Project Proposal

Sugarbeet Research and Education Board of MN & ND

FY 2018-2019

Project Title: Variation in plant tissue concentration among sugarbeet varieties

Project Number/Description: Continuation Project (U of M CON-65087)

Project Leader: Daniel Kaiser – University of Minnesota Twin Cities

Other Personnel Involved: Mark Bloomquist, Agricultural Research Department, Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota; David Mettler. Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota

Total request for 2018-2019: $26,562

Project Location: Four field sites will be selected (TBD) in conjunction with the Southern Minnesota Beet Sugar Cooperative on farm research site network.

Project duration – 4/1/2018 – 3/31/2019

Justification for Research: (For new projects only) – Plant tissue analysis has increasingly been used for crops as a tool to fine tune nutrient management. Plant analysis was developed as a diagnostic tool and is generally not been used to determine nutrients to apply. For sulfur, analysis of sulfur in plant tissue is commonly determined using inductively coupled plasma emission spectroscopy (ICP) even though older data that is typically used to develop sufficiency ranges may have been determined by dry combustion. Recent work in Minnesota on corn and soybean has found differences in the assessment of sulfur concentration by ICP versus combustion. Comparison of methods of analysis for sulfur for additional crops such as sugarbeet would help to determine the accuracy of ICP and where additional research in correlation of plant tissue tests to crop yield should be conducted. If differences in the methods can be documented it would indicate that sugarbeet growers should exercise extreme caution when interpreting plant tissue results for sulfur.

Plant tissue analysis has resulted in more recent questions on boron application than other micro-nutrients. Reports that list boron as being low typically suggest a foliar application of boron containing fertilizer sources. However, there is no documented evidence that tissue sufficiency ranges currently used are accurate and that when a low tissue boron concentration is reported that application will increase crop yield. Comparisons of yield response to tissue concentration are needed to provide evidence that a sufficiency range actually has meaning when deciding if fertilizer should be applied.

Recent surveys of corn, soybean, and hard red spring wheat plant tissue has shown significant variation in nutrient concentration when multiple hybrids/varieties are sampled in the same field at the same time. If taken at face value, tissue nutrient concentration should be reflective of soil nutrient status. Past research on corn, soybean, and wheat showed a significant portion of the variation in nutrient concentration was due to growth stage differences among hybrids/varieties at sampling. What needs to be addressed for sugarbeet if the degree of variation in tissue nutrient concentration in petioles and leaf blades for varieties grown at multiple locations and years and whether plant tissue analysis can be related to root or sugar yield. If there is significant variation in concentration that is reflective of genetics and not of yield potential, there should be a significant degree of caution when interpreting tissue results without further documentation of deficiencies with additional analysis such as soil tests.

Summary of Literature Review: (For new projects only)

Plant tissue analysis is being utilized more as a tool to determine whether nutrients should be applied in-season to maximize yield of crops. Plant analysis is only suggested for use for diagnosing problems that may occur in field (Kaiser et al., 2013). Fertilizer decisions should be made using soil samples which have been correlated and calibrated to crop response. Never the less, samples are being taken in fields and are being used to sell products which are likely not needed. Databases on "sufficient" levels for nutrients have been developed for use in diagnosing problem areas within fields (Bryson et al., 2014). It is not known whether these sufficiency values were generated using crop response data that documents that yield will be reduced when tissue concentrations are below the stated sufficiency level. It is more likely that the sufficiency values used currently for nutrients such as sulfur or boron are developed based on tissue concentration averages for plots where either nutrient was added but no yield response was achieved. Since both boron and sulfur can be taken up by plants in excess quantities, utilizing averages values of fertilized plots can result in the development of sufficiency ranges that are higher than what would actually be required for maximum crop yield. Most of the research previously cited has shown the effects of boron or sulfur on petiole or leaf blade boron or sulfur concentration the works have not taken the next step in correlating it to crop yield.

Understanding potential sources of variation is important when interpreting plant tissue analysis results. One major source of variation can be differences in uptake patterns among hybrids or varieties. In Minnesota, unpublished survey data for corn and soybean and published data for hard red spring wheat (Kaiser et al., 2014b) found significant variation among hybrids/varieties for a majority of the nutrients analyzed. For the wheat trials, the majority of the variation in nutrient concentration across locations could be attributed to when the samples were collected and the stage of development of the plant at the time of sampling. For all crops the variation in yield could not be explained by one or more nutrients measured in the plant tissue. For sulfur, data collected from multiple crops has noted differences in the amount of sulfur reported in plant tissue based on how the samples are analyzed in the lab (Sterrett et al., 1987). These sources of variation indicate that varieties may have their own sufficiency range for nutrients and that

ranges need to be developed based on specific laboratory methods used to determine the concentration of nutrients in plant tissue.

Objectives:

1. Compare nutrient concentration in petioles and leaf blades among varieties at three sampling times.
2. Determine if tissue nutrient concentration is predictive of root and sugar yield when sampling adequately fertilized fields.

