Section A – Agronomy
Paper Presentations

ADJESIWOR, ALBERT T.* and ANDREW R. KNISS, Department of Plant Sciences, 1000 E. University Avenue, University of Wyoming, Laramie, WY 82071. **Effects of reflected light quality on growth and yield of *Beta vulgaris*.**

Reflected light from vegetation has a reduced red (R) to far-red (FR) ratio. Plants are able to sense changes in R:FR and use this as a cue to perceive impending competition. Responses to reduced R:FR often involve modified morphology and physiology which can affect growth and yield even in the absence of resource competition. Little is known about the effects of reflected light quality on *Beta vulgaris*. This study evaluated effects of reflected R:FR from grass (Kentucky bluegrass) on growth and yield of *Beta vulgaris*. Grass was clipped frequently to prevent shading and competition for light. Roots of grasses were isolated from *B. vulgaris* to ensure there was no competition for water or nutrients. *B. vulgaris* was harvested at 15, 32, 50, and 77 days after planting (DAP). Relative to the control (no grass), there were longer cotyledons (2.2 vs 1.5 cm), wider cotyledons (0.6 vs 0.5 cm), and wider cotyledon surface area (1.8 vs 1.0 cm^2) in the grass treatment at 15 DAP. Presence of grass beyond 15 DAP generally resulted in reduced number of leaves, leaf area, and root fresh weight in *B. vulgaris*. There were three less leaves in the grass treatment compared to the control (no grass) at final harvest (77 DAP). The grass treatment reduced leaf area and root fresh weight by 10 to 21 and 15 to 48 % respectively, when *B. vulgaris* was harvested at 32, 50, and 77 DAP. These results showed that reflected light quality can reduce growth and yield of *B. vulgaris* even in the absence of direct competition for resources.

BLOOMQUIST, MARK W. *, JODY K. STEFFEL, Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **Spring seeded cover crop at Southern Minnesota Beet Sugar Cooperative – a success story.**

The use of a spring seeded cover crop in sugar beet fields is a practice that has been increasing at Southern Minnesota Beet Sugar Cooperative for the past 15 years. The practice involves seeding oats or spring wheat on sugar beet fields and incorporating the seed just prior to planting the sugar beets. This cover crop emerges just before the beets or at the same time as the sugar beet seedlings and protects the seedlings from damage due to winds. In 2003, approximately 36% of the fields in the SMBSC growing area utilized a spring seeded cover crop. During each of the seasons from 2012-2015, between 78-82% of the SMBSC sugar beet fields utilized a spring seeded cover crop. In the early 2000's, SMBSC built a water treatment plant to treat and discharge water from the processing campaign. The use of a cover crop in sugar beets provided phosphorus credits to offset the operation of the water treatment facility. As more growers utilized the cover crop program on their operations, the SMBSC Agronomic Practice Database discovered that not only did the use of cover crops provide phosphorus credits for the operation of the water treatment plant; fields that utilized a spring seeded cover crop had higher revenue per acre. During the 2003-2015 time period, spring seeded cover crop fields had a range of $11- $62 per acre higher revenue than non-cover crop fields.

HAFEZ, SAAD L.*, University of Idaho Research and Extension, 29603 UofI Lane, Parma, ID 83660. **Sugarbeet cyst nematode management using tolerant varieties, biological seed treatments, new compounds and chemistries.**

Sugarbeet cyst nematode (*Heterodera chitwoodii)* can cause major economic and yield losses for sugarbeet growers in the Pacific Northwest, these loses are extrapolated when sugarbeet cyst nematode (SCN) populations are high. The objective of this study was to determine the efficacy of tolerant varieties, new biological seed treatments, and new compounds and chemistries alone or in different combinations on SCN in naturally infested fields in Southwest Idaho. Fields infested with SCN were selected and sampled to determine initial populations before trial initiation. After planting and applications fields were allowed to grow under

normal field conditions until harvest. Yield and sugar content data was taken to determine efficacy for each treatment. Most tolerant varieties increased overall yield with two varieties exhibiting signs of being resistant to SCN as compared to the standard commercial variety. Biological seed treatments increased both overall yield and sugar content when combined with a tolerant variety as compared to the susceptible untreated control. New compounds and chemistries also increased overall yield as compared to the untreated control. These results show promising strides in SCN management for the Pacific Northwest.

