INITIAL INVESTIGATIONS OF POOR SUGARBEET AREAS

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INTRODUCTION

There have recently been grower concerns over certain poor-growing areas of sugarbeet in the Red River Valley (Figure 1). These areas grow good crops of small grains, corn or soybeans, but when planted to sugarbeets, marked differences in growth are observed from shortly following emergence through to harvest. Seedling leaves are usually curled more prominently than normal inward, with a purple rim are the leaf edge (Figure 2). Later in the season, the curling and purpling become less pronounced. Sugarbeet seedlings, though at the same leaf growth stage as normal growing beets, are shorter in height and lower in seedling weight. Although the rows may eventually fill in, final yields are lower at harvest than normal growing areas.

Grower investigations using additional N and surveying for herbicide carryover or phytotoxicity in these areas have not been successful in determining the reason for the poor growth. The objective of this first year of investigation was to determine likely causes of this poor growth as a step towards means of correcting the problem through means of soil amendments if possible.

Figure 1. View of Downer field, 6-leaf stage. Poor beets in foreground.

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Figure 2. Stunted seedling, 6-leaf stage, Downer field.

METHODS

Two sites were selected. The first site was located 3 miles north of Downer, MN. This site contained an area with about 20 affected acres. Prior to planting, three sampling transects were established, with 13 points within each transect, and each transect point was 30 feet apart. The transects were designed to begin in the middle of the affected zone, and end with three points approximately into the more normal growing beets. The end points of the transects were georeferenced. Cores were extracted from each sampling point to 4 feet. Core increments of 0-6 inch, 6-12 inch, 12-18 inch, 18-24 inch, and 24-48 inch were taken for analysis. Nitrate-N and organic matter was analyzed on all depths. Texture was estimated on all depths at sampling. Nitrate-N, salts (EC), sulfate-S and chloride were analyzed on a separate 6-24 inch core depth. Nitrate-N, P, K, pH, EC, organic matter, sulfate-S, Zn, Mn, Cu, Fe, Ca, Mg, and chloride were analyzed on the 0-6 inch core.

The second site was located about 2 miles southwest of Galchut, ND. Although an estimate of the gradient from poor to normal growing beets was estimated in marking off and sampling the transects prior to planting, the result was that the transects ended up parallel to the gradient rather than perpendicular to it as at Downer. Therefore the south transect was in the poorest beets and the north transect was placed in poor, but better growing beets.

Transects were also placed and sampled in two fields going to sugarbeets in 2001. These transects were also georeferenced, so that approximate areas could be used for treatments in 2001.

Whole plant samples were taken at the 6-leaf stage and analyzed for N, P, K, Ca, Mg, Zn, Mn, Fe, Cu, S, Na and B. Twenty plants were taken to represent each transect location. Twenty plants were cut at ground level and stored in a cooler. They were weighed following drying prior to grinding in preparation for analysis.

In addition to the transect samples, 0-6 inch soil samples and plant samples were also taken from another sugarbeet field west of Galchutt 3 miles. Three pairs of samples were taken from "normal beets" next to "poor" beets. These samples were subjected to the same analysis as the transect samples.

Results

Out of all of the comparisons, plant and soil magnesium content (Mg) is most consistently related to plant dry weight, yield and recoverable sugar per acre (Figure 1).

Table 1. Correlation of plant and soil factors with 6-leaf dry weight and yield. (indicates significance at 5%, * indicates significance at 1 %.)**

Factor	Downer				Galchutt			
	Dry wt.	Yield	% sugar	RSA	Dry wt.	Yield	% sugar	RSA
P* N	*							
P P	*	*						
P K								
P S	*							
P Ca	*	*		*	*			
P Mg	*	*		*	*			
P Na				*				
P Zn	*							

P Fe	*				*			
P Mn	*						**	
P Cu	*	*		*	*			**
P B	*	*						
S* N	*	*			*			
S P	*	*						
S K	*	*		*				
S pH	*				*			
S EC	*	*		*				
S OM	*	*		*	*			
S S	*				*			
S Zn	*							
S Fe								
S Mn	*							
S Cu	*							
S Ca					*			
S Mg	*	*		*	*	**		**

The magnitude of the difference between low dry weight/yield sugarbeets and higher dry weight/yield sugarbeets is also in favor of Mg levels in plant and soil (Table 2). Although some nutrient levels such as N, Ca and Cu were sometimes correlated with dry weight, the magnitude of the difference between beet types is small compared to the difference in Mg content at each location.

Table 2.Comparison of transect plant nutrient concentrations at each site between transect points with lower than mean dry weight and above mean dry weights.

Plant content	Galchutt		Downer	
	< 4.6 g dry wt.*	> 4.6 g dry wt.	< 4 g dry wt.	> 4 g dry wt.
%N	3.2	3.6	3.2	3.4
%P	0.21	0.29	.22	0.25
%K	0.54	5.0	.54	0.52
%S	0.29	0.36	.3	0.33
%Ca	2.01	1.46	2.04	1.66
%Mg	**0.7**	**2.03**	**0.66**	**1.49**

%Na	1.34	1.42	1.31	1.41
ppm Zn	9.6	13.5	10	11.4
ppm Fe	459	78.6	465	641
ppm Mn	45	60.7	46	53.1
ppm Cu	2.3	3.6	2.2	3.1
ppm B	19.9	23.4	19.9	21.9

* weight of ten plants at 6-leaf stage.

The soil in which the poor beets appear is different in texture at both sites compared to normal beets. The texture is coarser, and organic matter is lower. It appears especially at the Downer site that significant wind erosion has resulted in a thin organic matter horizon near the surface. Both sites also have limiting layers underneath the sandy topsoil. At Downer, the limiting layer appears to be a paleosol of heavier texture and slightly darker color than the horizon directly above. At Galchutt, the limiting layer is heavier textured lacustrine material. Both situations lend themselves to a leached environment.

Nitrogen and sulfur test levels tended to be lower in these poor-growing areas, probably due to the history of leaching and lower organic matter levels. However, the appearance of the sugarbeets, the lack of major differences in plant content between poor and normal beets of these two nutrients and grower experiences in the past suggest that these lower soil levels play only a minor role at best in causing the severe growth reductions observed.

The Galchutt site is lower in pH in the poor growing areas and it is easier to understand that Mg might be a problem there than at Downer where the pH is over 7. However, there is evidence in the literature that higher Ca levels in the soil may result in preferential replacement of Mg with Ca on soil exchange sites, causing increased leaching and depletion of that element.

SUMMARY

In an investigation of the possible causes of poor sugarbeet growth in certain coarse-textured, low organic matter areas, lack of available magnesium appears to be a likely factor. Subsequent research will apply a variety of treatments containing magnesium, including sugarbeet waste lime, in order to determine if magnesium amendments will help to solve this problem.

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