ABSTRACTS

of Oral Presentations and Posters

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PREFACE

The following section contains abstracts of papers/posters presented at the 37th Biennial Meeting of the American Society of Sugar Beet Technologists.

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Section A – Agronomy
Oral Presentations

BREDEHOEFT, MARK W.[1*], CHRIS DUNSMORE[1] and JOHN A. LAMB[2]. [1]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284 and [2]Department of Soil, Water, and Climate, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108. **PCC use in Southern Minnesota — a success story of collaboration between research and production.**

The sugarbeet industry is blessed with a co-product in mass quantity sometimes referred to as spent lime, but more appropriately referred to as Precipitated Calcium Carbonate (PCC). The use of PCC as an agronomic tool to enhance sugarbeet production has been a subject of research efforts since the late 1980's. Dr. Alan Dexter and Dr. Carol Windels conducted research showing PCC can reduce effects of imidazilone herbicides and Aphanomyces cochloides to sugarbeets. Studies conducted in the late 1990's by Southern Minnesota Beet Sugar (SMBSC) research showed significant benefit to PCC applications for sugarbeet and field corn production. More recent research conducted by SMBSC and University of Minnesota has shown that soil root indices of Aphanomyces cochloides and Rhizoctonia solani were reduced due to applications of PCC. University of Minnesota and SMBSC research initiated in 2008 and finalized in 2012 has shown that PCC applied 2 years in advance of crop production was the most advantageous compared to 1 and 3 years ahead of crop production. Sugar beet and field corn yields were increased 23-30% and 22-35%, respectively with 4, 8 and12 ton of PCC applied per acre. The cooperative research efforts between University personnel and SMBSC have led to grower acceptance of this research and have developed into a successful program of PCC use in the southern Minnesota region. As a result of research conducted and its adoption by growers southern Minnesota farmers have increased the use of PCC since 2001 by 6 fold. This accounts for a successful story of research to the farm.

COBURN, CARL W.* and ANDREW R. KNISS. University of Wyoming, Department of Plant Sciences, 1000 E. University Avenue, Laramie, WY 82071. **Comparison of the eco-efficiency of conventional and glyphosate-resistant sugarbeet herbicide treatments.**

The rapid adoption of glyphosate-resistant sugarbeets has largely displaced conventional production. Eco-efficiency analysis allows the comparison of production systems by quantifying the level of output per unit of input environmental risk. Using herbicide treatment and yield data from studies located in multiple growing regions in the U.S., an eco-efficiency analysis was performed on conventional and glyphosate-resistant herbicide treatments. The risk quotient method for various impact categories based on toxicity and amount applied enables a measurement of the environmental risk for an herbicide. The models GENEEC2 and SCI-GROW were used to estimate potential surface and ground water concentrations resulting from herbicide treatments. Avian, aquatic, and terrestrial risk was determined using widely available toxicity data for indicator species. The eco-efficiency of herbicide treatments was measured by dividing the yield by the sum of the risk-quotients of each herbicide for a particular impact category. Greater values of eco-efficiency correspond to less environmental risk per unit of sugar production.

HERGERT, GARY W*, ROBERT H. WILSON, ROBERT M. HARVESON, JEFFREY D. BRADSHAW and REX A. NIELSEN. University of Nebraska Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361. **Agronomic potential and limitations of using precipitated calcium carbonate in the High Plains.**

Precipitated Calcium Carbonate (PCC) is a by product of the sugar purification process. PCC has been shown to improve yields in the Red River Valley but has not been tested in the High Plains region. The ECC of PCC is about 42% and it also contains some N and P. The objective of this research project was to investigate the effect of PCC on soil chemical and physical properties and the impact of PCC on crop yield. A greenhouse study was conducted by mixing PCC with soil collected from ten soil types from NE, WY, and CO. Five PCC rates (0, 5, 10, 15, and 20 tons per acre) were used. There was no significant difference in plant dry weight on sugar beet (*Beta vulgaris* L), corn (*Zea mays* L.), or dry bean (Phaseolus vulgaris L.) 7 weeks after planting in the greenhouse. There was no significant difference in soil pH after dry matter harvest. PCC piles support a dense growth of Kochia (*Kochia scoparia* (L.) Roth) in wetter years. Seeds were collected from PCC piles in CO, NE and WY and grown in growth chambers and treated postemergence with glyphosate, atrazine or dicamba to develop dose response curves. The kochia populations collected from each site were susceptible to glyphosate,

atrazine and dicamba. Ten locations were chosen from grower fields in 2012 in CO, NE and WY. Seven fields were planted with sugar beet, two with corn, and one with dry beans. The experimental design was a Latin Square, with four replications and four PCC rates: 0, 4, 8, and 12 tons per acre. PCC was applied early spring and incorporated. Fields were monitored during the growing season for effects of PCC on plant growth, diseases severity and final yield. There were no negative effects of PCC on crop growth during the season. Growing season observations for *Aphanomyces* expression and final yield parameters at different PCC levels will be presented.

HUBBELL, LEE A.[1]*, JAMES F. STEWART[1], BRIAN J. GROULX[1] and GREGORY M. CLARK[2]. [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Drive, Bay City, MI 48706 and [2]Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI 48706. **Rhizoctonia solani: control measures in Michigan.**

Rhizoctonia solani root and crown rot is a significant problem in the Michigan Sugar Company growing region. The disease is caused by R. solani AG 2-2 IIIB and AG 2-2 IV, which are present in the soil in about equal proportions. Several Michigan Sugar Company varieties have good tolerance to R. solani, however, our most popular varieties lack tolerance to the disease. Fungicide applications are needed to control root and crown rot in most fields. Azoxystrobin (Quadris) is the most effective fungicide available for controlling the disease. Foliar Quadris treatments are applied at a rate of 0.6 fl oz/1000 row feet at the 4 to 8 leaf stage in Michigan. In-furrow (T-Band) Quadris applications have provided somewhat better disease control than foliar sprays. Quadris rates and band widths applied T-band are under investigation and results from this work will be discussed.

JAGGARD, KEITH W.[1]* and E. OBER[2]. [1]Jaggard Consultancy, Norton, Bury St. Edmunds, IP31 3LJ, UK and [2]Rothamsted Research, Harpenden, Al5 2JQ, UK. **Some effects of freezing and subsequent storage on beet quality and sugar yield.**

Does freezing affect beet storage losses? Experiments were done in three seasons using beet grown in boxes containing 33ft3 of soil. Each box grew 16 plants that were exposed to freezing treatments while still growing in the box. Freezing was done in a cabinet for 12 hour nights followed by 12 hour days at 41°F. Treatments differed from season to season but always included 21 and 14°F: exposure was for 1, 3 or 6 nights. Treatments also included a frost-free 'recovery period' (1, 3 or 6 days) prior to harvest, and storage for about 40 days at a range of temperatures (between 50 and 75°F). At harvest, beet were assessed for damage and put into nets for storage in the dark

in still air prior to being washed, weighed and assessed for sugar and impurity concentrations. Exposure at 27°F, even for 6 nights, never damaged roots, but damaged the foliage. Exposure at 21°F damaged 10% (1 or 3 night's exposure) to 65% (6 nights) of the roots. At 14°F, one day's exposure damaged 50% of the beets. Incidence of damage did not decrease during the 'recovery period', even after 8 days. Freezing had little effect on beet weight after storage, but did decrease sugar %. Three or six nights freezing reduced sugar percentage and sugar yield. This effect was mild if the storage was cool (about 56°F) but became very serious if the storage temperature rose into the mid 60's. Between 25 and 35% of the sugar in the stored beet was lost after about 40 days if the beet were allowed to become hot (about 70°F) in the store. The damage was more serious if the freezing occurred in September or October than in November or December. Freeze-damaged beet can be stored without serious loss of yield or quality if they can be kept cool (< 56°F). However, deterioration of all beets is rapid if the storage temperature is allowed to rise to about 70°F. This work was funded by the National Crop Insurance Service.

KAFFKA, STEPHEN R.[1]*, RUIHONG ZHANG[2], ALISSA KENDALL[3], SANTIAGO BUCAREM[1] and JAMES TISCHER[4]. [1]Department of Plant Sciences, One Shields Ave., University of California, Davis, CA, [2]Department of Biological and Agricultural Engineering, University of California, Davis, CA, [3]Department of Civil and Mechanical Engineering, University of California, Davis, CA and [4]Center for Irrigation Technology, California State University, Fresno, CA. **Can sugarbeets be used for energy in California?**

The last factory for sugar production from beets in Mendota in northern California closed in 2009. Recently, the grower-based Mendota Beet Energy Cooperative has formed to develop an integrated biorefinery based on sugar beets for ethanol and other bioenergy products. When developed, the biorefinery will link residual orchard biomass gasification for heat and power, ethanol production from sugarbeets (both advanced and cellulosic), and biogas from both stillage and crop and urban residues. Water and nutrients will be recycled. California's Low Carbon Fuel Standard incentivizes low carbon intensity (CI) biofuels, calculated using Life Cycle Assessment (LCA). Initial LCA estimates for the direct CI of beet ethanol are less than 20 g CO_{2eq} MJ^{-1} of ethanol, compared to more than 96 g CO_{2eq} MJ^{-1} for gasoline. Thirty thousand acres will be needed to produce an estimated 30 million gal of ethanol per year, plus biogas and other byproducts. Additional novel features of the proposed biorefinery call for harvesting beets daily for 12 months, and greater reliance on drip irrigation than previously. To achieve this goal, the previous system of varied planting and harvesting date districts that supported the

older sugar factory must be recreated. Challenges to this plan include important pathogens like beet curly top virus and Cercospora leaf spot, harvesting roots in wet periods in winter, and availability of sufficient annual crop land. To help identify costs of production for growers and the refinery, the California Biomass Crop Adoption model (a partial mathematical programming model) was used to estimate costs in each district, and overall costs to the biorefinerey. Economic and LCA analyses are integrated in this project and are described.

KHAN, MOHAMED F. R.[1]*, MELVIN D. BOLTON[2], GARY A. SECOR[3], and VIVIANA RIVERA-VARAS[3]. [1]Plant Pathology Department, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050; [2]USDA, Agricultural Research Service, 1605 Albrecht Blvd N, Fargo, ND 58102 and [3]Department of Plant Pathology, North Dakota State University, Fargo, ND 58108. **Effect of nitrogen rates, varieties, and fungicides in sugar beet yield and quality.**

North Dakota and Minnesota together produce 60% of the United States sugar beet (*Beta vulgaris* L.) crop of which over 97% is glyphosate tolerant. The objective of this research was to determine the effect of nitrogen rates, cultivars, and fungicides on glyphosate tolerant sugar beet yield and quality. Research was conducted at Foxhome, Minnesota in 2010 and 2011. The experimental design was a split-split plot arranged as a randomized complete block design with four replicates. There were four levels of the whole plot factor, nitrogen rates (78, 112, 146 and 180 kg/ha); two levels of the subplot factor, varieties, (HH 4022RR and Crystal 768RR); and five levels of the subsubplot factor, fungicides (Inspire XT, Headline, Eminent, Proline and non-treated check). Individual plots comprised of six 9 m long rows spaced 0.6 m apart. Nitrogen was incorporated just prior to planting. Weeds were controlled with multiple applications of glyphosate. Single applications of fungicides for their effect on yield and quality were applied on August 20 and 22 in 2010 and 2011, respectively. In 2011, thiophanate methyl was applied in July to the entire experiment to prevent infection by *C. beticola*. Roots were harvested and weighed in late September. There were no significant interactions among the factors evaluated. In both years, N rates of 112 to 180 kg/ha resulted in significantly higher recoverable sucrose compared to 78 kg/ha; variety HH 4022RR produced higher recoverable sucrose than Crystal 768RR; and in 2010, in the presence of severe Cercospora leaf spot, fungicides resulted in significantly higher recoverable sucrose compared to the non-treated check, but in 2011, when Cercospora leaf spot was not a problem, there were no significant differences in recoverable sucrose between the non-treated check and any of the fungicide treatments. Results suggest that current recommendation for

N of 146 kg/ha is still effective; the variety with more resistance to *Cercospora beticola* had greater yields; and fungicides are only necessary in the presence of disease.

KALSO, KEITH W., Michigan Sugar Company, 159 S. Howard Avenue, Croswell, MI 48422. **Alternatives to traditional sugarbeet piling using the Ropa Maus and Holmer Felis cleaner/loader beet machines.**

Michigan Sugar Company and several of its growers have utilized the sugarbeet field cleaning/loading technology that is commonly used in the European beet sugar industry. Since 2002, Michigan Sugar Company has transitioned from one cleaner/loader to twelve operating machines in 2012 (both Ropa Maus and Holmer Felis). Growers who have access to this system are permitted to field pile sugarbeets in field clamps for short periods of time. The cleaner/loader is used to field clean piled sugarbeets and simultaneously load onto large transport trucks for direct-delivery to factory wet hoppers or stackers (modified sugarbeet pilers).

Direct delivery allows traditional sugarbeet receiving stations to remain idle during the pre-pile segment of harvest. This system permits a fresher sugarbeet going to the factory wet hopper than conventional pile receiving operations and offers growers many advantages.

Beet stacking is the next step of direct delivery with the cleaning/loading machine. Stacking takes place during the permanent piling stage of harvest by growers placing sugarbeets in field piles briefly until the loader/cleaner system delivers it to a receiving station stacker piler. The stacker piler is a simplified sugarbeet piler that conveys beets to a boom for placement into a traditional long-term pile.

A historical time-line and the systems development at Michigan Sugar Company will be presented and how traditional beet handling methods have changed. Storage results of long-term stacker piles will be explained.

KNISS, ANDREW R. University of Wyoming, Plant Sciences Dept. 3354, 1000 E. University Ave., Laramie, WY 82071. **Sugarbeet stand in response to encapsulated acetochlor applied pre-emergence.**

A relatively new encapsulated formulation of acetochlor (Warrant, Monsanto Company) is currently registered for use in corn, soybean, and cotton. Previous research has shown this new product to also have some tolerance when applied PRE or POST in sugarbeet. In 2010, sugarbeet stand reduction was observed in research plots in Wyoming where sugarbeet was replanted (due to freezing tempera-

tures) into acetochlor-treated soil. A field study was conducted at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming in 2011 and repeated in 2012 to evaluate safety of encapsulated acetochlor to replanted sugarbeet. Sugarbeet ('Beta 66RR60') were planted in 30-inch rows at a rate of 70,000 seeds/A at 6 dates each year. Herbicide treatments were applied preemergence on the first planting date, and all subsequent planting was done into soil treated at the initial planting date. Herbicide was applied with a CO2-pressurized knapsack sprayer delivering 16.8 gallons of total volume per acre at 30 psi with TeeJet 11002DG nozzles. Plots were 10 feet wide by 30 feet long and arranged in a randomized complete block design with 4 replications. Sugarbeet populations were counted regularly throughout the season. Sugarbeet stand was influenced by acetochlor rate and sugarbeet planting date.

LAMB, JOHN A.[1]*, MARK W. BREDEHOEFT[2], and CHRIS DUNSMORE[2]. [1]Department of Soil, Water, and Climate, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 and [2]Southern Minnesota Beet Sugar Cooperative, 83350 County Road 21, Renville, MN 56284. **Where does turkey litter fit with sugar beet production?**

Turkey litter is a resource available to a large number of sugar beet growers in Minnesota. Earlier research has indicated that it its use was positive for root yield. There are concerns about the late season mineralization of N from the litter and the effect the N will have on root quality. The objective of this study is the determine when in a three year rotation should turkey litter be applied and what the nitrogen fertilizer equivalent of the turkey litter applied two and three years in advance of sugar beet production. To achieve the objectives a study was conducted at three locations for three years at each. The rotation was soybean/corn/sugar beet. The treatments were no N for the whole rotation, 6.7 and 13.4 Mg per ha of turkey litter applied 3 and 2 years before sugar beet production. Besides the 6.7 and 13.4 Mg of turkey litter per ha before corn production, 134 kg N per ha was applied. Before the sugar beet crop in the rotation, 6.7 and 13.4 Mg of turkey litter per ha was applied along with 6 rates of N fertilizer. These treatments were replicated 5 times. At the first two sites, the turkey litter increased soybean yield at one location. This increase was small. Turkey litter and 134 kg N per ha increased corn yields at both locations. At one location, sugar beet quality was not affected by the use of turkey litter. Root yield and sucrose per acre were increased with turkey litter and N fertilizer application.

LORENT, LOUISE*, DAVID A. CLAYPOOL, RYAN E. RAPP and ANDREW R. KNISS. University of Wyoming, Laramie, WY. **Characterizing shade-avoidance responses in sugarbeet.**

Low red:far red light ratio reflected from neighboring vegetation can be detected by plants and can trigger irreversible physiological changes known as shade-avoidance responses. These responses are suspected to determine the onset of crop-weed interaction before competition for resources occurs, and have been documented to cause yield losses in corn and soybean. Because of the biennial character of sugarbeet, the outcome of shade-avoidance responses in this crop could be different. Several studies were conducted to determine the effect of light quality on sugarbeet development and final yield. Pot experiments were conducted in Laramie and Lingle, WY under non-limiting resource conditions using weed species commonly found in irrigated Western crop systems. Sugarbeet was either grown surrounded by weeds or by bare soil. Weeds were removed at different timings between cotyledon and twelve true-leaf stages of sugarbeet development. Sugarbeet was harvested at two different times at Lingle and three different times at Laramie. At each harvest, leaf and petiole length, root diameter, length and weight, leaf area, canopy angle and above ground biomass were measured. Field and pot studies using colored plastic mulch as a way to change light quality environment were also conducted. We evaluated R:FR ratio and length of weed exposure correlation with all parameters measured.

MORISHITA, DON W.*, DONALD L. SHOUSE, J. DANIEL HENNINGSEN and ANDY NAGY. University of Idaho, Kimberly R&E Center, 3806 N. 3600 E., Kimberly, ID 83341. **Are there differences between adjuvants used with glyphosate for weed control in sugar beet?**

A study was conducted in 2010 and 2012 to compare various adjuvants applied with glyphosate applied at 0.5 and 1X rates (0.385 and 0.77 lb ae/A). Betaseed variety 'BTS 26RR14' was planted April 15 and 25, 2010 and 2012, respectively. Experimental design was a randomized complete block with four replications and individual plots were 7.33 by 30 ft. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa at 26 psi using 11001 flat fan nozzles. Crop injury and weed control were evaluated 8, 23, and 86 days after application in 2010 and 17, 27 and 91 days after application in 2012. The two center rows of each plot were harvested mechanically October 7, 2010 and September 27, 2012. None of the treatments injured the crop. Weed response differences were observed between years. Weather conditions during the first 30 days after planting in 2010 were colder and wetter than in 2012. Glyphosate applied at 0.75 lb ae/A with or without any of the adjuvants tested had better overall weed control than glyphosate applied

at 0.35 lb ae/A with or without any adjuvant. Some weed species such as redroot pigweed, hairy nightshade, and green foxtail were effectively controlled with 0.35 lb ae/A with or without an adjuvant. However, kochia, common lambsquarters and Russian thistle control were variable depending on the adjuvant used. Glyphosate + Alliance at 0.35 lb ae/A + 1.25% v/v had the best overall weed control with the lower glyphosate rate. However, most of the glyphosate treatments applied at 0.75 lb ae/A controlled one or more weed species better than glyphosate + Alliance at 0.35 lb ae/A + 1.25% v/v. Root yields ranged from 1 to 34 ton/A and sucrose yields ranged from 368 to 9,283 lb/A. Sugar beet root and sucrose yields were ranked in the same order, which indicates that herbicide treatment did not influence sugar content.