HAKK, PETER[1*], and KHAN, M.F.R[1], [1]North Dakota State University & University of Minnesota, Plant Pathology Department, Fargo. **Sugarbeet plant populations for optimum recoverable sucrose.**

For many years, growers in the North Dakota and Minnesota were advised to plant 150 plants per 100 foot of row spaced 22 inches apart. Research done at North Dakota State University and the University of Minnesota in 2003 and 2004 showed that a plant population of 175 evenly spaced plants per 100 foot of row spaced 22 inches apart at the six leaf stage was ideal for maximum recoverable sucrose per acre. This spacing was effective for both a high tonnage and a high sugar conventional sugarbeet variety. Since 2008, sugarbeet growers started planting Roundup Ready sugarbeet and currently, over 97% of the US sugarbeet acreage is using this technology. Growers will like to know if current plant population recommendations should be changed. The objective of this research was to determine the plant population of a widely grown Roundup Ready variety that will provide maximum recoverable sucrose. In 2015 and 2016, field trials were conducted at Prosper, ND. Plots comprised six 22-inch wide rows that were 25 feet long. Plots were planted at 2 5/8 inch seed spacing and then thinned at the 6- to 8-leaf stage. Plant populations after thinning were 50, 100, 150, 175, 200, 250 and 300 plants per 100 foot of row. Planting was done on April 18 in 2015 and May 2 in 2016 and harvesting was done on September 16 in 2015 and September 14 in 2016. In both years, tonnage and recoverable sucrose per acre (RSA) were significantly lower in the 50 plants per 100 ft of row compared to the higher populations. In 2015, there was no significant difference in RSA among the 100 to 300 plants per 100 ft of row populations whereas in 2016 there was no significant difference in RSA among the 150 to 300 plants per 100 ft of row populations. In both years, there were no significant differences in sucrose concentrations among any of the treatments. The data suggests that planting to achieve populations of 175 to 200 plants per 100 ft of row tend to produce optimum RSA and reduction in population to 150 plants did not adversely impact RSA.

KAHRE, SCOTT M., Castle Mountain Technology LLC, 3 Boone Rd., Garden Valley, ID 83622. **Improved sugar beet storage management via remote data collection, monitoring, and reporting of long-term ventilated storage conditions.**

Active management of temperature conditions within long-term sugar beet storage piles is of critical importance to the success of today's long processing campaigns. Many facilities now utilize forced ventilation systems with sophisticated control algorithms to maintain pile temperatures within pre-set limits. However, many beet storage locations are far from factories, and are thus unattended for most of the storage season following the end of harvest. With only periodic visits by company staff, pile temperature and ventilation equipment problems can go unnoticed for days or even weeks, leading to millions of dollars in sucrose losses. To address this problem, the Amalgamated Sugar Company LLC has installed a remote data collection and history system integrated with their company-wide dataPARC enterprise information platform. This solution collects data from the ventilated pile temperature probes, fans, and ambient sensors, and continuously transmits it via the internet to a central corporate server. This data is then made available to staff throughout the company in the form of graphical displays, trends, and reports. A web-interface has also been implemented for mobile data access. The use of these tools has greatly improved company staff's access to real-time information when making pile management decisions.

KOCH, HEINZ-JOSEF[1]* and MELANIE HAUER[1], [1]Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Goettingen, Germany. **Beet cyst nematode control by trap crop cultivation and sugar beet variety choice in Northern Germany.**

An integrated strategy is required to control the sugar beet cyst nematode *Heterodera schachtii* which causes severe yield losses in sugar beet. This study aimed at evaluating the effect of trap crop cultivation (nematode resistant mustard, crop mixture (*Trifolium alexandrinum* L., *Lupinus angustifolius* L., *Pisum sativum* L., *Phacelia tanacetifolia* Benth., *Guizotia abyssinica* (L.F.) Cass., *Avena strigosa* Schreb., *Vicia sativa* L.), straw mulch as control), and sugar beet variety (susceptible, tolerant or resistant to *H. schachtii*) on population dynamics of *H. schachtii* and sugar yield. Field experiments were conducted in twelve environments (site x year) located in Northern Germany in 2012–2013, 2013–2014 and 2014–2015.