Materials and Methods: (Briefly Describe) Six sugarbeet varieties (Beta 92RR30, Beta 9475, Crystal M509, Crystal M579, Crystal RR018, and Maribo MA109) will be planted at four locations and tissue analysis samples will be collected at three sampling times over the growing season. Varieties will be planted in four replications at each site. Sampling times will be mid-June, early July, and late July to early August. The newest developed leaf will be sampled. The petiole and leaf blade will be sampled separately. All samples will be dried, ground, and analyzed for nitrate N via extraction with 5% acetic acid, total N by combustion, and P, K, Ca, Mg, S, B, Cu, Fe, Mn, and Zn by ICP. A single composite soil sample consisting of six to eight cores will be taken from the 0-6, 6-24" depths from each site each time soil samples are collected and will be analyzed using recommended procedures of N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, and Zn. Weather data as well as other pertinent information (planting date, day of sampling) will be used and regressed with tissue concentration to determine what factors may be important for the prediction of root and sugar yield.

Progress Toward Objectives of On-going Projects:

- Four field locations were established in the southern growing region in 2017 near Clara City, Lake Lillian, Murdock, and Renville. Six varieties were planted and sampled three times, third week in June, second week in July, and near the end of July. All trials were harvested and data was generated for root yield and sugar content.
- Soil samples were collected at each sampling date but the sampling depths were modified from 0-6, 6-12, and 12-24" to 0-6" and 6-24". This change is reflected in the 2018/2018 proposal. The Clara City location was planted late so the sample timings were offset by one date compared to the other sites (Clara City sample date 1 coincided with sample date 2 at the remaining three locations).
- Petiole and leaf blade samples were collected as planned. At the time of this proposal, all soil data and total N + ICP data for sample dates 1 and 2 have been returned from the labs Petiole and leaf blade date 3 have been sent out to Brookside labs for analysis but the data are not yet retuned at this time.
- The data I have has been organized into a master data sheet for each of the sample timings but has yet to be statistically analyzed. Analysis of the data will be completed for the R&E board reporting meeting in January summarizing petiole and leaf blade nutrient

concentrations for each of the sampling dates, correlations among the sampling dates, and a correlation to root and sugar yield. All three dates should have completed total N + ICP analysis at that time.

I still have to complete the petiole and leaf nitrate analysis which will be analyzed in January-February 2018. Harvest data and quality data have also been calculated. At time I am on schedule to meet with goals for the 2017-2018 growing season. Potential locations are being sought for four new trials for 2018.

Time Line of Anticipated Accomplishments:

Year 1 - 2017	Year 2 - 2018	Year 3 - 2019
Spring	**Spring**	**Spring**
Plant sugarbeet in plant analysis trials. DONE	Plant sugarbeet in plant analysis trials.	Plant sugar beet for plant analysis trial
Summer	**Summer**	**Summer**
Petiole and leaf blade sampling –all trials, soil samples collected from plant analysis trial DONE	Petiole and leaf blade sampling, soil samples collected from plant analysis trial,	Petiole and leaf blade sampling, soil samples collected from plant analysis trial,
Fall	**Fall**	**Fall**
Harvest sugarbeet and process plant and soil samples DONE	Harvest sugarbeet and process plant and soil samples	Harvest sugarbeet and process plant and soil samples
Winter	**Winter**	**Winter**
Analyze and report results,	Analyze and report results,	Analyze and report results, finalize plant tissue analysis study data

Prepare a budget for each research project:

Budget: The budget has salary and fringe in it for a civil service person (12.5% time) located in St. Paul to supervise work on the research trials and for undergraduate labor used for the study to collect and process plant and soil samples (300 hours @ $10 per hour). The plant analysis is for sugarbeet petiole and leaf blade sulfur analysis is for this study by dry combustion and ICP (576 samples @ $12 per sample). The soil analysis is for soil samples for this research. The lab services charge is for fees for grinders used to process soil and plant samples. Supplies include fertilizer and plant and soil sampling supplies used for the study and lab supplies purchased to analyze nitrate in the petiole samples. The travel is for use of University vehicles and PI's personal vehicle to travel to plots to do work

Item	2018-19	2019-20
Travel	$4,500	$4,500
Civil Service Labor	$7,500	$7,725
Fringe @ 27.2%	$2,040	$2,102
Undergrad Labor	$3,000	$3,000
Soil Analysis	$1,260	$1,260
Plant Analysis	$6,912	$6,912
Postage	$100	$100
Supplies	$750	$750
ISO Fees/Equip Rent	$500	$500
Total	$26,562	$26,849

Total Budget Request for 2018-2019

Item	Total
Travel	$4,500
Civil Service Labor	$7,500
Fringe @ 27.2%	$2,040
Undergrad Labor	$3,000
Soil Analysis	$1,260
Plant Analysis	$6,912
Postage	$100
Supplies	$750
ISO Fees/Equip Rent	$500
Total	$26,562

Total request for 2018-2019: $26,562

$4,500 – Travel: travel to and from St. Paul to study locations for the collection of samples and for the cost of travel to outreach meetings within Minnesota related to the project

$12,540 – Labor: Associated costs for full time civil service labor (including 27.2% fringe) and 500 hours of undergraduate labor used in the study

-$7,500 civil service salary

-$2,040 civil service fringe

-$3,000 for undergraduate salary

$750 –Supplies: covers the cost of fertilizer soil and plant sampling bags, and other sampling supplied used in the field and for samples purchased for nitrate analysis of petioles in the lab

$100 – covers the cost of postage for mailing plant samples out to private labs for analysis

$500- covers the cost associated with U of M ISO fees for equipment used for collecting and processing samples for the trials

$8,172 – lab analysis to cover the cost associated with soil and plant tissue samples collected for the studies. The amount requested and cost per sample will vary by study.

Literature Cited

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Note: Add additional pages or photocopy these forms as needed.