POINDEXTER, STEVEN S.* and THOMAS J. WENZEL. Michigan State University Extension, One Tuscola St., #100, Saginaw, MI 48607. **Comparison of temperature change in defoliated and non-defoliated sugarbeets.**

Research was conducted to compare how fast topped and untopped sugarbeets warm during the day. The trial was initiated during early season delivery on October 4, 2011. Two different topping times were compared (10:45 & 1:30) to untopped beets. Digital temperature probes were inserted 2 inches into the beet crowns and 2 inches into the soil. Temperature readings were taken every 15 minutes. The day was bright & sunny with initial air temperature at 10:45 a.m. about 57 degrees and peaked at 1:45 p.m. at 72 degrees. Sugarbeets that were not topped, gained temperature slowly compared to sugarbeets that were defoliated. Defoliated beets actually increased temperature faster than the air temperature, indicating radiant energy (sun) was also heating the crowns. By 2:30 p.m., the 2 inch beet temperature was higher than ambient air temperature. At the end of the day, the 10:45 defoliated beets were about 13.5 degrees warmer than non-defoliated. Both the 10:45 and 1:30 topped beets increased the 2 inch beet temperature at a rate of 5 degrees per hour compared to about 2.4 degrees per hour for untopped beets.

REGITNIG, PETER J.* and BRYAN R. AVISON, 1Lantic Inc., 5405 – 64th Street, Taber, Alberta, T1G 2C4. **Roundup Ready® canola control in Roundup Ready® sugar beet.**

Commercial canola and seed canola are grown extensively in southern Alberta. With the adoption of a Roundup Ready® sugar beet production system in Alberta, volunteer Roundup Ready® canola (VRCC) is becoming a significant broadleaf weed concern in sugar beet fields. In a density trial conducted on a commercial sugar beet field, a natural infestation of 46 canola plants per 100 feet of sugar

beet row resulted in a significant sugar beet yield reduction of 4.47 tonnes/ac. Control options of VRRC are limited to stale seedbed treatments, in-crop treatment with conventional sugar beet herbicides or roguing canola plants from the sugar beet crop. Trial work between 2009 and 2012 has shown that in-crop treatments that included UpBeet herbicide gave the most encouraging results for controlling VRRC. UpBeet rates ranged from 3.5 to 28 grams/acre in trials and treatments with higher rates of UpBeet generally gave the most consistent levels of VRRC control. In 2011, UpBeet was shown to mix well with Roundup WeatherMax and the addition of Merge oil adjuvant with UpBeet and UpBeet Roundup WeatherMax mixtures resulted in significantly improved canola control. Trials in 2012 showed the only treatments that gave commercially acceptable VRRC control (≥ 80%) included 3 applications of UpBeet. Treatments that had only 2 applications of UpBeet did not result in commercially acceptable final control values. VRRC plants that survived UpBeet application and were not shaded by the sugar beet canopy produced viable canola seed.

STACHLER, JEFF M.* and AARON. L. CARLSON. North Dakota State University, Dept. 7670, P. O. Box 6050, Fargo, ND 58108-6050.
Weed management with postemergence ethofumesate in glyphosate-resistant sugarbeet.

Common lambsquarters and kochia are becoming more difficult to control with glyphosate in glyphosate-resistant sugarbeet in Minnesota and North Dakota. No postemergence conventional sugarbeet herbicide can completely and consistently control these species and provide any residual control. Ethofumesate may be able to provide additional control of common lambsquarters and kochia when mixed at higher than normal rates with glyphosate. The objectives of a small-plot research trial conducted near Crookston, Minnesota in 2012 were to determine the effectiveness of ethofumesate applied postemergence at various rates and times mixed with glyphosate to control common lambsquarters and kochia and determine the impact upon visual sugarbeet injury, root yield, and extractable sucrose. Ethofumesate was applied at 0.5, 0.75, 1.0, 1.25, or 1.5 lb ai/A/application plus glyphosate at 0.25 (to simulate glyphosate resistance) or 0.75 lb ae/A plus Destiny HC (high surfactant oil concentrate) at 1.5 pt/A plus N-Pak AMS at 2.5 %v/v in 17 gallons/A of spray volume. The ethofumesate plus glyphosate combination was applied two, three, or four times.

Glyphosate applied alone twice at 0.25 lb ae/A controlled 51 and 86% common lambsquarters and kochia, respectively compared to glyphosate applied alone twice at 0.75 lb ae/A controlling 82 and 98% of common lambsquarters and kochia, respectively just prior to harvest. The addition of ethofumesate at 1.0 lb ai/A to glyphosate at 0.25

lb ae/A applied twice controlled 88 and 94% of common lambsquarters and kochia, respectively. Increasing the rate of ethofumesate and the number of times it was applied with glyphosate improved common lambsquarters and kochia control.

STACHLER, JEFF M.* and AARON. L. CARLSON. North Dakota State University, Dept. 7670, P. O. Box 6050, Fargo, ND 58108-6050.
Management of waterhemp in glyphosate-resistant sugarbeet.

Glyphosate-resistant waterhemp continues to increase in Minnesota and North Dakota, making waterhemp management difficult in glyphosate-resistant sugarbeet. Multiple small-plot research trials have been conducted from 2010 to 2012 investigating waterhemp management with preplant incorporated, preemergence, and/or postemergence conventional herbicides in sequence or in combination with glyphosate.

Ethofumesate and cycloate plus EPTC applied preplant incorporated controlled the most waterhemp of those products available. Ethofumesate and S-metolachlor applied preemergence controlled the most waterhemp of those products available. The addition of dimethanamid or S-metolachlor with desmedipham or desmedipham plus phenmedipham plus ethofumesate and glyphosate was essential to improving waterhemp control compared to desmedipham and/or phenmedipham applied alone with glyphosate. Ethofumesate, S-metolachlor, cycloate plus EPTC, or cycloate followed by desmedipham plus phenmedipham plus ethofumesate plus dimethenamid or S-metolachlor was the only herbicide combinations capable of providing nearly complete waterhemp control. Ethofumesate at 0.5 to 3.75 plus glyphosate applied two to three times provided fair to excellent waterhemp control.

STEINKE, KURT* and ANDREW CHOMAS. Department of Plant, Soil, and Microbial Sciences, Michigan State University, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824.
Increased yield, static nitrogen? Sugarbeet nitrogen response to source and rate in Michigan.

Improving the ecological efficiency of sugarbeet production is a key goal in developing scientifically-validated nutrient management strategies for Michigan. Sugarbeet yields have increased substantially over the past 10 years yet nitrogen (N) recommendations have not changed. Growers are beginning to question: 1) N rates, and 2) whether or not fertilizers including slow-release N fit into sugarbeet production. Field trials were conducted in 2011 and 2012 to determine the nitrogen response of sugarbeet and the effect of slow-release N on sugarbeet yield and quality. The study was arranged as a ran-

domized complete block with four replications. Treatments included five total N rates (0-180 kg N ha^{-1}) in 45 kg N increments applied as urea (46-0-0) and three N rates of 90, 135, and 180 kg N ha^{-1} applied as slow-release N (44-0-0). Measureables included chlorophyll meter readings, tissue total N analysis, leaf biomass, in-situ soil nitrate analysis throughout the growing season using anion exchange membranes, and sugarbeet yield and quality. Soil nitrate to a depth of 60 cm during sidedress application timing was 35 kg ha^{-1}. Although total N had a significant effect on total yield, sugar produced, and brei-nitrate, the high N rate of 180 kg ha^{-1} remained at the peak of the yield curve. Brei-nitrate levels increased up to 135 kg N ha^{-1} then decreased at 180 kg N ha^{-1}. Sugar percentages were near or exceeded 20.0% for all N treatments. Slow-release nitrogen at 180 kg N ha^{-1} negatively affected recoverable sugar and quality. Additional treatments containing increased rates of total N were included for 2012 and will also be discussed.

STEWART, JAMES F.[1]*, LEE A. HUBBELL[1], BRIAN GROULX[1], GREGORY M. CLARK[2] and STEVEN POINDEXTER[3]. [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, [2]Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706 and [3]Michigan State University Extension, 1 Tuscola Street, Suite 100, Saginaw, MI 48607. **Influence of early harvest dates on sugarbeet yield, quality and grower payment.**

Sugarbeet yields in Michigan have increased by approximately 25 percent during the past ten years which has put a strain on the processing capacity of Michigan Sugar Company. Earlier harvesting has become necessary to avoid pile spoilage that can occur in early March. Small plot replicated trials were conducted in 2010, 2011 and 2012 to determine sugarbeet yield and quality levels at early, mid and late harvest dates: The harvest date treatments were: August 15, September 1, September 15, October 1, October 15 and November 1. Replicated grower strip trials were also conducted by Sugarbeet Advancement to evaluate the influence of harvest date on sugarbeet yield and quality under actual grower conditions. Temperatures and soil moisture levels were favorable for sugarbeet growth during the harvest period in each year. Averaged over two years (2010 and 2011) sugarbeet yields in small plot replicated trials increased by 1.0 ton per week and sugar content increased by 0.45 points per week. Similarly, sugarbeet yields increased by 1.2 tons per week and sugar content increased by 0.2 points per week during the same time period in the replicated strip trials. Information from the 2012 trials will also be presented.

UNVERZAGT, JARED C.[1]* and ANDREW R. KNISS[2]. [1,2]University of Wyoming, Department of Plant Sciences, Dept. 3354, 1000 E. University Ave., Laramie, WY 82071. **Weed control with corn herbicides that allow rotation to sugarbeet.**

Corn is an important rotational crop with sugarbeet in the High Plains. Glyphosate is the primary herbicide used in both glyphosate-resistant corn and sugarbeet. To reduce selection pressure for glyphosate-resistant weeds, it is important to identify herbicide programs for corn that increase herbicide diversity and also allow planting sugarbeet the following year. Field studies were conducted in 2011 & 2012 to evaluate corn herbicide programs that: (1) are effective on the weed spectrum in the High Plains; (2) allow rotation to sugarbeet the following season; and (3) utilize multiple modes of action for herbicide resistance management. Corn was planted on May 6 in 2011 and May 8 in 2012 at 84,000 seeds ha^{-1} in 76 cm rows. Plots were 3 m by 9 m and arranged in a two-factor factorial design with four replications. Factor one consisted of three PRE herbicides and an untreated check, while factor two included three POST herbicides and an untreated check. PRE herbicides included saflufenacil + dimethenamid-P at 70 and 612 g ai ha^{-1} respectively, acetachlor at 2100 g ai ha-1, and S-metolachlor at 1390 g ai ha^{-1}. POST herbicides consisted of glufosinate at 350 g ai ha^{-1}, glyphosate at 1270 g ae ha^{-1} and diflufenzopyr + dicamba at 56 and 140 g ai ha^{-1}. Visual control ratings were taken at 5, 8, and 16 weeks, and 6, 8, and 14 weeks after planting in 2011 and 2012 respectively. Corn was harvested on October 24 in 2011.

WILSON, ROBERT G.[1]* and ANDREW R. KNISS[2]. [1]University of Nebraska, Panhandle Research & Extension Center, 4502 Avenue I, Scottsbluff, NE 69361 and [2]University of Wyoming, Department of Plant Sciences, 1000 East University Avenue, Laramie, WY 82071. **Glyphosate-resistant kochia in the western sugar growing region.**

Kochia (*Kochia scoparia* (L.) schrad.) continues to be one of the most problematic weeds to control in sugarbeet. In the past, kochia has developed resistance to photosystem II inhibitors (atrazine), ALS inhibitors (triflusulfuron), and synthetic auxin (dicamba) herbicides. More recently, kochia has developed resistance to glyphosate (EPSPS inhibitor). Initial reports of glyphosate-resistant kochia were confirmed in Kansas in 2007. Since then glyphosate-resistance has spread and now has been observed in Colorado, Montana, Nebraska, and North Dakota. Experiments were initiated in Nebraska and Wyoming in 2012 to examine methods for controlling kochia in glyphosate-resistant sugarbeet and corn. In addition, Kochia accessions were collected by Western Sugar agronomists during the fall of 2012 and plant accessions were screened for tolerance to glyphosate. Results from these experiments will be reported in this presentation.

Section A – Agronomy
Poster Presentations

AWALE, RAKESH[1], AMITAVA CHATTERJEE[1], HANS KANDEL[2], NORMAN CATTANACH[1]. [1]Department of Soil Science, [2]Department of Plant Sciences, North Dakota State University, Fargo, ND 58108. **Sugarbeet soil nitrogen management under subsurface drainage condition.**

Tile drainage is a relatively new management tool for most RRV growers. Questions about the effects of subsurface drainage on sugarbeet production and nitrogen (N) use efficiency are common amongst growers and agriculturists. From 2012 summer, a three-year field experiment was initiated on the NDSU agricultural plot near Fargo, ND on a Fargo-Ryan silty clay soil complex. A Randomized Complete Block Design was laid out with four replicates in split-plot arrangement with (1) subsurface drainage and (2) undrained conditions as the main plot factors and nitrogen management practices as the sub plot factors. Five nitrogen management treatments were - (1) control (0 N), (2) 146 kg N ha^{-1} in the form of urea, (3) 180 kg N ha^{-1} in the form of urea , (4) 146 kg N ha^{-1} in the form of urea + instinct, (5) 112 kg N ha^{-1} as urea, plus 34 kg N ha^{-1} as urea at 3/4 leaf stage. Sugarbeet yield and quality parameters were recorded and soil samples were analyzed for nitrogen availability and gaseous N loss as nitrous oxide (N_2O) during growing season. Tile was not opened due to dry summer condition. Higher nitrogen application rate (180 kg N ha^{-1}) significantly increased soil N availability but also increased the N_2O loss than recommended N (146 kg N ha^{-1}). Nitrogen management like addition of nitrogenase inhibitor has potential to increase soil N availability and decrease the N loss.

CAMPBELL, L.G.[1], and A.W. CATTANACH[2]*. [1]USDA-ARS, 1605 Albrecht Blvd., Fargo, ND 58102 and [2]American Crystal Sugar Co., 101 N. 3rd St., Moorhead, MN 56560. **The American Society of Sugar Beet Technologists, advancing sugarbeet research for 75 years.**

The American Society of Sugar Beet Technologists (ASSBT) was created 75 years ago when a group of researchers that had been meeting informally as the Sugarbeet Roundtable adopted the constitution and by-laws that provided the basis for an organization that continues to foster the exchange of ideas and information. Biennial meetings and the publication of research articles have facilitated communication among the members. Prior to the launch of the Journal of the American Society of Sugar Beet Technology in 1956 (renamed the Journal of Sugar Beet Research in 1988), articles were published as proceedings. The availability of all issues of the journals

and proceedings to the general public on the internet was announced in 2011. Membership of ASSBT increased during the first 25 years from 256 two years after the formation of the Society to 633 on the 25th anniversary. As a result of changes in the industry, membership dropped to 550 on the 50th anniversary of the Society and in recent years has been near 300. Interactions with the international community begin as early as 1940 when a few Europeans were members. In 1960 ASSBT sent a delegation to the International Institute for Beet Research (IIRB) meetings in England and the first joint IIRB-ASSBT congress was convened in San Antonio, TX in 2003. Canadian researchers have been a part of ASSBT since the early days of the Society. Research priorities have ranged from the development of mechanical harvesting equipment and coping with multigerm seed to controlling threatening diseases, postharvest storage, resistance to broad-spectrum herbicides, etc. ASSBT has facilitated the cooperation necessary for overcoming numerous problems, allowing the industry to increase productivity and remain economically viable, and is poised to continue its role as a contributor to the future success of the industry in a highly competitive environment.

CHOMAS, ANDREW* and KURT STEINKE. Department of Plant, Soil, and Microbial Sciences, Michigan State University, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824.
Effects of foliar nitrogen on sugarbeet production.

Rising fertilizer prices have many Michigan sugarbeet producers considering foliar nitrogen (N) applications to improve production efficiencies and to reduce the risk of excessive levels of soil N adversely affecting sugarbeet quality. Foliar N applications are purportedly more efficient than higher rates of granular N application resulting in lower rates of application. Growers continue to question the effects of foliar N on sugarbeet yield and quality and whether or not to reduce base N application rates. A field trial was conducted in 2011 and 2012 in Michigan to determine if foliar N affects sugarbeet yield or quality and whether base nitrogen applications could be reduced by 10-20%, supplemented with foliar N applications. The study was arranged as a randomized complete block with four replications of the treatments. The treatments included total N rates of 0, 90, and 135 kg N ha^{-1} applied as urea (46-0-0). The 90 and 135 kg N ha^{-1} rates were each reduced by both 11 and 22 kg N ha^{-1} with this amount later supplied via three applications of foliar delayed-release N fertilizer (9 and 18 L ha^{-1}, 30-0-0) spaced two weeks apart. Measureables included chlorophyll meter readings, tissue total N analysis, leaf biomass, and sugarbeet yield and quality. Results from 2011 indicated a 10-40% reduction in brei nitrate levels with foliar N applications. However, foliar N treatment brei nitrate levels were less than 100 ppm potentially indicating that N limited overall sugar production.

Data showed no significant impacts on yield or sugar content though at the higher total N rate, supplemental foliar N applications began to show some positive yield and sugar responses. Data from 2012 will also be included and discussed.

DEAN, GREG A.[1]*, DAVID M. ELISON[2], and PAUL FOOTE. [1]The Amalgamated Sugar Company LLC, P.O. Box 8787, Nampa, Idaho, 83647, [2]The Amalgamated Sugar Company LLC, P.O. Box 700, Paul, ID 83347. **Understanding Southern Idaho Sugarbeet planting dates and populations.**

Sugarbeet growers in Southern Idaho want to know when to plant sugarbeets to maximize yield potential. They also want to know how much seed to plant so that they have best chance of achieving a maximum yield. Further growers want to know when they should replant a sugarbeet stand. The objective of this study was to determine how planting date and plant population effects sugarbeet yields so that growers can achieve the best possible yields. Also we want to develop a chart that will help sugarbeet growers determine when replanting should take place. This past year 6 planting dates and 6 plant populations were studied at 2 locations to see if planting date and population affects yield. Results from this one year study shows that planting date and population does affect yield.

DUNSMORE, CHRIS[1]*, MARK BREDEHOEFT[1], JODY STEFFEL[1], JOHN LAMB[2], ALBERT SIMS[3], DAN HUMBURG[4], AND RICHARD HORSLEY[5]. [1]Southern Minnesota Beet Sugar Cooperative, Renville, MN, [2]University of Minnesota, St. Paul, MN, [3]Northwest Research & Outreach Center, University of Minnesota, Crookston, MN and [4]South Dakota State University, [5]Dept. of Plant Sciences, North Dakota State University, Fargo. ND. **Development of a model for prediction of organic matter zones.**

The Southern Minnesota growing area is in the Prairie Pothole region of the upper Midwest. Therefore, organic matter (Om) varies considerably with elevation. Nitrogen (N) available to the plant through organic matter mineralization affects yield and quality of sugarbeet. A model to predict organic matter was developed using satellite imagery and elevation data to predict relative organic matter. Zones are created to delineate similar Om areas. The model has been incorporated into software allowing growers and consultants to access the zones as a map through the internet. The information is used to determine soil sampling locations and to create fertilizer application zones. Each organic matter zone is soil sampled to a 48-inch depth with nitrogen then adjusted to a given level to compensate for predicted Om mineralization. For example, if the Om ranged from zero to 3%, total N was adjusted to 120 pounds/acre; if Om was 3-4%,

total N was adjusted to 110 pounds; 4-5% Om, 100 pounds of N; 5-7% Om, 90 pounds; and finally, for organic matter soils above 7%, the nitrogen was adjusted to 70 pounds. The total N for each Om zone was established using previous research conducted at SMBSC. Harvest data has shown sugar in the Om zones increased 0.1% over the grid sampling method and 0.7% over conventional sampling. Purity in the Om zones increased 0.3% versus the grid method and 0.9% compared to conventional. Tonnage per acre was 0.8 ton higher in Om zones over grid and 1.2 tons better than the conventional. Grower revenue has been increased as a result of the program.