An insufficient trap crop dry matter yield (1.1–2.5 t ha^{-1}) mostly led to nonsignificant trap crop effects on the nematode population whereas in one environment a high dry matter yield of mustard (3.3 t ha-1) resulted in a nematode reduction of 40%. However, there were no significant differences to the straw mulch control. In contrast, population dynamics of *H. schachtii* were strongly influenced by the sugar beet variety and the initial nematode population (PiSB). The highest reduction of 70% was achieved when a resistant sugar beet variety was grown, while the tolerant and susceptible varieties increased the nematode population in most environments. There was evidence that the sugar beet harvest date can highly influence population dynamics of *H. schachtii*. Sugar yield was influenced by variety and PiSB, but not by trap crop cultivation. Sugar yield decreased with increasing PiSB for all varieties. The resistant and tolerant varieties did not differ in sugar yield and response to *H. schachtii*, while the susceptible showed the steepest decline in sugar yield with increasing PiSB. The cultivation of the resistant sugar beet variety can be clearly suggested with respect to sugar yield and nematode control.

KOCH, HEINZ-JOSEF[1]* and DANIEL LAUFER[1], [1]Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Goettingen, Germany. **Constraints for sugar beet growth in autumn strip tillage on Central European loess soil.**

On silt loam sites in Central Europe, autumn strip tillage (ST) might offer an option to produce high sugar beet yields at lower costs and improved erosion control compared to full-width tillage practices. Three field trials were conducted in 2013/14 and 2014/15 at Goettingen, Lower Saxony, Germany, to investigate the effect of three tillage systems (intensive tillage (IT), reduced tillage (RT), ST) and two fertilizer nitrogen levels (no fertilizer nitrogen (N0), fertilizer nitrogen required for optimum yield (Nopt)) on sugar beet growth.

Compared to IT and RT, field emergence period under ST was prolonged by 5-7 days, which was presumably caused by a coarse and uneven seedbed. In the early growth stage, chlorophyll present in the leaves (SPAD value) was higher for IT and RT compared to ST, indicating a lower nitrogen supply for ST, especially under N0. This was supported by a slightly higher nitrogen concentration in the plant dry matter and a higher soil mineral nitrogen content in spring under IT and RT compared to ST. Leaf area index of sugar beet was almost equal between IT and RT, while values for ST tended to be lower. As a result, plant dry matter yield and white sugar yield were approximately 7% higher for IT and RT compared to ST.

Penetration resistance and root length density in the top soil revealed no relation to yield. It was concluded that both, the prolonged field emergence period and the lower nitrogen supply under ST possibly impaired a rapid development of an adequate leaf canopy that facilitates efficient light interception and a high yield.

LAMB, JOHN A.[1]*, JAMES RADERMACHER[2], MARK W. BREDEHOEFT[3], MARK W. BLOOMQUIST[2], CHRIS DUNSMORE[2], and NICOLE VANOS[2]. [1]Dept. of Soil, Water, and Climate, Univ. of Minnesota, St. Paul, MN 55108, [2]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284, and [3]Monsanto, 517 Monongalia Avenue, Willmar MN 56201. **Nitrogen Management Strategies for Field Corn Before Sugar Beet**.

Nitrogen management for quality sugar beet production has been a focus of sugar beet nutrient management research. A key factor in being able to manage N for sugar beet production is to have as small amount of residual soil nitrate-N before planting sugar beet as possible. Close to 70 % of the sugar beet grown in the Southern Minnesota Beet Sugar Cooperative is preceded by corn. Corn needs proper N application to optimize grain yield and is not hurt by over application. The removal of the corn stalks for bedding or biofuel could affect the soil mineralization processes of nitrogen. This study was designed to investigate the effect on sugar beet production of N rate and N source used for a previous corn crop, and also the effect of corn residue removal. The N rate ranged from University based guideline of 120 lb N/A to 300 lb N/A. The N sources for the corn crop, were urea or a ¾ urea and ¼ ESN mix. The urea/ESN mix has been suggested for corn production as a slower release N product that would increase the efficiency of N fertilizer use by the corn plant. In general the following was learned from this study: 1. Additional N applied to corn had no negative effect on corn grain yield. 2. In this study and several other studies conducted in Minnesota, the use of ESN with urea did not consistently increase corn grain yields. 3. At most of the sites, the over application of N to corn will result in increased residual soil nitrate-N to a 4 ft depth. 4. Sugar beet production after corn can be affected by extreme application rates of N. 5. The use of slow release products in the previous production year will not consistently affect the root yield, extractable sucrose per ton, or extractable sucrose per acre. 6. The removal of corn crop residue one time, does not consistently affect sugar beet production in the proceding year.

