 lbs. N, 5-7% 90 lbs. N and Om above 7% was adjusted to 70 lbs. N. Within each field, a test strip using grid sampling technology and a test

strip using conventional sampling were added to compare the zone program to represent different soil sampling methods. It was found that total N to 4 feet averaged 51 lbs. in zones 3-5 and zone 6 averaged 321 lbs. Two sugarbeet samples collected from 10 foot of row were harvested from each geo-referenced soil sample location. A total of 406 samples were collected and analyzed at the Southern Minnesota Beet Sugar Cooperative quality Lab. In the first analysis, sugarbeet samples from organic matter zones adjacent to the test strips were used to compare zone, grid and conventional fertility management.

Results and Discussion:

The results showed that of the six fields, four had higher sugar in the zones. Five of the six fields had higher purity, three of six fields had higher tons and five of the six fields had higher net revenue in the zones than in the grid or conventional. Net revenue was calculated by taking the sugarbeet payment minus the costs associated with sampling, mapping, application and the cost of fertilizer. In further analysis of the data, all Om zones were weighted to equalize the zones impact on the means of the data in comparison to the grid and conventional. For example, if one zone covers 30 acres and another is 5 acres, the zone with the larger area (acres) would have a greater influence on the mean and bias the data toward that zones result. To best evaluate the influence of managing nitrogen by zone of varying Om levels, it was concluded that the zone data needed to be weighted to equalize the data across each zone. Zone six was not considered in the analysis of the results since the nitrogen level was very high and therefore, the nitrogen could not be managed by Om. Sugar in the Om zones increased 0.1% over the grid method and 0.7% over the conventional method. Purity in the Om zones increased 0.3% over the grid method and 0.9% over conventional method. Tons per acre increased 0.8 tons per acre over the grid method and 1.2 ton per acre over the conventional method. Net revenue in the Om zones increased $69.81 per acre over the grid method and $78.55 per acre over the conventional method. In 2011 the test was repeated, six fields were used for the test; however, the results were inconclusive. Heavy rains delayed planting until mid-May; a majority of the test fields were planted into wet soils. An abnormal hot and dry late summer slowed sugarbeet growth and N mineralization by Om. Harvest stands were variable due to disease and accurate sampling was not possible. For 2012, four fields were planted to sugarbeets and managed using this program. There was a small increase in tons and a small decrease in sugar and purity. Analysis of the results showed there was no significant difference in the zones. When the data was combined for the three years, 2010, 2011 and 2012, the zones showed an increase in sugar, purity and revenue. There was a small disadvantage in tons. A study was started in 2012 to verify the nitrogen recommendations for each Om level. The data, thus far, suggests that the Organic Matter Zone program should be successful in most growing conditions. The purpose of the program is to enhance profitability for the grower by optimizing sugarbeet production. A cooperative effort by consultants, retailers, advisors and growers is essential to the success of the program. As a result of this research, a tool is available to soil sample contractors (consultants) via the Southern Minnesota Beet Sugar Cooperative website. The purpose of the tool is to optimize the production of sugar across a given field by the use of organic matter zones to determine soil sampling points and management of nitrogen. SMBSC has secured a patent for this organic matter mapping system. Consultants that have been approved for access to the site can select a field by entering the location of the field via designating county and or township along with common land unit (CLU), 40 code (a code used to identify one quarter of a township section). or drawing tool. The consultant will be able to observe the number of zones and acres per zone to determine if they

want to purchase the selected field. For 2012, fields that are used for sugarbeet production can be purchased at no charge. The download options for the organic matter zone maps are in the format of shapefile, geo-referenced bmp and tiff, and pdf files. Once a shape file is downloaded, the zone boundaries can be changed by the soil sampler, if needed. Spreader maps can be produced based upon the organic matter zones. Layers of information such as yield and veris maps can be overlaid to enhance the organic matter map. Presently the area available for organic matter maps is determined by the Landsat image used for development of the project and covers the majority of the SMBSC growing area. The area available for mapping will be investigated for expansion as the program is further developed and needs are assessed.