GROULX, BRIAN J.[1] *, JAMES F. STEWART[1], LEE A. HUBBELL[1], and GREGORY M. CLARK[2]. [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, and [2]Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706. **Effect of planting date and population on sugarbeet yield and quality.**

In the effort to improve beet yield and quality in Michigan, planting date as well as the populations at those dates has become a major topic. The decision to risk planting early as well as the decision to replant a lower population field is a major concern through the first few weeks of the growing season. Three trials have been conducted testing multiple dates of planting, as well as various populations on those dates. All trials were planted at high populations, and then each plot was thinned to its desired amount at the 2-4 leaf stage. Trials planted in 2008 and 2009 featured 4 different planting dates. The dates began in early April, and then other plantings followed two weeks later. When the populations were averaged, the earliest planting date yielded 1.48 tons/acre more than the second date, and as much as 9.99 tons/acre more than the last plating date (LSD (P=.05) .84). Also, when populations were averaged, the earliest planting date had an increase in sucrose by .46 percentage points over the second planting date, and as much as 2.6 percentage points over the last planting date (LSD (P=.05) .4). In these trials, an earlier planting date will significantly out-perform a later planting date until populations drop below 100 beets/100 ft. of row. A third trial was planted in 2012 with five planting dates. These dates were March 22nd and 29th, as well as April 5th, 13th, and 24th. Visual ratings, as well as partial sampling throughout the season, have provided some interesting results. Earlier plantings have consistently yielded higher leaf ratings, as well as increased yield weights. Harvest of this trial will be taking place in late October 2012.

LAMB, JOHN A.[1]*, MARK W. BREDEHOEFT[2], and CHRIS DUNSMORE[2]. [1]Department of Soil, Water, and Climate, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 and [2]Southern Minnesota Beet Sugar Cooperative, 83350 County Road 21, Renville, MN 56284. **Nitrogen and potassium effects on sugar beet yield and quality.**

Growers in the Southern Minnesota Beet Sugar Cooperative area are concerned about potassium nutrition. There have been an increasing number of potassium soil test values from production fields that are decreasing into the 100 to 120 mg per kg range. The loss of root yield from the lower soil test values and the loss of root quality if potassium is applied is also a concern. The objective of this study is to determine the effect of nitrogen and potassium application on sugar beet root yield and quality. A study at six sites from 2010 to 2012 in the Southern Minnesota Beet Sugar Cooperative growing was established to meet the objectives. The treatments included a factorial arrangement of four N rates (0, 44, 88, and 134 kg per ha) and six potassium rates (0, 33, 66, 99, 336, and 560 kg K_2O per ha. The study was replicated five times. Root yield and quality were measured. Results indicate that potassium application increased root yield and quality at 50% of the sites. Nitrogen application increased root yield at 50% of the sites and decreased quality at 75% of the sites.

SPANGLER, ALICIA J., CHRISTY L. SPRAGUE*, and KURT STEINKE. Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Impact of nitrogen and weeds on glyphosate-resistant sugarbeet yield and quality.**

Field experiments were conducted in 2010 and 2011 at two locations in Michigan to determine the effects of nitrogen (N) and weed removal on glyphosate-resistant sugarbeet yield and quality. Nitrogen rates were 0, 67, 100, 134 and 67:67 kg N ha^{-1} and weeds were removed when they were <2, 8, 15 and 30 cm tall. At the beginning of the growing season, weeds responded to N sooner than sugarbeet. Nitrogen assimilation by weeds was 3 times greater than sugarbeet at 0, 67, 100 and 134 kg N ha^{-1} and 4 times greater than sugarbeet with the split application of N (67:67 kg N ha^{-1}) averaged over weed removal timings. Higher N rates increased N sufficiency index values and sugarbeet canopy closure; weeds 30 cm tall had lower N sufficiency index values and reduced the sugarbeet canopy. The effect of N on root yields varied, but the highest N rates (134 kg N ha^{-1} or 67:67 kg N ha^{-1}) was amongst the highest sugarbeet yields at all locations. Highest yields were achieved when weeds were controlled prior to reaching 2 cm tall at three of the four site-years. Waiting to control weeds until they were 8 or 15 cm tall resulted in up to 15%

yield reductions, while 30 cm tall weeds reduced yields up to 21%. Recoverable white sucrose per ha (RWSH) followed the same trends as root yield, and values were 8 to 16% lower if weeds were not controlled until they were 8 cm tall. These results indicate weeds are highly competitive with sugarbeet and weeds assimilate large quantities of N early in the growing season, especially at larger growth stages. Weed competition negatively impacted sugarbeet canopy development, root yield and sucrose production, and weeds should be controlled prior to 8-cm heights to avoid negative impacts.

SPRAGUE, CHRISTY L. and GARY E. POWELL*. Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Sugarbeet rotational crop sensitivity to flumioxazin as a dry bean desiccant.**

The registration of flumioxazin as a dry bean desiccant and the recent changes to shorten the rotational restrictions of flumioxazin to sugarbeet has caused concerns about crop safety. Therefore, a field study was conducted for 2 years to determine the crop safety of sugarbeet after a desiccation application of flumioxazin. Flumioxazin at 71 g ha^{-1} (typical desiccation rate) and 107 g ha^{-1}, glyphosate (0.84 kg ae ha^{-1}), and paraquat (0.56 kg ha^{-1}) were the four desiccation treatments examined. These treatments were applied in mid-September of 2008 and 2010. Sugarbeet were planted in no-till and conventional tillage plots in the spring. Intervals between desiccant applications and sugarbeet planting were 7 month and 16 d in 2009 and 7 month and 5 d in 2011. There was not a significant year by treatment interaction, so sugarbeet data are combined over the two years. In both conventional tillage and no-tillage sugarbeet flumioxazin applied at the 71 and 107 g ha^{-1} caused significant injury and reduced stand compared with either the glyphosate or paraquat treatments. Differences in injury and sugarbeet stand between the treatments were greatest in the no-till sugarbeet plots, with the higher rate of flumioxazin causing as much as 86% stand loss. In the conventional tillage plots sugarbeet stand at harvest was 25 and 50% lower when flumioxazin was applied at the 71 and 107 g ha^{-1} rates, respectively, compared with either glyphosate or paraquat. In no-till sugarbeet, recoverable white sucrose per hectare (RWSH) was lower at both rates of flumioxazin compared with glyphosate and paraquat. The current rotation restrictions for no-till sugarbeet are 8 and 10 months for the 71 and 107 g ha^{-1} rates, respectively. In our research sugarbeet were planted earlier than both of these restrictions. Differences in RWSH were not as apparent in the conventional tillage system and RWSH was only different between flumioxazin at the higher rate of 107 g ha^{-1} compared with glyphosate. Currently the flumioxazin rotation restrictions for sugarbeet that are tilled prior to planting are 4 and 5 months for the 71 and 107 g ha^{-1} rates, respectively. While

the crop rotation restrictions were met for both of these rates, we did observe significant injury and sugarbeet stand loss.

TARKALSON, DAVID D.* and BRADLEY A. KING. Northwest Soils and Irrigation Research Laboratory, USDA, Agricultural Research Service, 3793 N. 3600 E., Twin Falls, ID 83301. **Evaluation of irrigation water allocations under deficit irrigation.**

Increased water demands and drought have resulted in a need to determine deficit water management practices in sugar beet production. This study was conducted from 2010-2012 at the NWISRL in Kimberly, ID on a Portneuf silt loam soil. Irrigation treatments consist of end of season cumulative ETc water application rates of 100% (100% evenly throughout the growing season, **100% even**), 60% (60% evenly throughout the growing season; **60% even**), 60% (100% from emergence to end of June, 55% end of June to harvest; **60% early**), 60% (rain-fed from emergence to end of July, 100% end of July to harvest; **60% late**), 35% (35% evenly throughout the growing season; **35% even**), 35% (100% from emergence to end of June, 25% end of June to harvest; **35% early**), and 35% (rain-fed from emergence to mid August, 100% mid August to harvest; **35% late**) and rain-fed (no irrigation, 8% ETc; **rain-fed**). All ETc percentages are based on non water stressed crop. Results show that when deficit water inputs are applied, it is better to apply the water evenly throughout the season (even treatments) or supply 100% of ETc early then deficit irrigate later in the season (early treatments). Sugar beet with severe water stress early in the season (rain-fed) followed by 100% ETc later (late treatments) did not result in recovered yield potential.

WENNINGER, ERIK J.*, OLIVER T. NEHER, KRISTIN E. DAKU, HOWARD NEIBLING, AND DON W. MORISHITA. University of Idaho, Kimberly Research & Extension Center, Kimberly, ID 83341. **Effects of tillage and irrigation practices on sugar beet yield and soil moisture.**

Strip tillage (ST) saves grower time and fuel expenses by reducing tillage to a narrow band where the seed and fertilizer are placed. Residue from the previous crop may reduce erosion and near-surface wind velocity, enhance soil moisture, and improve soil tilth and water infiltration. A study at the University of Idaho Kimberly Research & Extension Center (Kimberly, ID) was initiated during 2010 to compare yield and soil moisture among two tillage treatments (ST and conventional tillage [CT]) and four irrigation treatments based on evapotranspiration (ET) rates of CT sugar beet (50, 75, 100, and 125% ET). During 2010, clean yield did not differ between tillage treatments, but was significantly lower in 50% ET plots relative to the other irrigation treatments. Percent sucrose in 75% ET plots was

higher for strip-tilled treatments during 2010, possibly due to increased water retention on these plots; however, estimated recoverable sucrose (ERS) did not differ among treatments. During 2011, clean yield and ERS were higher in conventionally tilled plots, possibly due to a wet spring that may have slowed seedling development in strip-tilled plots. Percent sucrose did not differ among treatments during 2011. Weekly soil moisture readings were taken during each season at 15-cm increments to a depth of 1.52 m. Where differences were observed, strip-tilled treatments generally showed greater water retention than conventionally tilled treatments.

Sections B & E
Physiology, Biotechnology, Genetics and Germplasm
Oral Presentations

EUJAYL, IMAD A.* and CARL A. STRAUSBAUGH. USDA-ARS, Northwest Irrigation and Soils Research Laboratory, 3793 N. 3600 E. Kimberly, ID 83341. **Whole genome sequencing of sugarbeet and identification of differentially expressed genes regulating beet curly top resistance.**

The genome of the sugar beet doubled haploid line (KDH13) has been sequenced using the whole genome shotgun (WGS) next generation sequencing HiSeq2000 platform. This line was released by USDA-ARS as a genetic stock resistant to beet curly top (PI663862). WGS sequencing of a short-insert paired end (PE) and 2 kb-insert mate-pair (MP) genomic libraries yielded 82.9 Gb (38.76 Gb from PE and 44.17 Gb from MP) of sequence data. The PE and MP sequencing had quality scores of 35.56 and 33.41, respectively. The WGS sequencing data achieved estimated genome coverage of approximately 76 fold. The assembly of the consensus sequence of the two libraries yielded 16,546 contigs of 7.8 Kb lengths at N50 and 2.5Kb at N80. The contigs were assembled into 16,136 scaffolds of 8.6Kb at N50. The current assembly spans 472 Mb representing about 62% of the 758 Mb sugar beet genome. Approximately, 85% of the PE, 56% of MP, and 69% of the KDH13 consensus sequence were mapped to the draft genome sequence (RefBeet-0.9) that was generated from KWS2320 line. A comprehensive array of single nucleotide polymorphisms (SNP) and insertions and deletions (indels) variants were identified between KDH13 (curly top resistant) and KWS2320 (curly top susceptible). A thousand SNP were selected using the beet physical map to span the nine chromosomes for developing a public genotyping platform in a 96X96 Fluidigm genotyping chip.

FUGATE, KAREN KLOTZ[1]*, JOCLEITA P. FERRAREZE[2] and MELVIN D. BOLTON[1]. [1]USDA-ARS, Northern Crop Science Laboratory, 1605 Albrecht Blvd. N., Fargo, ND 58102-2765 and [2]Federal University of Viçosa, Viçosa, MG, Brazil 36571-000. **Use of jasmonic acid and salicylic acid to inhibit growth of sugarbeet storage rot pathogens.**

Jasmonic acid (JA) and salicylic acid (SA) are endogenous plant hormones that induce native plant defense responses and provide protection against a wide range of diseases. Previously, JA, applied after harvest, was shown to protect sugarbeet roots against the storage pathogens, *Botrytis cinerea*, *Penicillium claviforme*, and *Phoma betae* by reducing severity of rot symptoms due to these pathogens by 51, 44, and 71%, respectively (Fugate et al., 2012, Postharvest Biol. Technol, 65:1-4). Research was conducted to determine the ability of SA to protect sugarbeet roots from these storage rot pathogens and to investigate the use of preharvest treatments of JA or methyl jasmonate (MeJA), a low cost derivative of JA, to reduce storage rot due to *B. cinerea*, *P. claviforme*, *P. betae*, or *Fusarium graminearum*. SA, applied after harvest at concentrations of 0.01 to 10 mM, had no effect on the severity of storage rot symptoms in roots obtained from healthy, unstressed plants after inoculation with *B. cinerea*, *P. claviforme*, and *P. betae*. However, when roots were obtained from water-stressed plants, 0.01 to 10 mM SA reduced the severity of rot symptoms due to *B. cinerea* by 49—58%, *P. claviforme* by 30—53%, and *P. betae* by 47—74%. The effect of JA or MeJA applied to foliage 7, 14, or 30 days prior to harvest at concentrations of 0.01 or 10 µM is also under investigation. Preliminary results suggest that preharvest treatments reduce storage rot severity, but are less effective than postharvest treatments.

HANSON, LINDA E.[1]*, R. M. BEAUDRY[2], T. R. GOODWILL[1], and J. M. McGRATH[1]. [1]USDA-ARS, 1066 Bogue Street, Lansing, MI 48824 and [2]Michigan State University, East Lansing, MI 48824 **Response of sugar beet recombinant inbred lines to post-harvest rot fungi.**

Sugar beet (*Beta vulgaris*) is commonly stored in outdoor piles prior to processing for food and animal feed. During this storage period the crop is subject to multiple post-harvest rots. Resistance to three post harvest rots was identified in two sugar beet germplasm in the 1970s, but there has been little work done on host resistance to post-harvest storage pathogens in recent years. In recent survey work in Michigan, several fungi known to cause post harvest rot were found. Recombinant inbred lines (RILs) of sugar beet have recently been developed, and these were screened for susceptibility to biotic post-harvest deterioration. Significant differences ($P < 0.05$) were found in this population for responses to three pathogens: *Botrytis*

cinerea, *Penicillium claviforme*, and *Rhizopus stolonifer*. The response in several RILs varied depending upon the length of time in storage. A poor correlation between reduced damage by these pathogens suggests independent genetic control of susceptibility. There is the potential to develop materials that may be less damaged by post harvest rot pathogens for the North Central US growing region, as well as gaining a better understanding of the interaction between fungal storage rot pathogens and host genotype.

HUYGHE, CHRISTIAN[1], MARC RICHARD-MOLARD[2], BRUNO F. DESPREZ[3]*. [1]Institut National de la Recherche Agronomique, 147, Rue de l'Université, F-75338 Paris, France , [2]ITB, 45, rue de Naples , F-75008 Paris, France, and [3]Florimond Desprez Veuve & Fils SAS, BP41, 3, Rue Florimond Desprez, F-59242 Cappelle-en-Pévèle, France. **French Research Initiative for a sustainable beet improvement: Innovative breeding strategies based on allelic variation mining, and novel genomic and phenomic tools.**

In 2010, the sugar world production was rising up to 153 million t, 22% of which coming from sugar beet. Since Napoleon, the French sugar beet industry has grown to become the first one in the world, producing on 400,000 ha, 4 million t of white sugar, 3 million hectoliters of potable alcohol and 6 million hl of ethanol. Yielding actually 13.1 t/ha of white sugar, sugar beet improvement is keeping a constant 2% year rate of sugar yield increase. Within the next decade, due to bio-ethanol and world population increase, sugar demand will most probably grow. Major exporters will not be able to fulfill this demand, and EU and France especially should contribute enhancing competitiveness. Genetic improvement then appears to the French sector to be the key lever to meet future global challenges for a high-quality, safety and sustainable agriculture. Thus, the aim of the AKER project (8 years, 11 partners from public and private sectors) is to double the rate of sugar yield gain per ha, from 2 to 4%/year and to create new varieties higher yielding varieties and with a better fitness (to biotic and abiotic stresses). The AKER project gathers all the French sugar industry partners including growers and factories, represented by ITB (French Technical Institute for Beet), the French breeder Florimond Desprez which is the first world sugar beet breeding company, and public research laboratories and training institute worldwide recognized for their competences and expertise in genetics, genomics, bioinformatics, seed and beet phenotyping or imagery analysis.

McGRATH, J. MITCHELL[1]*, VINAY HIREMATH[2], PAUL GALEWSKI[3], and SAFA ELZOHARY[3]. [1]USDA-ARS, 1066 Bogue St., East Lansing, MI 48824-1325, [2]High School Honors Science Program, Michigan State University, and [3]Plant Breeding, Genetics, and Biotechnology Program, Dept. of Plant, Soil, and Microbial Sciences,

Michigan State University, East Lansing, MI. **Transcriptions of seedlings germinating in water, hydrogen peroxide, and salt for discovery of seedling vigor genes and biochemical pathways.**

Germination is crucial to developing healthy, vigorous, and productive field populations of sugar beets. Despite planting high-quality, technically-augmented seed for growers with very high germination (>92%), field emergence and persistence continues to hover at ~60% in Michigan. Previous research suggests this difference is the result of stress during germination in the field environment. For many years, the East Lansing USDA-ARS sugar beet program, located at MSU, has focused on stress responses during germination. To date, we have identified some biochemical pathways that appear to influence seed germination and seedling vigor in ways that can improve emergence potential. However, we still do not understand the panoply of responses in a way that might allow us to increase genetic gains for traits related to emergence, seedling vigor and stand establishment, a goal for the 'one seed – one beet' concept. One way to identify additional genes involved is to examine expression of all genes during germination in different environments. In this case, we generated transcriptome datasets of a high vigor variety germinated in a variety of stressful laboratory environments. Currently we have six sets of 48 hour germinating seedling transcriptomes and are in the process of identifying the major differentially expressed genes between water or salt (low germination conditions) and hydrogen peroxide (high germination condition). To date we have identified 75 differentially expressed candidate genes that appear to have roles in signal transduction pathways, as transcription factors, and as enzymatic proteins.

McGRATH, J. MITCHELL[1]*, NIZAR DROU[2], DARREN WAITE[2], DAVID SWARBRECK[2], EFFIE MUTASA-GOTTGENS[3], and BELINDA TOWNSEND[4]. [1]USDA-ARS, 1066 Bogue St., East Lansing, MI 48824-1325, [2]The Genome Analysis Centre, Norwich, UK, [3]University of Hertfordshire, Herts, UK, and [4]Rothamsted Research, Harpenden, Hertfordshire, AL5 2JQ, UK. **The 'C869' sugar beet genome: a draft assembly.**

Sugar beet 'C869' is a diploid, self-fertile, public germplasm release used extensively as the seed parent of recombinant inbred lines designed to genetically dissect agronomic, disease, domestication, and other traits. From the original release, three additional generations of inbreeding were done, and 68 progeny from seven F_3 families were screened with a panel of 61 SNP markers to determine heterozygosity (which ranged from 0 to 15.5%). Accession EL-A025943-17 was chosen for genomic sequencing due to no detected heterozygosity as

well as its overall vigor and trueness-to-type sugar beet appearance. Sequencing was performed on the Illumina HiSeq 2000 platform with 100 bp paired-end sequences, for which five lanes of genome sequence data were collected, representing 820,126,310 pairs of reads. Reads were cleaned and quality trimmed, and the resulting ~150X coverage of the 750 Mb sugar beet genome was assembled *de novo* using ABySS 1.2.4 with a Kmer value of 61. More than 3.1 million contigs were output (N50 = 2,845 bp; max = 75,288, min = 61), with 91,343 contigs >1 kb in size (N50 = 7,778; max = 75,288, min = 1000). The latter contigs summed to >446 Mb, or ~60%, coverage of the beet genome. Since the sugar beet genome is predicted to have ~60% highly repetitive DNA elements (~450 Mb, which current algorithms do not assemble well). In addition, leaf and petiole transcriptome data from EL-A025943-17 (360,697,168 read pairs) were assembled *de novo* using Trinity to complement the genome assembly. We conclude the current genome assembly contains the majority of the genetic information encoded and organized in the 'C869' sugar beet genome.