LAMB, JOHN A.[1]*, ISRAEL SANTIAGO[2], and MARK W. BLOOMQUIST[3]. [1]Dept. of Soil, Water, and Climate, Univ. of Minnesota, St. Paul, MN 55108, [2]Spreckels Sugar Company, Box 581, 396 West Keystone Rd. Brawley, CA 992227. and [3]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. MN 56201. **Nitrogen and Potassium Effects on Sugar Beet Quality in the Imperial Valley**.

Growers in the Imperial Valley have been concerned about optimum nutrition of the sugar beet plant. Potassium is one of the more important nutrients for sugar beet growth. Potassium is needed for root growth, but can be an impurity in the extraction of sucrose at the refinery. The objective of this study is to determine the effect of nitrogen and potassium applications on sugar beet root yield and quality. An experiment was established at two locations in the fall of 2013 and the fall of 2014, and at one site in the fall of 2015 in the Imperial Valley of California. The experiment included the factorial combination of four nitrogen application rates: 0, 45, 90, and 135 lb N/A in the 2013-14 production year; 0, 50, 100, and 150 lb N/A in the 2014-15 production year; and 0, 40, 80, and 120 lb N/A in the 2015-2016 production year and six potassium rates (0, 30, 60, 90, 300, and 500 lb K_2O/A) in all production years. The two highest potassium rates are extreme to assess the effect of potassium on the root quality, percent sucrose and beet purity. The study had five replications at each location. The potassium was broadcast applied as potassium sulfate (0-0-50) preplant while the nitrogen was injected urea ammonium nitrate solution (UAN, 32-0-0) at layby. Roots were harvested during late June or early July. The following are conclusions from this study: 1. There is little interaction between N and K for the parameters measured and 2. The use of substantial amounts of K did not reduce sugar beet quality at the sites in this study.

LAWRENCE, NEVIN C. [1]*, DAVE REICHART[2], ROBERT M. HARVESON[2], and JEFFREY D. BRADSHAW[2]. [1]Panhandle Research and Extension Center, University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361, and [2]Western Sugar Cooperative, 2100 East Overland Scottsbluff, NE 69361 **To replant or not: establishing lower end sugarbeet population threshold.**

Replanting of sugarbeet due to early season frost or wind damage is a common practice in the western Great Plains and Intermountain West. Replanting delays the crop several weeks and may results in reduced sugar and root yield. To provide a better threshold for how much stand loss is needed to justify replanting sugarbeet, a series of studies were conducted to compare sugarbeet root and sucrose yield between a normal planting date and a delayed planting date. Studies were established in Scottsbluff, NE in 2014, 2015, and 2016

under both furrow and sprinkler irrigation, using 22 inch and 30 inch row spacing. The two most common sugarbeet varieties for the region were planted near 1 May at populations of 12, 18, 24, 30, 36, 42, and 50,000 plants acre^{-1}, and compared to a replant treatment of 36,000 plants acre^{-1} planted near 1 June. Replanted sugarbeets did not yield better than sugarbeets planted near 1 May regardless of planting population, variety, irrigation system, or row spacing. Regression analysis was used to project a replanting threshold, however the threshold varies by year, irrigation system, and row spacing. Depending on conditions a population of 5,000 to 15,000 plants acre^{-1} may warrant replanting. Results suggest sugarbeet populations as low as 15,000 plants acre^{-1} should not be replanted.