MÜLLER, ANDREAS E.[1], GRETEL SCHULZE-BUXLOH[2], SEBASTIAN H. VOGT[2], MARKUS WOLF[3], AXEL SCHECHERT[1]*, BENJAMIN STICH[4], CHRISTIAN JUNG[2], and ELENA ORSINI[1]. [1]Fr. Strube Research GmbH & Co. KG, 38387 Söllingen, Germany, [2]Plant Breeding Institute, Christian-Albrechts-University of Kiel, 24098 Kiel, Germany, [3]Saaten-Union GmbH, 30916 Isernhagen, Germany, and [4]Max Planck Institute for Plant Breeding Research, 50829 Köln, Germany. **Genetic control of flowering time in biennial beets.**

Seed production in hybrid crops such as sugar beet (*Beta vulgaris* ssp. *vulgaris*) is greatly facilitated by synchronous flowering times of the hybrid parents. In the model species *Arabidopsis thaliana*, many of the genes that control flowering time have been identified, but knowledge of the genetic and molecular basis of flowering time control in sugar beet is just beginning to emerge. Here, we followed two complementary approaches to start deciphering the genetic landscape of flowering time control in cultivated biennial beets after vernalization over winter. First, we developed multi-parent QTL populations derived from breeding lines, and by use of a mixed-model approach identified several additive and dominant effect QTL for flowering time. Second, we identified candidate sequences for flowering time control genes in sugar beet and genetically mapped 14 genes, including floral integrators and homologs of key genes in the major regulatory pathways in Arabidopsis. Several genes mapped within the confidence intervals of QTL. The most prominent of these QTL was located in a chromosomal region also harboring the recently isolated *B* locus for annuality (Pin *et al.*, 2012, *Curr. Biol*. 22:1095-1101). An additional QTL co-localized with markers closely linked to a second major locus for annuality on chromosome II (Abou-Elwafa

et al., 2012, *Mol. Breed.* 29:989-998). Genes and markers identified in this study can be used for marker-assisted selection of sugar beet genotypes with adequate flowering times for breeding programs and hybrid seed production.

PANELLA, LEE[1]*, CHRISTOPHER M. RICHARDS[2], ANN L. FENWICK[3], and PATRICK A. REEVES[2]. [1]USDA, ARS, 1701 Center Avenue, Fort Collins, CO 80526, [2]USDA, ARS, 1111 South Mason St., Fort Collins, CO 80521, and [3]Beet Sugar Development Foundation, 800 Grant Street, Denver, CO 80203. **Genetic structure and immigration in French sea beet.**

In this study we examined accessions of sea beet (*Beta vulgaris* subsp. *maritima* (L.) Arcang.), collected along the Mediterranean Sea and the Atlantic coast of France. The aim was to identify the scale and magnitude of differentiation and diversity in these accessions using both molecular and quantitative traits. Data filtering (allowing only one missing locus per multilocus genotype) reduced the final sample size from 336 (12 individuals each for 28 accessions) to 277 individuals. With SSR data, the observed heterozygosity was high across the accessions (mean 0.48), the mean inbreeding coefficient was fairly high (0.13) and significantly greater than zero. Inbreeding increased northward and heterozygosity increased southward. The mode value for K (number of genetic clusters) was found to be 2. Phenotypic foliar traits were significantly different among accessions in a one way ANOVA. Leaf length/width ratio, petiole length/width ratio and leaf thickness were significant at the 0.001, 0.05 and 0.001 levels respectively. Combining all three traits into a multivariate discriminant analysis using group assignments based on the genetic clusters resulted in a statistically significant discriminant function that could correctly predict group membership 75% of the time. Migration rate was estimated among three classes of genotypes (Mediterranean, Atlantic and Atlantic immigrant) using a Bayesian approach. The rates of migration were quite low between the Mediterranean and Atlantic groups in both directions. The rate of migration from the Mediterranean group to the putative Atlantic immigrant group was 20 times higher than from the Mediterranean group to the Atlantic group. Migration was four times higher from the Atlantic immigrant group to the Atlantic group than the reverse.

RICHARDSON, KELLEY L.[1]* and BARBARA HELLIER[2]. [1]USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905 and [2]USDA-ARS, 59 Johnson Hall, Washington State University, Pullman, WA 99164. **Wild/weed Beta populations in the Imperial Valley, California.**

California's Imperial Valley is the major sugar beet producing region for the state. In 1928 wild beet populations were reported in this

area and have infested sugar beet fields since. It is important to characterize these wild and weedy populations to understand their origin, determine the species, and explore potential gene flow between wild beets and cultivated beet. Seed, tissue samples, herbarium specimens and locality data were collected from 27 commercial sugarbeet fields infested with wild beet populations throughout the Imperial Valley, CA. Morphological characteristics of collected plants were evaluated and while many samples were identified as *Beta macrocarpa*, others had questionable taxonomic identity with confounding features similar to *Beta vulgaris* subsp. *maritima*. DNA was extracted from collected tissue and check samples of sugar beet, *Beta macrocarpa*, and *Beta vulgaris* subsp. *maritima* and screened with a preliminary panel of 20 SSR molecular markers. SSR markers were identified able to differentiate cultivated sugarbeet from wild/weed *Beta* samples. Little polymorphism was detected in wild/weed *Beta* samples suggesting low genetic diversity or high similarity.

WINTERMANTEL, WILLIAM M.* USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905. **Effect of curtovirus species competitiveness in host plants on transmission and incidence of *Beet severe curly top virus* and *Beet mild curly top virus*.**

Curly top disease, caused by viruses in the genus Curtovirus, causes significant economic losses for sugarbeet and other crops throughout the western United States. Recent studies demonstrated the two most abundant curtovirus species in the US are *Beet severe curly top virus* (BSCTV) and *Beet mild curly top virus* (BMCTV), but other less prevalent curtoviruses have been found affecting sugarbeet, pepper, tomato and pumpkin with several new species characterized within the past decade. Studies were undertaken to examine virus accumulation, competition and transmission among common weed and crop curtovirus hosts. Examination of virus titers in plants clearly demonstrated BMCTV accumulates preferentially to BSCTV in bean, shepherds purse, and to a lesser degree, tomato. In contrast, BSCTV accumulates preferentially to BMCTV in sugarbeet. Each virus has at least one host plant from our study in which it accumulates more efficiently than the competing curtovirus. Accumulation patterns can shift during mixed infection due to the impact of a competing virus; however, the efficiency of transmission for an individual curtovirus is directly related to its relative titer compared to the competing virus. A corresponding study examined the prevalence of individual curtovirus species in weed and crop host plants in the San Joaquin Valley of California. DNA was isolated from a wide array of curtovirus host plants, including sugarbeet, and analyzed by PCR. A select region of the genome exhibiting DNA sequence divergence among species within the genus Curtovirus was amplified by PCR. DNA sequence analysis of amplified viral genomic segments demon-

strated both viruses were prevalent in the valley, and confirmed lab results that particular host species support BMCTV accumulation preferentially to BSCTV and *vice versa*. Some rare and recombinant curtovirus isolates were also recovered, indicating the virus population in California remains dynamic.

Sections B & E
Physiology, Biotechnology, Genetics and Germplasm
Poster Presentations

HARPER, STEPHEN. Germains Seed Technology, Hansa Road, King's Lynn, Norfolk, PE30 4LG, UK. **Performance of primed seed under drought stress.**

Priming of sugar beet seed increases speed and uniformity of germination, which in turns supports both faster and more uniform emergence. Additionally, laboratory tests have indicated increased tolerance of both wet and dry conditions. Relative to a standard of 40 ml water in pleated paper tests, an increase to 50 ml and/or 60 ml typically will reduce germination percentage of unprimed check seed. In contrast, germination of primed seed is not affected. With reducing moisture below 40 ml, germination progresses at an increasingly slower rate. However, the margin of the difference in speed between primed and check seed is not affected.

Recent adverse weather conditions have provided an opportunity to test predictions from laboratory tests on the impact of drought within field trials. In some trials, there has been little or no rainfall during the period of March through May during which seedlings would normally emerge. As in laboratory tests with restricted water availability, the period of emergence was more protracted than normal. Additionally, in the field, dry conditions may cause some degree of reduction in plant populations relative to historical norms. Priming alleviates this reduction in plants numbers only on occasion, but the margin of difference in speed of emergence relative to check is always maintained.

LI, HAIYAN and ANN C. SMIGOCKI*. USDA-ARS Molecular Plant Pathology Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705. **Molecular technology for developing durable resistance to the sugar beet root maggot (*Tetanops myopaeformis*).**

Sugar beet root maggot (SBRM), *Tetanops myopaeformis* von Röder, is a major economic insect pest of sugar beet in North America. While several moderately resistant breeding lines have recently been registered, they do not offer complete control. Recent advances in bioinformatics and functional genomics are providing a significant

amount of knowledge about how plants protect themselves against insect invasions. Lacking are complementary molecular studies on insect adaptive mechanisms used to overcome host resistance and develop tolerance to many insecticides. This study was initiated to establish a transcriptomic profile of SBRM genes and to identify physiologically valuable genes that can serve as targets for bio-insecticides and RNA interference mediated pest control. PCR-select suppressive subtractive hybridization (SSH) was used to produce a substantial and annotated SBRM EST dataset as a reference point for genes whose expression is modulated by interactions with the resistant or susceptible sugar beet roots. The SSH libraries generated more than 760 SBRM ESTs that were differentially expressed in the initial interaction of the pest with a moderately resistant (F1016) and/or susceptible (F1010) sugar beet line. Expression patterns of 20 randomly selected EST clones were supported by RT-PCR analysis. Comparison of the EST sequences to the GenBank non-redundant database and FlyBase using BLASTX/BLASTN homology searches identified 342 (45%) matches to at least one known protein with an e-value threshold of 1×10^{-5}. The remaining SBRM EST clones showed no significant similarity to any known genes. Of the 342 genes, 136 were unique and included 53 clones in the subtraction obtained following feeding on the F1016 (34 forward subtraction; 19 reverse subtraction) and 46 clones from the subtraction obtained on F1010 (40 forward subtraction; 6 reverse subtraction). Blast2GO v.2.4.2 which incorporates GO, KEGG maps, InterPro and Enzyme Codes software revealed a dominance of metabolic and catalytic genes that are involved in the initial interactions of the SBRM larvae with the sugar beet root. This data will provide new insights into the molecular response elicited by SBRM in interactions with sugar beet roots will advance the development of novel approaches for more effective SBRM control.

MARCINEK, RAFAL and STEPHEN HARPER*. Germains Seed Technology, Hansa Road, King's Lynn, Norfolk, PE30 4LG, UK.
Speed and uniformity of sugar beet seed germination and plant development determined by image capture and analysis.

Seed priming increases yield potential primarily by causing faster and more uniform germination, which in turn supports faster and more uniform emergence and crop development. Automated germination time course analysis has allowed more precise characterisation of the impact of priming and other seed treatments. The technology finds application both in priming and coating protocol development and in commercial product quality assurance. The detailed germination time course profiles generated have been exploited to provide indices of both speed (time to 50% germination and mean germination time) and uniformity (time from 25% to 75%, and 10%

to 90%, germination). Generally, primed seed is within the range of 20-30% faster and 15-40% more uniform than checks, depending in part on the method by which treatments are compared. While a close relationship between speed of laboratory germination and field emergence has been established, the relationship between uniformity in laboratory and field remains to be fully characterised. Methods are described to fill this gap in knowledge, whereby individual plant sizes for the period between emergence and canopy closure are determined from field plot images.

McGRATH, J. MITCHELL* and LINDA E. HANSON. USDA-ARS, 1066 Bogue St., East Lansing, MI 48824-1325. **RILS: What are they, what are they good for, and do we have any?**

RILs, or recombinant inbred lines, are a set of genetically related individuals that can simplify the gene discovery process. They are constructed using regular breeding processes rather than using tissue culture or other advanced biotechnology. Operationally, a hybrid is made, and this hybrid is self-fertilized to produce a population that is segregating in a Mendelian fashion for whatever differences were present in the original parent's gametes. Each of these differences is then fixed in individual lines through continued inbreeding in successive generations, resulting in a population of plants that captures the genetic variability of the initial hybrid distributed among a relatively large number of genetically-fixed, true breeding, inbred lines, also known as RILs. Genetic analyses of these stable populations can be accomplished across years and locations, thus facilitating analyses of major and subtle effects of genes and environments on the expression of heritable characters. These are precisely the characters for which the traditional breeding process is effective at concentrating into varieties, and knowledge of the inheritance of these characters (such as sugar yield) will allow more effective breeding strategies to be developed. Additionally, RIL populations can be marked with molecular markers. Because RILs are genetically stable, a stable genetic map can be created such that any new variation discovered can be partitioned against the map and thus discover genes at any time in the future with no additional investment in mapping, at least to a first approximation. Currently there are four RIL populations created at East Lansing being evaluated for agronomic and disease resistance traits, and molecular mapping is in progress.

SHAABAN, MONA[1]*, GREG CLARK[2], and RANDOLPH BEAUDRY[1]. [1]Department of Horticulture, Michigan State University, East Lansing, MI, 48824 and [2]Michigan Sugar Company, 2600 S. Euclid Ave., Bay City, MI 48706. **Modeling heat exchange in sugarbeet piles in Michigan.**

Harvested sugarbeet (*Beta Vulgaris* L.) roots are stored out-of-doors in Michigan in large piles and exposed to weather during the winter storage period, which generally lasts three to four months. During this time, the air temperature may range from as low as -10 °F to as high as 60 °F. The temperature of the pile will affect the storability of the roots. Given the variability in air temperature and the long-term trends of increasing global temperatures, it is important to gain a good understanding of the factors that affect pile temperatures. We wanted to be able to predict pile temperatures based on the history of air temperature, pile age, and pile architecture. We therefore embedded thermocouple sensors in transects across the beet pile through winter storage of 2011-2012 and monitored air, beet and soil temperatures. From these data, we developed a contour map of the cross-section of the beet pile and used these profiles to depict changes in the specific heat of the pile and thereby heat transmission. We found that the temperature of the pile generates a temperature gradient that commonly reaches 20 °F throughout the holding period, with the warmest point in the center of the pile near the earth. We found the pile temperature to vary rapidly on a daily basis with changing air temperature. These data, in conjunction with data previously collected describing respiratory heat production, will be used to develop a model for predicting pile temperature and root storability.

TAGUCHI, KAZUNORI[1], MARI MORITANI[2], TETSUO MIKAMI[2] and TOMOHIKO KUBO[2]. [1]Hokkaido Agricultural Research Center (HARC), Memuro, Hokkaido, Japan 082-0052 and [2]Hokkaido University, N-9, W-9, Kita-ku Sapporo, Japan 082-8589. **Molecular cloning of X locus and marker-assisted selection of non-restoring allele for Owen cytoplasmic male sterility.**

Hybrid seed production in sugar beet relies on cytoplasmic male sterility (CMS). As time-consuming and laborious test crosses with a CMS tester are necessary to identify maintainer lines, development of a reliable marker-assisted selection (MAS) method for the *rf* gene (the non-restoring allele of restorer-of-fertility locus) is highly desirable for sugar-beet breeding. Owen proposed that the sterility depends on the interaction between at least two recessive chromosomal genes and a 'sterile cytoplasm' (S). According to Owen(1945), fully male sterile plants have the genotype (S)xxzz, while the remaining eight genotypes usually show varying degree of pollen fertility. To obtain offspring from male-sterile plants, which are themselves male sterile, CMS plants must be pollinated by so-called maitainer plants (O-type), which carry the same sterility genes as the male sterilities but in normal cytoplasm (N)xxzz. To develop MAS method, we investigated genetic variation at the *Rf1* locus (Matsuhira et al. 2012), one of the two *Rf* loci known in sugar beet. After digestion with HindIII, DNAs from beet plants known to have a restoring *Rf1* allele yielded

a range of hybridization patterns on agarose gels, indicating that *Rf1* is a multiallelic locus. However, 22 of 23 maintainer lines showed the same hybridization pattern. The sequences of the *rf1* coding regions of these 22 maintainer lines were found to be identical, confirming that they shared the same *rf1* allele (Moritani et al, submitted). Two PCR markers targeting a downstream intergenic sequence and the first intron of *Rf1*, respectively, were developed. The electrophoretic patterns of both markers showed multiple *Rf1* alleles. One of these alleles, named the dd(L) type, was associated with the maintainer genotype.

TARKALSON, DAVID D.*, IMAD EUJAYL, and BRADLEY A. KING. Northwest Soils and Irrigation Research Laboratory, USDA, Agricultural Research Service, 3793 N. 3600 E., Twin Falls, ID 83301. **Drought tolerance selection in sugar beet.**

Increased water demands and drought have resulted in a need to determine if drought tolerance exists in sugar beet lines. This study was conducted to determine if drought tolerance existed among a group of genetically diverse sugarbeet lines by evaluating sucrose yields over a range of water inputs levels. The study was conducted over three consecutive growing seasons (2008-2010) at the NWISRL in Kimberly, ID on a Portneuf silt loam (coarse-silty mixed mesic Durinodic Xeric Haplocalcid) to assess the production of six KWS breeding lines and one commercial cultivar line under a range of water inputs [125% (W1), 100% (W2), 75% (W3), 50% (W4), and 25% of estimated crop evapotranspiration (ETc) and rain-fed (W6)] with water applied 3 times a week. There were differences in sugarbeet sucrose yield responses to water for the sugarbeet lines used in this study. The differences were demonstrated by comparing sugarbeet lines sucrose yields over the range of deficit water inputs using linear regression slope and intercept comparisons, drought stress index, and near maximum yield at the W2 water input level. Greater drought tolerance or greatest difference in sucrose yield between lines was seen at the lowest water input treatment (intercept difference). Linear regression analysis and drought stress index collaborated to show greater drought tolerance for KWS-05 compared to the commercial cultivar. There were also differences in overall yield potential among lines.

Section C
Entomology and Plant Pathology
Oral Presentations

BOETEL, MARK A.[1]*, ROBERT J. DREGSETH[1], ALLEN J. SCHROEDER[1], and F. ADNAN AKYÜZ[2]. [1]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108, and [2]Department of Soil Science, North Dakota State University, Dept. 7680, P.O. Box 6050, Fargo, ND 58108. **Degree-day modeling to forecast peak activity of sugarbeet root maggot flies.**

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* Röder is the most damaging insect pest of sugarbeet in the Red River Valley growing area. It is also a significant threat to the crop in western beet-producing states and the Canadian province of Alberta. Infestations of this pest are occasionally so severe that postemergence rescue insecticides are required to avoid major economic loss. Postemergence control of the SBRM mostly involves a spray application of a liquid insecticide formulation to kill adult flies and also provide additional management of neonate larvae as they begin to establish on young sugarbeet plants. The performance of these applications is optimized by applying the spray(s) as close to peak fly activity as possible. This project involved compiling 15 years of root maggot fly activity data and correlating it with temperature accumulation data obtained from the North Dakota Agricultural Weather Network (NDAWN) Center. The data set involved 119 sampling sites, each of which was comprised of four months (April through July) of temperature accumulations. The result was a simple degree-day (DD) developmental model, which helps growers, Extension personnel, sugar company agriculturists, and other crop advisors to anticipate the timing of root maggot colonization of sugarbeet fields in their respective areas. The model is now available online as an interactive application on the NDAWN website for site-specific DD monitoring by growers, crop advisors, and extension personnel. The site also includes links to results of the North Dakota State University root maggot fly monitoring program and to a "help sheet" that includes latitude-based recommendations to optimize control intervention timing based on sugarbeet root maggot development stage. Additionally, the model's output is now linked to a voluntary text-messaging system that alerts growers as degree-day accumulations approach levels at which insecticide applications should be made.

BOLTON, MELVIN D.[1]*, GARY A. SECOR,[2] VIVIANA RIVERA-VARAS,[2] and MOHAMED F. R. KHAN[2]. [1]USDA, Agricultural Research Service, 1605 Albrecht Blvd N, Fargo, ND 58102 and [2]Department of Plant Pathology, North Dakota State University,

Fargo, ND 58108. **Molecular basis of fungicide resistance in *Cercospora beticola*.**

Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola*, is the most important foliar disease of sugarbeet. Control measures include the application of sterol demethylation inhibitor (DMI) and quinone outside inhibitor (QoI) fungicides. Understanding the molecular mechanism of fungicide resistance is critical for fungicide resistance management. To gain and understanding of the molecular basis of DMI resistance, we cloned the *C. beticola Cyp51* gene, which encodes the DMI target Cyp51. Resistance to DMIs was shown to be related to over-expression of *Cyp51*. The gene encoding the mitochondrial QoI-target enzyme cytochrome *b* was cloned. All resistant isolates harbored a G143A mutation in cytochrome *b*. A probe was designed to specifically amplify and differentiate both alleles of the gene. The use of this probe was shown to vastly increase throughput of fungicide sensitivity testing. Isolates harboring the G143A mutation have now been found in many sugarbeet growing regions around the world. Sensitivity testing and concomitant fungicide resistance management programs will be necessary ensure efficacy of fungicides for CLS control.

BRANTNER, JASON R.* and CAROL E. WINDELS. University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **Control of Rhizoctonia crown and root rot by seed treatment, in-furrow, and postemergence fungicides is affected by disease onset and severity.**

Rhizoctonia crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2, is a common root disease on sugarbeet. Azoxystrobin typically is applied postemergence (PE), but optimal timing for application is uncertain and disease control is inconsistent because of variability in disease onset. We evaluated efficacy of seed and in-furrow (I-F) fungicides, with and without PE application of azoxystrobin, for disease control and effect on sugarbeet yields in four field trials over two years. Treatments included penthiopyrad and pyraclostrobin on seed and I-F, azoxystrobin I-F, and an untreated control. Application of PE azoxystrobin occurred 4 wk after planting. Three sites were inoculated with 35 kg ha^{-1} *R. solani*-infested barley before planting, and one site was in a naturally infested grower's field. At the four sites, there was no interaction between at-planting and PE treatments. Under severe, early-season disease conditions (one site in 2011), I-F fungicides and penthiopyrad seed treatment reduced RCRR and increased sugar yield compared to the untreated control, but PE azoxystrobin did not affect RCRR or sugar yield. When disease onset did not occur until later in the season (the other 2011 site), seed treatments had no effect, while I-F fungicides and PE azoxystrobin reduced RCRR and increased sugar yield compared to the un-

treated control. In 2012, soil moisture was low and unfavorable for RCRR. In one site, seed and I-F fungicides protected stands, increased the number of harvested roots, and reduced RCRR, but yields were not significantly different. In another site, there were no significant differences in sugarbeet stand, number of harvested roots, RCRR or yield among seed, I-F, and PE fungicides. Overall, efficacy of seed, I-F, and PE fungicides depended on disease onset and severity, but I-F applications were most consistent.

BRANTNER, JASON R., JEFFREY D. NEILSEN* and CAROL E. WINDELS. University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **In-furrow fungicide and starter fertilizer application effects on sugarbeet stand establishment.**

Rhizoctonia crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2 is a common root disease on sugarbeet. Postemergence applications of azoxystrobin typically are used for disease control, but in-furrow (I-F) fungicides provide excellent control without application timing concerns. Stand establishment problems, however, have been reported when applied in combination with starter fertilizer. We evaluated the effect of three (I-F) fungicides (azoxystrobin, pyraclostrobin, penthiopyrad) applied alone and in combination with 3 GPA 10-34-0 starter fertilizer on sugarbeet stand and sucrose yield at two planting dates in both 2011 and 2012. Fungicides were applied (6 GPA total volume) either mixed with starter fertilizer and applied I-F at 18 psi, or applied in a t-band (Teejet 400067E nozzle at 30 psi) positioned directly behind the disc openers. There were significant effects of starter fertilizer application in all four trials. Stands in each trial with no starter and starter, respectively, averaged 201 and 189, 160 and 148, 191 and 162, and 102 and 84 per 100 ft of row. In three trials, there were significant interactions for I-F fungicide by application method. Azoxystrobin applied by t-band and pyraclostrobin applied I-F reduced stands compared to no fungicide for both planting dates in 2011 and penthiopyrad applied I-F reduced stands compared to no fungicide in the second planting date of 2011. In the first planting date of 2012, azoxystrobin and pyraclostrobin applied by t-band reduced stands compared to the no fungicide. In the second planting date in 2012, conditions were very dry, and there was a significant three-way interaction (starter fertilizer x fungicide x application method). There were no significant interactions or main effects on sucrose yield in the four trials. Overall, impact of starter fertilizer was more consistent in reducing stands than application of in-furrow fungicides, which varied by application method.

BREDEHOEFT, MARK W.* and CHRIS DUNSMORE. Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. **Evaluation of fungicide seed treatments for control of *Rhizoctonia solani* in sugarbeet in southern Minnesota.**

Rhizoctonia solani is one of the most detrimental root diseases across all sugarbeet growing areas in the U.S. The objective of these trials was to evaluate fungicides applied as seed treatments for control of *Rhizoctonia solani* with a susceptible and resistant variety and to evaluate the seed treatments with and without an application of azoxystrobin at the 8-10 leaf sugarbeet growth stage. The test was conducted at three locations over two years. Sugarbeets plots were inoculated with the *Rhizoctonia solani* fungus grown on barley and applied to the soil prior to planting. The Rhizoctonia strain used for inoculation was AG 2-2 IIIB. The sugarbeet stand tended to not change over time at either location in 2011. Sugarbeet stand decreased over time at the location in 2012 and the decrease was related to the treatment. Rhizoctonia root ratings indicated the level of disease pressure at 2 of the three locations was medium and one location had a high disease level. However, regardless of the disease level the data showed a statistically significant difference among treatments for Rhizoctonia root ratings. Tons per acre, sugar percent and extractable sugar per acre were significantly influenced by treatments, regardless of disease pressure. Resistant varieties tended to enhance sugarbeet production more than susceptible varieties. Seed treatments tested were penthiopryriad, pyraclostrobin, ipconazole, metconazole. The revenue from the tolerant varieties tended to be higher for like treatments compared to the susceptible variety. Revenue was related to seed treatment. Azoxystrobin applied at 8-10 leaf stage was beneficial to both susceptible and tolerant varieties. Azoxystrobin applied to sugarbeets with seed treatments was beneficial for Rhizoctonia control and sugarbeet performance.

CLARK, GREGORY M.*[1], JAMES F. STEWART[2], WILLIAM W. KIRK[3], and LINDA E. HANSON[3],[4]. [1]Michigan Sugar Company, 2600 S. Euclid Ave., Bay City, MI 48706, [2]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, 3Michigan State University, Department of Plant Pathology, East Lansing, MI 48824, and 4USDA-ARS, East Lansing, MI 48824. ***Cercospora beticola* insensitivity in Michigan and Michigan Sugar Company's resistance management strategies.**

Cercospora leafspot, caused by the fungus *Cercospora beticola*, is the most serious foliar disease of sugarbeets in Michigan. Research trials conducted in Michigan show that poorly controlled Cercospora (25 to 50% canopy desiccation) resulted in losses of 2 to 4 tons per acre and from 0.25 to 1 point of sucrose. Cercospora leafspot is con-

trolled by a combination of cultural methods, variety selection and fungicides.

Triazole and strobilurin fungicides have been the predominant fungicides used in recent years. In 2011, fields sprayed with strobilurin fungicides (FRAC group 11, Quinone outside Inhibitors [QoI]) failed to control Cercospora leafspot. Small, replicated efficacy trials conducted by Michigan Sugar Company and Michigan State University also showed that strobilurin fungicides were performing poorly in 2011. As a result of poor field performance, leaf samples were sent to Michigan State University for laboratory analysis and insensitivity to strobilurin fungicides were confirmed, thus indicating that a mutation in the cyt b that would encode for a change in the amino acid at codon 143 from glycine to alanine (G143A) was identified.

To effectively manage Cercospora in Michigan, tank-mixed fungicides should be applied just prior to the first sign of the disease. The BEETcast prediction model has worked well in Michigan for timing our fungicide applications. Our region is divided into Cercospora risk zones and 50 weather stations provide growers with spray recommendations which are appropriate for the grower's location. Application timings are also modified by the Cercospora tolerance level of the variety being grown. Fungicides insensitivity in sugarbeets can be managed; however, growers will need to follow a resistance management program that includes the following practices:

Plant susceptible varieties only if you are willing to follow an aggressive spray recommendation; use of more tolerant varieties is especially important when planting next to a field that had fungicide failure in controlling Cercospora leafspot the previous year; fungicides must be tank mixed with another mode of action; never spray with the same mode of- action back-to-back; follow BEETcast for first spray; and use 20-25 gallons of water with a minimum of 90 PSI with 100 PSI for better performance.

DREGSETH, ROBERT J.[1]*, BOETEL, MARK A.[1], ALLEN J. SCHROEDER[1], and AYANAVA MAJUMDAR[2]. [1]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108, and [2]Alabama Extension Service, Auburn University, Auburn, AL 36830. **Insecticidal seed treatments to manage wireworms and springtails in sugarbeet: a multi-year assessment.**

North American sugarbeet producers often face the threat of economically damaging infestations of soil-inhabiting insect pests. Conventional at-plant granular and liquid insecticide formulations have been used to manage these pests for decades; however, recently labeled insecticidal seed treatments have been widely adopted by producers in the past few years. This research involved multiple field trials between 2004 and 2012 to compare insecticidal seed treatments with conventional insecticides for efficacy against natural infesta-

tions of wireworms (*Limonius* spp.) and subterranean springtails (*Onychiurus* spp.). Good control of wireworms was achieved by using the combination seed treatment Poncho Beta (clothianidin+beta-cyfluthrin, respectively applied at 60+8 g a.i./unit [100,000 seeds]), Cruiser 5FS seed treatment (thiamethoxam; 60 g a.i./unit), and a conventional granular soil insecticide, Counter (terbufos; applied at 1.5 lb a.i./ac). Insecticidal seed treatments (i.e., Nipsit Inside [clothianidin; 60 g a.i./unit], Cruiser, and Poncho Beta) also provided comparable levels of springtail control to those of Counter at low and moderate rates (0.9 to 1.5 lb a.i./ac). The seed treatments we evaluated are likely to provide similar levels of wireworm and subterranean springtail control to that of currently labeled conventional soil insecticides. In addition to increased applicator safety, an additional benefit of seed treatment technology is that adequate control of these pests can be achieved while allowing for major (up to 95%) reductions in the amount of insecticide active ingredient released into the environment at planting time.

GOLLNOW, MAREEN, DANIELA CHRIST, CHRISTA HOFFMANN and MARK VARRELMANN*. Institute of Sugar Beet Research, Departments of Phytopathology and Physiology, Holtenser Landstr. 77, 37079 Göttingen, Germany. **Mycotoxin production and colonization patterns of different *Fusarium* spp. in sugar beet.**

During long-term storage in outdoor piles, sugar beets are affected by various degrading and mycotoxin producing fungi. In a two year study, the occurrence of *Fusarium* mycotoxins in freshly harvested and stored sugar beets was analyzed. Sugar beet roots were stored at three different temperature regimes for zero, five and twelve weeks. A significant reduction of root yield and sucrose concentration was observed after long-term storage at high temperature. Under these conditions also high amounts of deoxynivalenol (DON) and zearalenone (ZEA) were detected, while in freshly harvested sugar beets only beauvericin and enniatins were found. These results were confirmed by a survey of commercially grown sugar beets which were stored for five weeks in outdoor piles: neither DON or ZEA were detected. Additionally, colonization patterns and species specific mycotoxin production of five *Fusarium* spp. were studied. Roots of five months old greenhouse cultivated plants were mechanically injured, inoculated and kept for 30 days. At harvest, roots were divided into three parts: necrotic tissue, surrounding discolored tissue and sound tissue. Hand sections of each part were stained and fungal colonization was visualized by confocal laser scanning microscopy. The most severe root rotting symptoms were caused by *F. graminearum* followed by *F. cerealis*, *F. culmorum* and *F. tricinctum* while *F. equiseti* inoculated plants did not differ from the control. Fungal growth of all isolates was detected in the necrotic tissue, while inter- and in-

tracellular growth in the surrounding discolored tissue was only observed for *F. graminearum*, *F. culmorum* and *F. cerealis*. Higher amounts of mycotoxins were only detected in the necrotic tissue independent of the inoculated species.

JACOBSEN, BARRY J.[1] and KEN KEPHART[2]. [1]Department of Plant Sciences and Plant Pathology, Montana State University, P.O. Box 173150, Bozeman, MT 59717-3150 and [2]Southern Agricultural Research Center, 748 Railroad Highway, Huntley, MT 59037. **Integrating fungicide seed treatments, in-furrow fungicides and fungicide band applications for improved control of Rhizoctonia crown and root rot.**

Fungicide band applications have proven to be very effective in controlling Rhizoctonia crown and root rot when properly timed. Their use poses two problems for growers; 1.the proper timing relative to growth stage can differ year to year and 2. the proper application window can be only 1-3 days, too short a time for optimally treating large acreages. In 2011 and 2012, we compared penthiopyrad seed treatment (7, 14 and 28 grams a.i./kg seed) with azoxystrobin (Quadris, Syngenta) or penthiopyrad (Vertisan, DuPont) applied in-furrow at 17 and 35.4-54 grams a.i./305 meters of row respectively with application of azoxystrobin applied at 0 or 4.25 g a.i./305 meters of row at the 4-6, 8-10 and 10-12 leaf stages. Azoxystrobin band applications at the 4-6 leaf stage provided optimal yield and disease control, with applications at the 8-10 and 10-12 leaf stages being less effective. The use of penthiopyrad seed treatments alone were not effective in reducing disease severity or increasing yields but when combined with azoxystrobin band application, all seed treatment rates provided optimal disease control and yield increase. In-furrow treatments alone provided optimal disease control and high yields but disease control and yield were optimal when combined with azoxystrobin band timing treatments. The use of penthiopyrad seed treatment or infurrow treatments combined with azoxystrobin band applications provided optimal control and yield increases while allowing growers nearly 3 weeks to apply band applications compared to the 3-5 day period where azoxystrobin band application had to be done to achieve optimal disease control. In-furrow applications required 50-100 times more penthiopyrad or azoxystrobin compared to penthiopyrad seed treatment alone.

KHAN, MOHAMED F. R. Plant Pathology Department, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050. **What are the options for managing *Rhizoctonia solani* on sugarbeet?**

Rhizoctonia solani is the causal agent of damping off, crown rot

and root rot of sugar beet (*Beta vulgaris* L.). Growers have reported during 2009 through 2011 that Rhizoctonia root rot is the most important disease of sugarbeet in Minnesota and North Dakota. It is difficult to incorporate multiple genes required for resistance to *R. solani* and agronomic characters that will result in varieties with *R. solani* resistance that are also high yielding. Most commercial sugar beet varieties are susceptible to or have only partial resistance to *R. solani*. In fields with a history of moderate to severe Rhizoctonia root rot, fungicides are needed to provide protection for acceptable yields. Research was to evaluate fungicide treatments in controlling *R. solani* on sugarbeet. Penthiopyrad, a succinate dehydrogenase inhibitor, was evaluated as a seed treatment at different rates alone, and with a post application of azoxystrobin, a quinone outside inhibitor. Azoxystrobin was applied in-furrow at planting followed by a post application; and azoxystrobin was used only as a post application. *R. solani* resistant and susceptible cultivars were used in the experiment. Plant populations were recorded during the season. Roots were harvested, weighed and analyzed to determine recoverable sucrose. Azoxstrobin applied in-furrow followed by a post application consistently resulted in significantly high plant populations and recoverable sucrose compared to the non-treated control. Penthiopyrad provided early season control by protecting plant populations compared to the nontreated check, but was not effective during the latter part of the season as populations were reduced. Penthiopyrad followed by azoxystrobin resulted in higher populations and recoverable sucrose compared to the control. The use of penthiopyrad as a seed treatment followed by azoxystrobin will serve as a fungicide resistance management strategy while providing effective disease control.

KIRK, WILLIAM. W.[1]*, L.E. HANSON[1,2], N. ROSENZWEIG1, G.D. FRANC[3], W.L. STUMP[3], Q.W. JIANG[1], E. GACHANGO[1], G. CLARK[4] and J. STEWART[4]. [1]Department of Plant, Soil and Microbial Science, Michigan State University, 612, Wilson Road, 35 Plant Biology Building, East Lansing, MI 48824, [2]USDA-ARS, 1066 Bogue Street, Room 494, East Lansing, MI,48824, [3]Department of Plant Sciences, University of Wyoming, Laramie, WY 82071 and [4]Michigan Sugar Company, Euclid Road, Bay City, MI 48706. **Assessment of strobilurin resistance in *Cercospora beticola* on sugar beet in Michigan and Nebraska, USA.**

Cercospora leaf spot (CLS) caused by *Cercospora beticola* Sacc. is the most important foliar disease of sugar beet (*Beta vulgaris*) worldwide (Jacobsen & Franc, 2009). CLS is controlled mainly with fungicides, including strobilurins (FRAC group 11). Resistance to strobilurins in C. beticola was first identified in 2011 from several fields in Michigan and in one field in Nebraska, USA (Kirk *et al*.

2012). In these fields, sugar beet treated with strobilurins had severe CLS and diminished control was also noted in small plot trials in Michigan. Individual leaf spot lesions were sampled from leaves and grown on sugar beet leaf extract agar (SBLEA). A conidium germination bioassay was done on SBLEA covered with water agar amended with pyraclostrobin, azoxystrobin or trifloxystrobin at 0, 0.001, 0.01, 0.1, 1, 10, or 100 µg/ml supplemented with salicylhydroxamic acid (SHAM) to block the alternate oxidation pathway (Olaya *et al.*, 1998). After 24 h incubation at 22°C, under ambient light, percentage germinated conidia (n = 50) was calculated from three replicates per treatment. Germination was recorded as positive when the germ tube was at least half the length of the conidium. A representative wild type isolate was unable to germinate over the 0.01 µg/ml concentration. Effective concentration for 50% reduction in germination (EC_{50}) values for each isolate were calculated by regression analysis of percentage spore germination vs. the log fungicide concentration using Sigmaplot Version 9.01 (Systat Software, Chic ago). The EC_{50} for the sensitive isolate was <0.01 µg/ml. Isolates from several counties in Michigan had uninhibited germination and EC_{50} values exceeded the highest concentration tested. Isolates also grew on spiral gradient dilution plates (Förster *et al.*, 2004) amended with the three strobilurins. Two isolates were obtained from Nebraska and each showed similar response to strobilurin fungicides in amended plate assays. In 2012, widespread strobilurin resistance was recorded in isolates of *C. beticola* collected in Michigan although a few isolates submitted to the program were sensitive.

Pure cultures of a subset of resistant isolates were grown in potato dextrose broth at 125 rpm, and DNA extracted. A fragment of the cytochrome b (*CYTB*) gene was amplified by PCR using the *C. beticola* primers of Malandrakis *et al.* (2011) to amplify the region of the *CYTB* gene likely to contain resistance mutations (Malandrakis *et al.*, 2011). This fragment was sequenced at the Genomics Technology Support Facility (MSU, East Lansing, MI) and showed 99% identity with both the *C. beticola* cytochrome b mRNA, partial sequence (GenBank Accession No. EF176921.1) and the *C. kikuchii* mitochondrial gene for cytochrome b partial sequence (AB231863.1). Sequence results revealed that each resistant isolate contained a change in codon 143 that is predicted to lead to a substitution of G143A, which was demonstrated to confer QoI resistance in several other fungi (Ma & Michailides, 2005). All four Michigan isolates with the G143A mutation germinated at 100 µg/ml pyraclostrobin (50% of conidia), while sensitive isolates that lacked the mutation failed to grow. Additional isolates that contained the G143A mutation included representatives from Michigan and Nebraska, USA. A high proportion of isolates (~90%) from the commercial growing region that were screened in 2012 have been found to contain the G143A mutation by PCR-RFLP screening using digestion of the above PCR products. These findings

reveal that reduced Cercospora leaf spot control in some commercial sugar beet fields may be due to the development of resistance to strobilurins. In 2012, three consecutive applications of pyraclostrobin treatments failed to adequately control *C. beticola* at MSU Bean and Beet Research Farm.

LARSON, REBECCA[1]*, BRITT-LOUISE LENNEFORS[2], DAVID BELLES[3], BILL GILBERT[1], DOUG RUPPAL4, THOMAS KRAFT[2], ELISABETH WREMERTH-WEICH[2], ANNA PRANGER[1], and NEIL GLYNN[1]. [1]Syngenta, 1020 Sugar Mill Road, Longmont, CO 80501, [2]Syngenta, Sabyholmsvagen 24 Box 302, Landskrona, Sweden 261-23, [3]Syngenta, 4037 E. Karsten Drive, Chandler, AZ 85249, and [4]Syngenta, 5146 Rogers Road, Akron, MI 48701. **One Syngenta: seed, seed care, chemistry and technology for total sugar beet health.**

Over the last 18 months, Syngenta has gone through a strategic realignment in order to optimally leverage the depth and breadth of our seed treatment and crop protection chemistries against our genetic and seed technology portfolio. Hilleshög has long been recognized as the disease tolerance provider, offering strong native tolerance and resistance to a wide array of pests and pathogens, including industry leading *Cercospora*, *Rhizoctonia*, and Curly Top tolerance. Additionally, Syngenta has offered the industry leading chemistries and seed treatments necessary for season long disease and weed control. Developing a "One Syngenta" approach to solving grower issues has allowed the sugar beet seed business access to all new seed technologies, molecular tools and GM platforms formerly limited to our corn and soybean business, launching our breeding efforts forward into the new millennium. Additionally by building working groups across business functions key weaknesses in one portfolio are quickly recognized and the gaps are filled with strengths from another. One Syngenta strategies and success stories will be addressed.

LIEBE, SEBASTIAN and MARK VARRELMANN*, Institute of Sugar Beet Research, Department of Phytopathology, Holtenser Landstr. 77, 37079 Göttingen, Germany. **Development of microarray based detection of sugar beet colonizing microorganisms.**

Sugar beets are subjected to various degrading microorganisms in the field and in outdoor piles. The resulting root rot is not only liable for direct sugar losses due to microbial respiration but also negatively interferes with factory processing. Juice impurities and the accumulation of invert sugars reduce the technical quality of the beets, thus resulting in an economically important reduction of the potential white sugar yield.

The exact diagnosis of the causing microorganisms is crucial for the development of management strategies like selection assays for sugar beet breeding. However, species identification by classical *in vitro* isolation is time-consuming and error-prone. Moreover, primary pathogens or wound parasites often cannot be isolated because of the vast number of decomposers additionally colonizing the damaged beets as secondary invaders. DNA-based detection by means of multiplex PCR technique is as well limited by the high number of potential candidates and target sequences. A microarray in a 2 ml reaction tube (ALERE Technologies) with 225 probes was supplied with oligonucleotides specific to 33 microorganism species known to cause sugar beet root rot. Candidate species belong to the group of pathogens (i.a. *Rhizoctonia solani*, *Helicobasidium purpureum*, *Phoma betae*), wound pathogens (i.a. *Fusarium* spp.), decomposers (i.a. *Aspergillus* spp., *Penicillium* spp.) and bacteria (i.a. *Pectobacterium betavasculorum*, *Rhanella aquatilis*). Experimental parameters were optimized allowing specific detection of all targets. Reliability was tested with purified DNA as well as with inoculated sugar beet slides *in vitro*. All 33 species were reproducibly detected. The microarray was successfully used in the examination of diseased sugar beets from the field.

MOTTEBERG, CHRIS[1]*, Peter Carson[2] and Allan W. Cattanach[1]. [1]American Crystal Sugar Company, 101 North Third Street, Moorhead, MN 56560 and [2]7953 Highway 81, St. Thomas, ND 58276. **Control of Rhizoctonia crown and root rot with seed treatments and post applied fungicides in commercial grower fields.**

Rhizoctonia Crown and Root Rot (RCRR) have dramatically increased in the last decade in the Red River Valley to the point where it is now the most severe root disease impacting yield and quality. Yield losses when environmental conditions favor the disease can exceed 30%. Occasionally disease severity in a field is so great that the field will not be accepted for long term storage and has to be abandoned. Several new seed treatments, at plant fungicide applications and post emergence applied fungicides were evaluated for control of RCRR in commercial grower fields in 2011 and 2012 for control of RCRR. Significant differences in RCRR control were observed between treatments. Treatments were replicated four times, crop harvested, and yield and quality determinations made. Eight treatments were evaluated in 2011 and 25 treatments in 2012. Treatments with Quadris gave exceptional disease control significantly increasing revenue per acre, recoverable sugar per acre, recoverable sugar per ton and tons per acre. Dynasty as a seed treatment gave poor control. The 2012 treatments included Quadris, Metlock , Headline, Proline and Vertisan. Fungicides were used alone and in combinations. Yield and quality data from 2012 have not yet been determined. Soil tem-

peratures were correlated to treatment application timing and control efficacy.

POINDEXTER, STEVEN S.* and THOMAS J. WENZEL. Michigan State University Extension, One Tuscola St., #100, Saginaw, MI 48607. **Quadris (azoxystrobin) and Vertisan (penthiopyrad) fungicide efficacy on natural Rhizoctonia infections in sugarbeets.**

Rhizoctonia solani of sugarbeets has become a significant problem in many sugarbeet producing areas of the United States and Europe. In the past, control of this disease has been mostly limited to resistant varieties and utilization of Quadris (azoxystrobin) fungicide from Syngenta Crop Protection. Recently, approval was given to Vertisan (penthiopyrad) fungicide from DuPont for control of Rhizoctonia on sugarbeets. The objective of this study is to compare the effectiveness of both fungicides on Rhizoctonia solani root rot. The research was conducted in fields with a history and potential for high levels of natural (uninoculated) disease infection. Most current research is or has been utilizing artificial inoculation techniques.

In 2012 susceptible Rhizoctonia beet varieties were planted in three field locations. All three trials were conducted as replicated strip trials utilizing grower equipment for planting, in-furrow fungicide applications, and harvest. Foliar fungicide applications in a 7 inch band at the 6-8 leaf stage were done with a research trial sprayer. Two locations had high levels of Rhizoctonia and the third location had a moderate level. Significant differences did occur between check, Quadris and Vertisan treatments. Rhizoctonia dead or dying beet counts taken in June and July generally indicated significantly less beet die off with Quadris than the check or Vertisan treatments. Under high Rhizoctonia pressure, season long control was not achieved with either fungicide. Yield data from 2012 trials is forth coming.

PRETORIUS, JOHAN[1]*, JEFF BRADSHAW[1] and GARY HEIN[2]. [1]University of Nebraska-Lincoln, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361-4939 and [2]University of Nebraska-Lincoln, 279D Plant Sciences Hall, Lincoln, NE 68583. **Seasonal fluctuations in the beneficial arthropod complex associated with conventional tilled and zone tilled sugar beets.**

From planting, sugar beet is subjected to attack by several arthropod pests. Chemical control of these pests is not always feasible. This has led to increased attention to the ecosystem services provided by beneficial arthropods in agroecosystems. However, we have a poor understanding of how the species composition and relative abundance of key predatory groups vary throughout the growing season,

especially in sugar beet fields. This ongoing study aims at addressing this problem. Pitfall traps are used to monitor the activity density of soil-dwelling predatory arthropods in conventional till and zone till sugar beets. The traps are activated for a total of six times during the season and for five days at a time. Data collected during the 2012 field season indicate that ground beetles (Coleoptera: Carabidae) are the most abundant soil-dwelling predators in the sugar beet plots. Other important predatory taxa included spiders (Araneae) and rove beetles (Coleoptera: Staphylinidae). For most of the collecting dates, the zone till sugar beet plots had on average higher numbers of the various predatory taxa, with the exception of ground beetles that were more abundant in the conventional tilled plots. The relative abundance of individual ground beetle species also showed clear shifts throughout the season in both tillage types. In addition to monitoring predatory abundance, direct measurements of the ecosystem services provided by the arthropods present in these plots were also made by means of a weed seed removal study and a predation study. Preliminary results for these studies are discussed.

RUSH, CHARLES M.[1], BEAU BEALMER*[1], MARK BREDEHOEFT[2] and CHRIS DUNSMORE[2]. [1]Texas A&M AgriLife Research, P. O. Drawer 10, Bushland, TX 79012 and [2]Southern Minnesota Beet Sugar Cooperative, Renville, MN. **Relationship between *Beet necrotic yellow vein virus* and incidence and severity of Rhizoctonia root rot.**

In all sugar beet production areas throughout the USA, most approved cultivars possess genetic resistance to *Beet necrotic yellow vein virus* (BNYVV), conferred by *Rz1*, *Rz2* or some combination of the two. It has been reported that cultivars with *Rz1* resistance are more susceptible than those with *Rz2* and that a combination of *Rz1* & *Rz2* provides the strongest resistance. However, the minor genes associated with these major dominant genes frequently play an important part in the final degree of resistance exhibited by a particular cultivar, and cultivars with the same dominant gene/s can vary significantly in their susceptibility to BNYVV and rhizomania. When susceptible sugar beet roots are infected by BNYVV, their physiological functions become disrupted and normal plant/soil water relations become impaired. It was hypothesized that chronic infection by BNYVV might be affecting susceptibility to *Rhizoctonia solani* and cultivars with less tolerance to infection by BNYVV possibly would be more susceptible to Rhizoctonia root rot. A field study was conducted near Hector, MN in which nine cultivars that varied in susceptibility to BNYVV and *R. solani* were evaluated to see if incidence and severity of Rhizoctonia root rot were correlated to BNYVV titer. The field was naturally infested with BNYVV. Plants were inoculated with *R. solani* AG2-2 IIIB barley inoculum July 10 and harvested

September12. The incidence and severity of Rhizoctonia root rot in each plot was evaluated and root subsamples were collected to determine titer of BNYVV. Significant differences existed in incidence and severity of Rhizoctonia root rot among cultivars, but differences were not strongly correlated to original Rhizoctonia root rot ratings and were not affected by *Rz* gene or gene combinations.

SECOR, GARY A.[1]*, VIVIANA V. RIVERA-VARAS[1], MELVIN D. BOLTON[2] and MOHAMED F. R. KHAN[1]. [1]Department of Plant Pathology, North Dakota State University, North Dakota State University, Department 7660, Box 6050, Fargo, ND 58108 and [2]USDA-ARS, Northern Crops Science Lab, 1605 Albrecht Avenue, Fargo, ND 58102. **Frequency, changes and distribution of fungicide sensitivity in *Cercospora beticola* populations from 1998 to 2012.**

Cercospora leaf spot, a potentially serious disease of sugar beet throughout the world, is caused by the fungus *Cercospora beticola*. The disease is managed by crop rotation, resistant varieties and timely fungicide applications. Fungicide resistance in *C. beticola* is a concern where ever sugar beet is grown. Populations of *C. beticola* from the US have been monitored for changes in sensitivity to fungicides to four classes of fungicides using bulk spore germination, growth reduction and spore germination compared to baseline sensitivities. The number of isolates with resistance to tin at 2 ppm has decreased from 65% to < 10% during this period, ostensibly due to registration of new fungicides. Percentage of isolates with resistance to thiophanate methyl initially decreased but returned quickly in local populations. Sensitivity of isolates to the triazole fungicides as measured by EC_{50} values gradually increased over time, but increase dramatically in 2011. Reduced sensitivity correlates with increased disease losses. Triazole resistance is associated with overexpression of the Cyp51enzyme in *C. beticola*. There has been a 40 fold increase in EC_{50} values since the introduction of pyraclostrobin compared to baseline values of isolates recovered from ND and MN. In 2011, isolates of *C. beticola* were collected in MI from fields with high incidence of Cercospora leaf spot. These isolates had high EC_{50} values to pyraclostrobin and had the G143A mutation. Bulk spore samples collected from 1412 fields in 2012 showed that 24 of the samples (1.7%) contained the G143A mutation. Limited testing in several European populations has shown high levels of resistance to triazole and QoI fungicides, and the presence of the G143A mutation.

WEBB, KIMBERLY M.*, PAUL COVEY, BRETT KUWITZKY, and MIA HANSON. USDA-ARS, Sugar Beet Research Unit, 1701 Centre Ave., Fort Collins, CO 80526. **Characterization of a population of *Fusarium oxysporum*, from sugar beet, using the population structure of putative pathogenicity genes.**

Fusarium oxysporum f. sp. *betae* is an important pathogen in sugar beet (*Beta vulgaris* L.) which can lead to reductions in root yield, sucrose percentage, and juice purity. *F. oxysporum* f. sp. *betae* can be highly variable in growth, pigmentation, conidial production, and in virulence. Additionally, high rates of *F. oxysporum* isolated from symptomatic sugar beet are actually non-pathogenic. Many methods have been used to characterize the genetic diversity of *F. oxysporum* f. sp. *betae* from sugar beet however many of these technologies do little to describe regional populations of *F. oxysporum* f. sp. *betae* and are unable to differentiate between pathogenic *F. oxysporum* f. sp. *betae* and non-pathogenic isolates of *F. oxysporum*. *F. oxysporum* utilizes a wide array of secreted molecules, called effectors, and pathogenicity genes, which encode host determining factors that are used by the pathogen to cause disease in sugar beet. Utilizing these target effectors, it is possible to utilize patterns of nucleotide diversity (both within and among populations) to infer the molecular basis of pathogen relatedness. In this work, we obtained the nucleotide sequence for thirteen putative effectors, and characterized their diversity in the population from thirty isolates of *F. oxysporum* originally collected from symptomatic sugar beet. Using this information, we characterized the pathogen population by "clade" and "pathogenicity" to 1) determine the genetic diversity of the *F. oxysporum* population from symptomatic sugar beet and 2) determine if this diversity could be correlated to "pathogenicity" or "clade" designations of *F. oxysporum* f. sp. *betae*. We determined that eight genes were able to significantly describe the *F. oxysporum* population to "clade" and that five genes were significantly able to describe the population to "pathogenicity".

Section C
Entomology and Plant Pathology
Poster Presentations

BLOOMQUIST, MARK W.[1]*, GARY LINDAHL[1], STEVE ROEHL[2] and OSTEN TVEDT[1]. [1]Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284 and [2]West Central Inc., 2508 Trott Avenue SW, Willmar, MN 56201. **Development of an aphanomyces nursery for variety approval at Southern Minnesota Beet Sugar Cooperative.**

Aphanomyces root rot is a serious disease problem in the Southern

Minnesota Beet Sugar Cooperative growing area. Entire sugarbeet fields and portions of sugarbeet fields have been lost or severely damaged due to aphanomyces root rot. Because of the devastating effects of aphanomyces root rot, SMBSC created an aphanomyces tolerance criteria for variety approval. SMBSC is currently the only sugar cooperative in the United States to have an aphanomyces rating criteria in place for a variety to make full approval for planting. SMBSC has submitted entries to the Betaseed Aphanomyces Nursery in Shakopee, MN for many years. In 2006, SMBSC decided to have an aphanomyces nursery within our growing area to provide additional data on variety tolerance to aphanomyces. In 2007, Steve Roehl and Osten Tvedt broke ground on SMBSC's aphanomyces nursery. The land used for the nursery was owned by SMBSC and had previously been used for wastewater irrigation from the factory, but had never been planted to sugarbeets in the past. Aphanomyces susceptible sugarbeets were planted on the parcel each year to build up the disease pressure within the nursery area, and an irrigation system was installed. The planting of aphanomyces susceptible sugarbeets each year allowed a natural infestation of aphanomyces to develop. In the fall of 2011, soil samples were sent to Jason Brantner at the Northwest Research and Outreach Center in Crookston, MN for aphanomyces indexing. The south portion of the nursery had an aphanomyces index value of 99 on a 1-100 scale. In the spring of 2012, all entries in the SMBSC Official Variety Trials were planted in the SMBSC nursery as well as submitted to Betaseed's nursery in Shakopee. Root ratings were taken in September of 2012 and the data was used in variety approval for the 2013 sugarbeet crop.

BORNEMANN, KATHRIN[1,2], VARRELMANN, MARK[1] and MELVIN BOLTON[2], [1]Institute of Sugar Beet Research, Holtenser Landstrasse 77, 37079 Goettingen, Germany and [2]USDA, Agricultural Research Service, Northern Crops Science Laboratory, 1605 Albrecht Blvd. N, Fargo, North Dakota 58102. **Characterization of the influence of *Beet soil-borne mosaic virus* on the aggressiveness of *Beet necrotic yellow vein virus* in sugarbeet.**

Beet necrotic yellow vein virus (BNYVV) strains with different levels of aggressiveness have spread to sugarbeet growing areas worldwide. In the US and Europe, resistance breaking properties of some strains causing high yield losses have been observed. The objective of the study was to identify the influence of (i) the sugar beet genotype, and (ii) *Beet soil-borne mosaic virus* (BSBMV) on the aggressiveness of BNYVV strains. Both viruses are vectored by the plasmodiophoromycete *Polymyxa betae*. Competition experiments with different BNYVV strains from Europe (Germany, France and Italy), and the US were performed under standardized greenhouse conditions. Infected roots of different sugarbeet genotypes (suscepti-

ble and resistant) were analyzed after five weeks of cultivation to determine virus titer (ELISA), and amino acid composition by means of "deep sequencing" of the viral pathogenicity factor. In a second experiment, the same BNYVV strains and the same sugarbeet genotypes were used in mixed infections with BSBMV. Additionally, another experimental approach was chosen to compare the aggressiveness of resistance breaking and wild type BNYVV strains in single and mixed infections with BSBMV. Therefore, the same vector population was loaded with both viruses, which also showed that the ability to overcome resistance was independent of the vector population. The results of the first experiment showed that, depending on the sugarbeet genotype, certain amino acids of the viral pathogenicity factor, which determine the resistance breaking properties of the virus strain, occur with a higher frequency. At harvest, typical virus symptoms were observed in mixed infections with BNYVV and BSBMV. Further analysis remains to be done.

HANSON, LINDA[1]*, TING MO[2], and TOM GOODWILL[1]. [1]USDA-ARS, 1066 Bogue Street, East Lansing, MI 48824 and [2]Michigan State University, East Lansing, MI 48824. ***Phoma* species on beet: more cause disease than just *Phoma betae*.**

Phoma can cause damage to sugar beet (*Beta vulgaris*) at multiple growth stages. It has historically been an important seedling disease, but this is largely managed by ensuring clean seed for planting. The pathogen also can cause a root rot, a leaf spot, and rotting of beets during storage. In the United States, the only pathogenic *Phoma* associated with beets has been *Phoma betae*. In Europe, other species of *Phoma* have been reported to cause symptoms on sugar beet. *Phoma* isolates from sugar beet in the United States were examined to determine whether there might be more species causing symptoms on beet. *Phoma* isolates had been collected as part of ongoing surveys for seedling diseases and root rot, and additional samples were collected from leaf spots. Isolates were examined for morphological characters on malt extract agar and oatmeal agar and a portion of the ITS region was sequenced. Of 16 isolates identified as *Phoma* by both morphological and molecular testing, eight were identified as *P. betae* while the remaining isolates showed highest identity with *Phoma* species other than *P. betae*, particularly in *Phoma* section Peyronellaea. Symptoms, including storage rot and leaf spot, were produced on beets inoculated with different *Phoma* species.

HARVESON, ROBERT M.[1]* and MELVIN D. BOLTON[2]. [1]University of Nebraska, Panhandle REC, 4502 Ave I, Scottsbluff, NE 69361, and [2]USDA-ARS, Northern Crop Science Laboratory, 1307 18th St N Fargo, ND 58102. **A new occurrence of dry rot canker?**

In mid-September, 2011 a field in Morrill County near Bridgeport NE was noted with wilting and yellowing symptoms suggestive of Rhizoctonia root rot. Root symptoms consisted of localized, dry sunken lesions covering brown spongy material penetrating deeply into taproots sharply delimited from healthy beet tissue. The surface tissues of the cankers produced a series of concentric circles. These symptoms are inconsistent with Rhizoctonia root and crown rot disease, but are suggestive of the rarely occurring dry rot canker (DRC). DRC is a root disease first identified from Utah in 1921, and has since been reported from California, Colorado, Minnesota, Montana, Nebraska, North Dakota, and Wyoming. The disease is caused by an uncharacterized strain of *Rhizoctonia solani*, but little else is known about the pathogen or disease due to its rare appearances. To initiate characterization of the pathogen, the internal transcribed spacer (ITS) was sequenced from four strains isolated from separate DRC lesions. Sequence analysis suggests that these isolates are distinct from *R. solani* anastomosis groups (AGs) that typically cause disease in sugarbeet.

KIRK, WILLIAM. W.[1]*, L.E. HANSON[1], [2] and C.L. SPRAGUE[1]. [1]Department of Plant, Soil and Microbial Science, Michigan State University, 612, Wilson Road, 35 Plant Biology Building, East Lansing, MI 48824, [2]USDA-ARS, 1066 Bogue Street, Room 494, East Lansing, MI,48824. **Glyphosate and fungicide effects on Cercospora leaf spot in four glyphosate-resistant sugar beet (*Beta vulgaris*) varieties.**

The potential for improved management of Cercospora leaf spot [CLS (*Cercospora beticola*)] using the herbicide glyphosate in glyphosate-resistant sugar beet varieties was investigated. Controlled field experiments were conducted in 2008 and 2009 to determine if glyphosate and glyphosate-fungicide combinations improved the management of CLS in four commercial varieties of glyphosate-resistant sugar beet. Variety and fungicide main effects were significant for CLS development. However, regardless of the herbicide program, glyphosate or a conventional herbicide program, CLS development was not affected. Therefore, results from of this research indicate that glyphosate and glyphosate-fungicide combinations do not significantly contribute to CLS management.

MACRAE, IAN[1]*, MARK BOETEL[2], and SOIZIK LAGUETTE[3]. [1]Dept. of Entomology, University of Minnesota, UMN-NWROC, 2900 Univ. Ave, Crookston, MN 56716, [2]Dept. of Entomology, North Dakota State University, PO Box 6050, Fargo, ND 58108 and [3]Dept. of Earth System Science & Policy, University of North Dakota, 4149 University Ave, Stop 9011, Grand Forks, ND 58202. **Remote sensing of sugarbeet root maggot, *Tetanops myopaeformis*.**

Feeding damage by a variety of insect species has been associated with measureable changes in plant reflectance. This facilitates the potential use of remotely sensed data to estimate the within-field populations of these insects. In an effort to determine if this technique is applicable to sugarbeet root maggot (SBRM), in the summer of 2012 remotely sensed data were obtained from plots supporting different SBRM populations. Plots in St Thomas, ND were categorized as having high, medium or low SBRM populations by assessing the mean root maggot feeding injury ratings in each plot. Canopy reflectance data were obtained using a CropScan® MSR-16 multi-spectral radiometer and compared across estimated SBRM populations. In addition, visible and NIR imagery, obtained using a TetraCam® ADC camera, were used to construct and compare several vegetation indices (including Normalized Difference Vegetation Index and the Soil Adjusted Vegetation Index). Analyses of these data indicate that there is a significant difference in canopy reflectance of plots with high SBRM feeding injury ratings and those with low injury ratings. These results suggest further refinement of these relationships may aid in estimating populations of sugarbeet root maggot.

MCDUFFEE, DAIR A.* and SCOTT HALLEY. Valent U.S.A. Corporation, 7906 Goodway Dr. Indianapolis, IN. **Using metconazole and tolclofos-methyl as a seed treatment to protect sugarbeets from early season Rhizoctonia crown and root rot.**

Rhizoctonia solani Kuhn is found in the soil of all sugarbeet growing regions. It is the casual pathogen of Rhizoctonia Crown and Root Rot, an economically important disease of sugarbeets. Recent reports have noted the increase in the distribution and severity of RRCR. In extreme situations, RRCR can destroy up to half of the crop. Currently metconazole is the only registered seed treatment that offers protection from *R. solani* for sugarbeets. Tolclofos-methyl is a contact, aromatic hydrocarbon fungicide that has shown activity against *R. solani* in other crops. It is applied at a rate of 0.5 grams of active ingredient per 100,000 seeds, on pelleted blank seed or incorporated into the pelleting. The combination of metconazole and tolclofos-methyl has been shown to provide a reduction in infection severity and early season survivability in the field. Metconazole and tolclofos-methyl, applied as a seed treatment, has been shown to provide protection from early season RRCR.

MSANGOSOKO, KONDWANI R.[1], MARK A. BOETEL[2]*, ROBERT J. DREGSETH[2], and ALLEN J. SCHROEDER[2]. [1]Agricultural Research and Extension Trust, Mchinji Road, Private Bag 9, Lilongwe 265, Malawi, and [2]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108. **Oviposition preference and larval host range of the sugarbeet root maggot.**

Oviposition preference and larval survival of the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), was evaluated on three cultivated plant species and five native North American weed species during the 2010 and 2011growing seasons near St. Thomas, in northeastern North Dakota. Treatments included the following: sugarbeet, *Beta vulgaris* L.; spinach, *Spinacia oleroceae* L.; sunflower, *Helianthus annuus* L.; common lambsquarters, *Chenopodium album* L.; redroot pigweed, *Amaranthus retroflexus* L.; Palmer amaranth, *A. palmeri* S. Watts.; spear saltbush, *Atriplex patula* L.; and common ragweed, *Ambrosia artemisiifolia* L. The most preferred plant species for egg deposition by SBRM flies included Palmer amaranth, sugarbeet, spinach, common lambsquarters, spear saltbush, and redroot pigweed. Recovery of live third-instar larvae was highest on spinach, sugarbeet, and spear saltbush. Spear saltbush is considered to be native to central and northern latitudes of the continent, further indicating that this species could have served as a common or preferred SBRM host before the apparent host preference shift to sugarbeet. Lower levels of survival were observed on common lambsquarters, redroot pigweed, and Palmer amaranth. These findings suggest that the SBRM could have used some of these weed species as hosts because sugarbeet and spinach are not native to North America. Our observed SBRM survival on weed species in this study suggests that the pest made a significant preference shift to sugarbeet monocultures. Oviposition and larval survival on other plant species suggests that these plants can still serve as alternate hosts. These findings may have important SBRM management implications, especially if one of these weeds becomes resistant to herbicides commonly used sugarbeet.

NEHER, OLIVER T.*, HOWARD NEIBLING and ERIK J. WENNINGER. University of Idaho, Kimberly Research & Extension Center, 3806 N 3600E, Kimberly, ID 83341. **Beta vulgaris grown under different evapotranspiration levels and the effects on three *Rhizoctonia solani* AG 2-2 IIIB isolates and *Pegomya* betae.**

Excessive irrigation can lead to soil erosion and can increase the potential for soil-borne diseases. The widespread use of sprinkler or surface irrigation in Idaho in combination with irrigation mismanagement can potentially predispose local growers to disease and insect pest problems including Rhizoctonia root rot (RRR, *Rhizoctonia solani*) and Beet leaf miner (BLM, *Pegomya betae*). A study estab-

lished as a 3 by 4 factorial experiment was conducted to investigate the interaction between irrigation (Irrigation levels: 40%, 70%, 100% and 130% evapotranspiration (ET)) and *R. solani* AG 2-2 IIIB isolates (isolates F521 – closely related to the widely used *R. solani* isolate R9, F551 – isolate found in the southern production area of Idaho and F517 – isolate from the western production area) was conducted at the University of Idaho Kimberly Research & Extension Center, Kimberly, Idaho. The study was conducted using drip irrigation to ensure consistent and precise water delivery. Statistical analysis for RRR disease index (DI, based on a 1-9 rating scale with 1 = no disease observed on beet root, 9 = root completely dead) showed significant differences for different ET levels (Pr>F 0.0025), *R. solani* isolates (Pr>F <0.0001) and for the interaction between ET and *R. solani* isolates (Pr>F 0.0201). Comparing Rhizoctonia isolates across ET levels showed a 6.4-fold increase in DI for F521, a 3-fold and 2-fold for F551 and F517 respectively when compared to the non-inoculated control.

PRETORIUS, HENDA* and JEFF BRADSHAW. University of Nebraska-Lincoln, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361-4939. **Effect of tillage and crop rotation on the sugar beet cyst nematode, *Heterodera schachtii* Schmidt, 1871.**

Sugar beet cyst nematode, *Heterodera schachtii* Schmidt, 1871 has long been known to be a serious pest of sugar beet (*Beta vulgaris* L.). Fields infested with this pathogen exhibit chlorosis and a reduction in tap root size which can lead to decreased yield. The objective of this study was to evaluate the impact of tillage and crop rotation on the sugar beet cyst nematode for potential use as control mechanisms in the North Platte Valley of western Nebraska. A trial was conducted during the 2011 growing season at the University of Nebraska's Panhandle Research and Extension Center with corn, beans and sugar beet in rotation under two tillage conditions (plowed and no till). Soil samples were collected at planting and before harvest. Cysts were extracted and then counted under a microscope. Plots with no sugar beet in rotation had the lowest number of eggs (< 25 eggs/ 100 cm^3). In plots with sugar beet in the rotation, egg numbers varied between planting and harvest. At planting the highest egg numbers (205 eggs/ 100 cm^3 soil) were present in plots planted with sugar beet the previous growing season. At harvest the plots currently in sugar beet had the highest egg numbers (100 eggs/ 100 cm^3). When comparing egg numbers between tillage types, the plowed plots contained lower egg numbers.

STRAUSBAUGH, CARL A.[1]*, IMAD A. EUJAYL[1], and LEE PANELLA[2]. [1]USDA-ARS NWISRL, 3793 North 3600 East, Kimberly, ID 83341, [2]USDA-ARS, 1702 Center Ave., Ft. Collins, CO 80526. **Interaction of sugarbeet host resistance and *Rhizoctonia solani* AG-2-2 IIIB strains.**

Rhizoctonia root rot caused by *Rhizoctonia solani* can cause serious economic losses in sugarbeet fields. Preliminary evidence suggests there could be interactions between different strains and resistance sources. Thus, field studies were conducted to determine if nine *R. solani* AG-2-2 IIIB strains varied for virulence when compared with a non-inoculated check and interacted with five sugar beet lines (four resistant lines and a susceptible check). The studies were arranged in a randomized complete block design with six replications. Roots were evaluated for surface rot and internal fungal and bacterial rot in September. All strains were virulent on the susceptible check, FC901/C817, and had the same ranking ($r = 1.0$) regardless of disease variable. Line FC709-2 was resistant (strain responses were not different from non-inoculated check; $P \geq 0.1042$) to all strains, while the strain responses resulted in weak interactions with less resistant lines in 14 of 19 variable-year combinations. The ranking of strains compared across lines within a disease variable was frequently correlated, but when compared across disease variables the strain ranking tended to differ. Since most commercial sugarbeet cultivars contain low to intermediate resistance to Rhizoctonia root rot, the strain used to screen should be given consideration in order to maintain consistent responses between nurseries and commercial fields.

WENNINGER, ERIK J.*, OLIVER T. NEHER, KRISTIN E. DAKU, HOWARD NEIBLING and DON W. MORISHITA. University of Idaho, Kimberly Research & Extension Center, Kimberly, ID 83341. **Effects of tillage and irrigation practices in sugar beet on diseases, weeds, and insect pests and their natural enemies.**

Strip tillage (ST) provides a number of agronomic and economic benefits to sugar beet production. However, little is known regarding how reduced tillage affects pests and their natural enemies. During 2010, a study at the University of Idaho Kimberly R & E Center (Kimberly, ID) was initiated to examine disease, weed, and insect responses to two tillage treatments (ST and conventional tillage [CT]) and four irrigation treatments based on evapotranspiration (ET) rates of CT sugar beet (50, 75, 100, and 125% ET). No uniform disease development was observed for *beet necrotic yellow vein virus* (BNYVV) or *Rhizoctonia solani* during 2010. During 2011, *Rhizoctonia solani*-inoculated rows showed stronger reduction in ERS relative to non-inoculated rows for CT plots than for ST plots. During 2010, densities of common lambsquarters, hairy nightshade, green foxtail, and barnyardgrass were higher in CT than ST treatments; irrigation

treatment had little effect on dicotyledonous species, but more grasses emerged in 50% ET plots compared to the other irrigation treatments. During 2011, neither tillage nor irrigation treatment influenced weed species densities. Beet leafminer eggs (but not larvae) and bean aphids were more abundant in CT plots on some sampling dates during 2010. Neither leafminers nor aphids responded to irrigation treatments during 2011; however, bean aphids were less abundant on low-irrigation plots on one sample date during 2010. Spiders generally were more abundant in ST plots. Staphylinid beetles and harvestmen were more abundant in ST plots early in the season and more abundant in CT plots late in the season. Carabid beetle densities did not differ between tillage types. Results suggest that pest (disease, weed, and insect) pressure may be similar between CT and ST systems, and certain soil-dwelling predatory arthropods are favored by ST.

WINTERMANTEL, WILLIAM M.[1]*, KIMBERLY M. WEBB[2], LAURA HLADKY[1], PAUL COVEY[2] and CAROLYN BROCCARDO[3]. [1]USDA-ARS, Salinas, CA 93905, [2]USDA-ARS, Ft. Collins, CO 80526, and [3]Proteomics and Metabolomics Facility, Colorado State University, Ft. Collins, CO 80523. **Differentiating *Rz-1* AND *Rz-2* resistance reactions to *Beet necrotic yellow vein virus* through proteome analysis in sugarbeet.**

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV), is one of the most economically important diseases affecting sugarbeet, and is widely distributed in most sugarbeet growing areas of the world. Control is achieved almost exclusively through planting of resistant varieties. Following the introduction of *Rz1* varieties in the 1990s, new pathotypes that break resistance have appeared. Previous studies demonstrated that a relatively small number of differences in sugarbeet protein expression were associated with BNYVV infection as well as for resistance. Current studies are examining protein differences among resistant (*Rz1* and *Rz2*) and susceptible sugarbeet, when infected with both traditional (pathotype A) and *Rz1* resistance-breaking BNYVV (pathotype IV, from California's Imperial Valley). Near isogenic lines differing only for Rhizomania resistance were provided by KWS, and raised in virus-specific soils under standardized growth chamber conditions. Protein was extracted from sugarbeet seedlings three weeks after planting to represent a time point early in the infection cycle. Total protein extracts were processed through SCX fractionation, followed by reverse phase liquid chromatography and mass spectrometry (LC-MS-MS). Peptide Spectra were examined for identity using the NCBI 'all plant' and *Beta vulgaris* genome initiative (BvGI) databases. Subtractive analysis was performed to identify differences among treatments, and indicate variation in protein content among treatments. These studies

build on the knowledge generated through previous research, which identified protein interactions responsible for infection of sugarbeet by BNYVV pathotype A (the predominant BNYVV pathotype in the US) in susceptible and resistant (*Rz1*) interactions, and how these interactions differ with another source of resistance (*Rz2*). Ultimately, this may lead to methods to prolong the longevity of *Rz* resistance sources by understanding the fundamental mechanisms that cause resistance to break down.

YANASE, YUJI. Mitsui Chemicals Agro, Inc., Shiodome City Center 1-5-2, Higashi-Shinbashi, Minato-ku, Tokyo, 105-7117, Japan. **Development of a novel fungicide penthiopyrad**

Penthiopyrad,(RS)-N-[2-(1,3-dimethylbutyl)thiophen-3-yl]-1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide is a novel fungicide that belongs to SDHI fungicides. It has been well known that carboxamide type fungicides such as carboxin have an activity against rust and Rhizoctonia diseases but penthiopyrad shows a remarkable activity against not only these diseases but also grey mold, powdery mildew and apple scab. Here, we describe chemical and biological properties and recent development status of penthiopyrad.

The first generation compound, carboxin, was developed over 40 years ago and has been used as an important seed treatment fungicide. Mepronil and flutolanil are used to control some diseases caused by Basidiomycetes and *Rhizoctonia solani*. Then thifluzamide were developed in late nineties, and their activities became higher but anti-fungal spectrum was not broadened.

On the other hand, some possibility was shown that anti-fungal spectrum was broadened a long time ago, for example, some oxathiin compounds showed activity against *Alternaria solani*, *Botrytis* sp. as well as Basidiomycetes. BC-723, a kind of benzamide derivatives, discovered by Mitsubishi Chemical Corporation, has an activity against *Botrytis cinerea*. We had paid attention to the fact that *N*-phenyl benzamide compounds had a weak and broad-spectrum activity against pathogenic fungi. After long research, we found that a novel carboxamide derivative with two heteroaromatic rings and had a high fungicidal activity. Branched alkyl substitution on the heteroaromatic ring on the amino part of the carboxamide played an important role to expand its anti-fungal spectrum. After intensive research, we finally discovered penthiopyrad having a pyrazole unit and a thiophen ring.

Although carboxamide family is one of the oldest groups of fungicides, the discovery of penthiopyrad has opened a new avenue for further research and development of novel fungicides.

Section D
Chemistry & Instrumentation
Oral Presentations

None Submitted

Section D
Chemistry & Instrumentation
Poster Presentations

None Submitted

Section F
Factory Operations
Oral Presentations

CARLSON, JEFFREY L., Southern Minnesota Beet Sugar Cooperative, PO Box 500, 83550 County Road 21, Renville, MN 56284. **Technical and economic considerations of sugar losses from long-term sugarbeet storage.**

Stored beets are materially different that fresh ones. In storage the beets lose sugar through respiration, degradation (internal metabolic processes) and deterioration (attack by microbes). They also experience physical changes including dehydration, freezing and thawing. This paper looks at how these changes affect the extractable sugar and factory operations. It also discusses how these changes should be taken into account when analyzing the risk/reward for different operational and capital improvement strategies.

CARLSON, JEFFREY L., and RON D. KAWLEWSKI*. Southern Minnesota Beet Sugar Cooperative, PO Box 500, 83550 County Road 21, Renville, MN 56284. **Effect of washhouse makeup and blowdown flow on sugar losses for non-frozen and frozen sugarbeets.**

It has long been known that frozen sugarbeets experience much higher washhouse sugar loss than non-frozen beets. This paper uses data gathered during the 2010-11 and 2011-12 campaigns at Southern Minnesota Beet Sugar Cooperative to develop a relationship between the amount of water added to the sugar lost. Microbial activity in the wash water converts a portion of the sucrose to other organic compounds. A relationship between the Chemical Oxygen Demand (COD) and sucrose in the juice used to determine the actual sucrose loss. Changes the water addition and subsequent blow-down had no

measureable effect on sugar losses when slicing non-frozen beets. However, when washing frozen sugar beets an incremental increase of one gallon per minute increased the sugar loss by about 800 pounds per day. The importance of this finding and implications for reducing sugar loss are discussed.

CARLSON, JEFFREY L., Southern Minnesota Beet Sugar Cooperative, PO Box 500, 83550 County Road 21, Renville, MN 56284. **Benefits of maintaining high pH in wash water with calcium hydroxide.**

Southern Minnesota Beet Sugar Cooperative (SMBSC) has a 1.65 million gallon beet washing loop that includes two rotary washers; rock, sand beet chip separation; and beet chip recovery; noncontact heat exchangers; and a 1.5 million gallon settling clarifier. For both operational and environmental reasons, the coop is maintaining as high of a recirculation rate and as low of a blow down rate as possible. It has been found that maintaining the pH above 10.5 using slaked lime has several advantages for this system. The high pH controls corrosion and microbial growth, which maintains a high sugar concentration and minimizes organic acid production. This allows the factory to maintain the high pH with 5-to-8 tons of lime per day. With the wash water purity reaching as high as 85 and the infection controlled, problems from carryover of wash water to the process are minimized. In addition, the mud solids settle well when the pH and calcium concentration are kept high.

CARLSON, JEFFREY L., BLAKE R. KLINGER*, JAMES SCHUELLER, and RON D. KAWLEWSKI. Southern Minnesota Beet Sugar Cooperative, PO Box 500, 83550 County Road 21, Renville, MN 56284. **Sugar-end management implications for the method chosen to measure dry substance.**

The dissolved solids or its inverse, moisture is an important parameter for evaluating sugar-end operations. The dissolved solids of sugar-end streams can be determined using refractive index (RDS); oven dry, dry substance (DS); near infrared (NIR); and Karl Fischer titration (KF). The accuracy and precision from each method is dependent on a variety of factors including the exact composition of the sample, sample collection and handling and the skill of the analyst. This study looked at the differences at RDS, DS and KF dry substance determinations and how they can affect purity, non-sugar-to-water ratios, crystallization calculations and steam economy calculations.

CASE, STAN* and CHRISTOPHER D. RHOTEN. The Amalgamated Sugar Company LLC, 50 South 500 West, Paul, Idaho 83347. **Energy reduction at the MC factory of the Amalgamated Sugar Company, LLC.**

With the ever increasing cost of energy and tightening environmental permit restrictions, the Amalgamated Sugar Company (TASCO) has recently emphasized energy reduction and optimization with regard to capital improvements. In basic form, energy reduction does nothing more than reduce the over-all annual energy cost for operation. In the case of TASCO, however, energy improvements have done little to reduce the final year-end energy cost. The realized benefits, with regards to the Mini-Cassia (MC) facility, have included the ability to maximize total annual beets sliced at increased slice rate while also maximizing sugar production rate without a corresponding increase in total energy consumption. More importantly, the energy reduction improvements have provided substantially improved operating flexibility allowing the MC factory to maintain an optimal energy balance through highly variable environmental conditions while maintaining a nearly steady-state rate of throughput.

GEYER, IRMA[1]* and HANS J. SCHMIDT[2]. [1]BMA AG, Am Alten Bahnhof 5, 38122 Braunschweig, Germany and [2]BMA America Inc., 3127 Wild Meadow Ln, Aurora, IL 60504. **New approaches in batch centrifugal design and its operational benefits.**

Batch centrifugals rank among the key equipment in the sugar production process It is quite rightly expected that they should meet the highest requirements regarding process optimization and productivity even under heavy workloads. When selecting a new centrifugal, the following criteria are important for the decision making process: (a) optimum sugar quality depending on the individual requirements, (b) maximum yield, (c) high throughput together with the lowest possible power consumption, (d) minimized use of washwater, (e) simplicity of operation, (f) low maintenance (g) long service life of the equipment. For the development of a centrifugal it is thus equally important to combine these aspects in an optimal way and to ensure a safe and stable process.

To meet the ever increasing customer requirements and to further optimize an already highly sophisticated product, new design-engineering approaches are needed. As a worldwide leading manufacturer of centrifugals, BMA has accepted this challenge and developed a new standard-setting batch type centrifugal.

As an outstanding feature, the new and innovative basket design allows a significantly longer service life of the basket. In addition, the basket allows higher throughputs based on its volume and contributes to the smoother operation of the centrifugal. This in turn makes the process safer, even when difficult massecuites are being processed.

With the innovative monaxial discharger, BMA reduces the discharging time by up to 20%.

A significant amount of a centrifugal's life cycle costs are attributable to the regularly required maintenance. During the development of the new centrifugal BMA paid a lot of it's attention to the simplification of the mechanical system by reducing the number of components. This has helped to minimize not only the amount of maintenance and consequently the associated costs and downtimes, but also the risk of machine failure.

A new failsafe control system and redundant, certified sensors and analyzing units provide an increased operational reliability. The controlled and monitored breaking ramp leads to higher safety for operators and the machine itself.

This presentation highlights the most important innovations of the batch centrifugal and its operational benefits based on experiences with the first installations.

GRECH, JASON M. [1]* and CARL SCHOENFELDER[2]. [1]BetaTec Hop Products, Stanford Park, Stanford Bridge, Worcestershire, England and [2]Hydrite Chemical Co. 300 N. Patrick Blvd. Brookfield, Wisconsin 53045. **Infection control using natural hop beta acids, a focus on thick juice storage.**

Bacterial infection during the production of sugar is a significant issue. Bacteria consume sugar leading to loss of yield and quality. Hop Beta Acids have been used for over 15 years as an antibacterial agent controlling infections in all diffuser types. In recent years interest has turned to the stabilisation of thick juice. Producers are storing juice for longer periods especially if used as a feed stock in ethanol production as is the case in Europe. Several pilot studies have been carried out to look at the possibility of using Hop Beta Acids as a preserving agent in thick juice. This paper will summarise the literature to date and discuss the practical problems faced in applying the product. The application is in its infancy but some pioneers have put the pilot results to full scale application to good effect, experiencing improved stability, maintenance of high pH, low invert sugar and low bacterial counts. There has also been no problem in further processing the juice through the crystallisation process.

HATCH, ROBERT O.[1]* and JAY S. CREIGLOW[2] and DAVID R. SMITH[2]. [1]Organic Defoamer Group, P.O. Box 4883, Jackson, WY 83001 and [2]Spreckels Sugar, 395 W. Keystone, Brawley, CA 92227. ***Propylene Glycolate*** **used as a top coat seal to protect thick juice from degradation in ellipsoidal storage tanks.**

From a "tail gate session", to a literature review, to a modification from the literature review, *propylene glycolate* was evaluated at

Spreckels Sugar, Brawley California. The paper will: Review the Literature search; Laboratory evaluation of potential caustic top coat seals; Chemistry of *propylene glycolate*; The plant application of *propylene glycolate*; Chemistry and Quality of the thick juice stored; Results as compared to past treatments experienced at the Brawley plant; Costs; and Results with Conclusions.

KNIEPER, LOUIS H.[1]*, GLENN AUGUSTINE[1] and KEITH PILGRIM[2]. [1]Southern Minnesota Beet Sugar Cooperative, P. O. Box 50, Renville, MN 56284-0500 and [2]Barr Engineering Company, Inc., 4700 West 77th Street, Suite 200, Minneapolis, MN 55435. **Evaluating and applying whole effluent toxicity (WET) testing and TIE/TRE protocols to improve wastewater treatment performance and permit compliance.**

NPDES discharge permit requires passing the Whole Effluent Toxicity acute test at 100% concentration of treated effluent using fathead minnows (*Pimephales promelas*), *Daphnia magna* and *Ceriodaphnia dubia*. Success was inconsistent with a 50% pass rate causing costly response activities and regulatory displeasure. SMBSC voluntarily entered a Toxicity Identification Evaluation (TIE) protocol which confirmed toxicity and general causes but did not identify a toxicant. Test methods had to be developed to quantitatively determine the presence of suspected toxicants. Only *Ceriodaphnia dubia* exhibited a consistent toxic response to the treated effluent. The Toxicity Reduction Evaluation (TRE) protocol immediately followed and spanned 3 years. Different data evaluation methods were employed to tease some understanding from the testing results. Treatment chemicals such as anti-foam oils and alum were found to increase toxicity and their use ceased or replacement products were employed. Testing procedures increased toxicity and modifications including CO2 head space were used. Exiting the TIE/TRE protocol presented a challenge due to lack of defined completion and was accomplished with 89% passing tests. SMBSC was able to establish a monitoring protocol and prediction model for the complex toxicity associated with the treated effluent discharge. Total Dissolved Solids, Potassium, Ammonia and Carbonate solubility are the synergistic causes of toxicity.

KOCHERGIN,VADIM[1]* and FRANK VAN NOORD[2]. [1]Audubon Sugar Institute, 3485 Higway 75, St.Gabriel, LA, USA and [2]Suiker Unie, Postbus 1004750 AC Oud Gastel, Noordzeedijk 1134671 TL Dinteloord, Netherlands. **Crystallization of thick juice and of raw cane sugar blends.**

Co-processing of cane raw sugar in the beet sugar factories has been practiced with various levels of success in several locations worldwide. It typically results in lower sugar quality. It had been

proven that relatively small (10-15 %) ratios of VHP (very high pol) sugar can be co-processed with thick juice with good results using existing infrastructure of a beet sugar factory. However, proper integration and optimization of raw sugar processing into beet sugar production requires additional knowledge of color transfer and quality of sugar that could be obtained by crystallization of blended raw cane sugar and beet syrup mixtures. Various blends of raw sugar, beet thick juice and partially purified refinery syrups have been boiled at controlled conditions at the Audubon Sugar Institute. Several seeding procedures and supersaturation control formulae were evaluated. Affinated and non-affinated samples of raw sugar were analyzed using standard ICUMSA procedures. Crystal size distribution during boiling was monitored by laser diffraction crystal size analyzer. Significant differences were observed during pan boiling at higher concentrations of cane syrup in the blend, where it was more difficult to achieve the required crystal size. Different supersaturation levels may be required to successfully boil sugar of the desired size. In general, higher color transfer is expected for larger proportions of cane sugar in the blends.

RHOTEN, CHRISTOPHER D.. The Amalgamated Sugar Company, LLC, 50 South 500 West, Paul, Idaho 83347. **An innovative approach to self-optimizing batch vacuum pan control.**

Various approaches to vacuum pan control have been utilized in the sugar industry for many years with varying degrees of success and ability to produce a consistent massecuite quality. The development of improved and more reliable devices for the measurement of mother syrup ds concentration (refractometric measurement) and overall massecuite ds concentration (microwave density measurement) during the sugar boiling process have enabled a more or less complete control of the boiling process to manage both syrup concentration (supersaturation) and crystal content (massecuite concentration relative to syrup concentration) during the boiling cycle. This paper discusses the theory, development and application of refractometric and microwave measurement for the automatic and self-optimizing computerized control of the batch crystallization process developed and installed at the Mini-Cassia Factory of the Amalgamated Sugar Company, LLC. Operator interaction and selection of various input set points allow adjustment for pan seeding optimization and final grain size while the control system offers feed-back for seeding set point adjustment relative to standard liquor purity (sucrose solubility) and processing conditions to maintain consistent massecuite quality and uniform crystal size distribution. Multiple operating modes allow for continued pan operation in the event of necessary refractometer or microwave measurement maintenance and calibration.

ROGERS, GALAN M.* and TOM DOLECHECK. The Amalgamated Sugar Company, P.O. Box 700, Paul, Idaho 83347. **Lime kiln influence on factory operations.**

The Mini-Cassia Factory has installed a new Eberhardt mixed feed (coke fired) kiln during the 2012-2013 campaign. It replaced two kilns, one a mixed feed kiln using anthracite coal and one using natural gas. Both of these kilns together would only support 1/2 of the factory slice and the other half of factory slice was supported by buying pebble lime and liquid CO_2. The new kiln was operated upon the premise that the amount of CO_2 needed for the carbonation station would be supplied by the kiln with the remainder of the needed lime supplied by purchasing pebble lime. Several unexpected operational conditions were observed under these conditions that have improved the factory operations. First, the carbonation tank agitation was much less violent and the quality of the first and second carbonation juices are excellent. Second, the amount of raw materials needed from the new kiln and purchased pebble lime is less than the amount used in preceding years. This has resulted in savings in raw materials and a much smoother factory operation through the purification process. The operation of the kiln is much simpler and safer than the previous combination of kilns and pebble lime.

There is however a down side to the new kiln and that is the amount of raw material that is being discarded due to the prescreening operation. The new kiln needs larger sized rock than the previous kilns and results in the removal of fines and small rock to recover the large fraction of the rock supplied to the kiln. Work with the quarry is under way to reduce the amount of fines shipped to the factory to reduce the amount of fines that have to be handled or discarded.

SCHOENFELDER, CARL[1]* and LARRY LEBEAU[2]. [1]Hydrite Chemical Co., 300 N. Patrick Blvd., Brookfield, WI 53045 and [2]American Water Solutions, 256 E. 700 South, Salt Lake City, UT 84012. **Applications of chemical addition monitoring and flow control in sugar refining.**

Accurately measuring chemical additions to process streams in a sugar refinery has an impact to process performance, chemical cost control, and regulatory compliance. Until recently, conventional methods were typically limited to spot checks with calibration cylinders or other means of draw down measurement. Recently developed thermister technology has continued to mature and is now a reliable and cost effective alternative to historical standards, which provides far greater accuracy and capability for data management. Automated chemical monitoring systems are currently implemented at three major beet sugar refiners. This technology allows real time monitoring of process defoamer, or other process chemical addition,

which provides the operator immediate information to optimize chemical usage. Data collected is exported to alarms, trended, or integrated to multiple output signals. Further development of this technology has included an in-plant pilot system with sensors measuring entrained air, from which data is then processed though a PLC, and converted to an output signal that controls chemical addition. This paper will document the system(s) capability to date and describe the effectiveness of practical applications that are currently in place, as well as forward opportunities and developments with the technology, as it relates to cost management and regulatory compliance the sugar industry.

STAUFER, SIMON M., Swiss Combi, Taubenlochweg 1, CH-8803 Dintikon, Switzerland. **Revival of the low temperature belt drier for sugar beet pulp.**

Sugar beet pulp drying is energy intensive and produces emission nuisance in beet sugar factories with direct fired rotary drum driers. Most of these driers are in operation since several decades without major improvements. Low temperature belt driers (LTD) are in operation for almost 30 years in the sugar industry, for example at the Südzucker plant in Offstein, Germany. A 600m^2 LTD with a water evaporation of 30t/h pre-dries the beet pulp with waste heat from the sugar plant. Since its start-up it has saved more than a Terawatthour of fuel. For some reasons this technology has been forgotten for a long time. Now, 30 years later, the low temperature drying technology has got its revival and 3 LTD plants have been installed. Since the campaign 2012/13 a LTD with 580m^2 pre-dries the sugar beet pulp at the Südzucker plant in Plattling, Germany, with a capacity of 30t/h water evaporation, utilizing waste heat from the sugar factory. Besides the natural gas savings it allows to run the rotary drum driers with a lower drum inlet temperature which reduces significantly the emissions. At Agrana's beet sugar plants in Tulln and Leopoldsdorf, both Austria, LTDs with 870m^2 and 45t/h water evaporation pre-dry the beet pulp, utilizing also waste heat from the sugar plant, additionally flue gas from the boiler and heat recovered from the drum driers. Condensing the drum drier exhaust gases allows to heat a part of the LTD at a temperature equal to the wet bulb temperature of the drum drier exhaust gas. As a side effect it is scrubbed in the condenser, which reduces the dust load significantly and condenses some of the VOC and odor emissions. With the LTDs the two Agrana plants achieve natural gas savings of 60% for the pulp drying.

SULLIVAN, SHAWN* and ROBERT M. ZIMMERMAN. Western Sugar Cooperative, 1221 Eighth Ave, Greeley, CO 80631. **Sugar beet flume solids separation and mud pressing.**

Waste water regulations require minimizing impacts to surface and ground water including flume mud pond systems. Western Sugar Cooperative's Fort Morgan factory installed screening systems to remove sugar beet particles from flume water and provide marketable feed product. This also removes organic material in system reducing potential impacts to mud ponds and groundwater. Two twin wire (nylon belts) mud presses were also installed to remove topsoil from flume system. These belt type presses were based on pulp and paper mill type press systems. The overall system included automatic polymer batching, individual spray wash systems for each wire or belt, and solids handling to stage the recovered topsoil. The initial startup phase has indicated good moisture reduction (about 50% solids) along with reasonable performance with the highly variable incoming solids type. Future systems will likely be required to address topsoil generation and recycling as compost or soil amendment.

SULLIVAN, SHAWN and ROBERT M. ZIMMERMAN*. Western Sugar Cooperative, 1221 Eighth Ave, Greeley, CO 80631. **Putsch Pressure Leaf Filter Installation and Results.**

Waste water regulations require minimizing impacts to surface and ground water including lime pond systems. Western Sugar Cooperative's Fort Morgan factory installed three Putsch PKF-140 pressure leaf filters to replace the existing rotary vacuum drum filters. This change allowed the lime cake to be handled on a dry basis where the drum filters required the cake to be slurried and pumped to a pond. This was a rare environmental project that had return as the lime sewer loss was reduced from 0.15-0.20% OB to 0.03% OB. The installation design and start up issues with the project will be detailed. The first three months of operational performance will be discussed.

Section F
Factory Operations
Poster Presentations

BOUCHÉ, CATHERINE. ITECA SOCADEI Color & Vision Department, 445 Rue Denis Papin, 13592 Aix-en-Provence, France. **Crystallization control through image processing and image analysis.**

The only way to ensure good and constant sugar quality production is to follow the crystallization process directly on the production line. We believe that there are two key phases on the sugar production process that must be monitored and controlled to achieve those quality objectives: crystal growth inside the vacuum pans and color measurement after the centrifugals. The study shows how Digital Image Processing technique can be used to optimize manufacturing processes and enhance sustainable methods. Crystal growth is analysed using a digital pan microscope directly mounted behind a window on the pan. Very sharp images of the crystals (from 4 µm) moving behind the window are sent to a dedicated software. Specific algorithms are applied in real-time to every image in order to count and measure crystal sizes and shapes. Out of specification alarms are triggered and valuable statistical information is presented with the videos on the main screen (CV, AM, etc...). Color of sugar is measured using an on-line colorimeter with a camera. Images of the conveyor are processed by a dedicated software. The data is filtered and segmented to calculate the coloration values in ICUMSA or CE Units. A morphological algorithm is then applied to each pixel highlighting out-of-specification objects; the processed data can be used to avoid contamination of the dryer or the silos and provide valuable information on centrifugals operation. The system communicates with the centrifugals PLCs to adjust their washing time. This last feature is used in many plants to dramatically reduce water, steam and power consumption, while increasing productivity and avoiding customer's claims. Digital Image Processing has already contributed to a significant step forward in the understanding of crystallization process and will continue to bring more benefits to sugar industry.