LIBSACK, STEVE A. *, FRANK J. TURANO, KATHLEEN A. TURANO, Plant Sensory Systems, LLC, 1450 South Rolling Road, Baltimore, MD 21227. **Foliage application of natural plant compound on sugar crops increases sugar yield.**

A challenge facing the sugar industry is the need to increase sugar yield in early harvested sugar crops. Plant Sensory Systems (PSS) has identified a naturally occurring plant compound for use as a foliage application on sugar crops that significantly increases sugar yield. The compound, which has FDA Generally Regarded as Safe (GRAS) status, has been tested with multiple sugarbeet genetics, environmental conditions, and timings of application. PSS' proprietary formulation has been tested in controlled greenhouse conditions in Beltsville, Maryland, coded trials on Eastern Shore, Maryland, and multiple commercial fields in Nebraska. The PSS' formulation was applied to sugarbeet as a foliar treatment at either two or three weeks prior to harvest. Samples of the treated and untreated beets were harvested, sugar content was analyzed, and root yield was determined. For sugarbeet treated with the formulation, overall average sugar yield was 7% higher compared with the untreated matched controls. In early harvest or less mature beets, the increase in sugar yield was the result of higher sugar content. In more mature beets the increase in sugar yield was impacted by both root yield and increased sugar content.

PETERS, THOMAS J.* and ANDREW B. LUECK. North Dakota State University and the University of Minnesota, NDSU, Dept 7670, PO Box 6050, Fargo, ND 58108-6050. **Mixtures of effective herbicides for control of broadleaf weeds in sugarbeet.**

Survey of sugarbeet growers in Minnesota and North Dakota indicated a significant percentage still use multiple applications of a single herbicide, glyphosate, for weed control in sugarbeet. This statistic is especially great in the northern region of the Red River Valley or acres where glyphosate-tolerant weeds are not as common. There is agreement among weed scientists that a weed control program should contain multiple herbicide groups (sites of action), effective against target weed. That is, a) herbicide labeled for control of target weed and 2) target weed is sensitive to the herbicide group. Experiments were conducted in 2014, 2015 and 2016 to investigate a systems approach for management of common ragweed, kochia, lambsquarters, redroot pigweed, and waterhemp in sugarbeet. Weeds were indigenous to grower/cooperator field and often demonstrated a low level resistance to glyphosate. Weed control from glyphosate applied twice at 0.98 lb ai/A was compared to a systems approach including soil-applied followed by postemergence herbicide(s) or mixtures of postemergence herbicides. Data were a visual assessment of control 14 and 30 days after treatment with an expectation of a minimum 90% control. Control also meant at least two effective SOA against target weed. Results indicate there was one herbicide group depending on weed species but there seldom were two herbicide groups that meet said criteria. The implication on the weeds management in sugarbeet is significant and requires action. At the commodity level, more emphasis must be placed on registering new herbicide groups and proactively re-registering older sugarbeet herbicides that require additional environmental and human health assessment data. At the field level, weeds management in crops planted in sequence with sugarbeet must be carefully planned to create appropriate herbicide diversity. The strategy will also require renewed emphasis on mechanical and cultural approaches to weeds management.

POINDEXTER, STEVEN S.*, THOMAS J. WENZEL, Michigan State University Extension, One Tuscola Street, Suite #100A, Saginaw, MI 48607. **Field evaluations of Clariva™pn seed treatment on beet yield and sugarbeet cyst nematode.**

Research was conducted in 2014, 2015 and 2016 to evaluate the effect of Clariva™pn seed treatment on beet yield and sugarbeet cyst nematode (SBCN) population. Six replicated strip trials were conducted in commercial sugarbeet fields that are known to have SBCN. A commercial nematode tolerant and susceptible variety treated with and without Clariva seed treatment were used at each location. Nematode samples were taken in late summer between sugarbeet plants in two fifty foot rows per replication. All seed treatments were commercially applied.

Visual observations in all three trial years did not show any difference in growth, coloration or wilting when comparing Clariva treated treatments to the untreated check of the same variety. Nematode susceptible varieties showed more wilt during hot periods as compared to tolerant varieties. Yield and quality results in four trials with significant nematodes conducted in 2014/15 did not show any significant difference (LSD 5%) when comparing treated versus untreated of the same variety. Yields for the nematode susceptible variety with Clariva averaged 34.4 tons/acre compared to the susceptible check at 34.7 tons/acre. The average of the nematode tolerant varieties with Clariva yielded 36.3 tons/acre compared to the tolerant check of 35.6 tons/acre. Clariva treated seed with any variety did not significantly reduce nematode populations compared to check. Research data from two trials conducted in 2016 is pending.

PRATT, DAVID V.*, MICHAEL D. WEISS, JON B. ALEXANDER. Michigan Sugar Company 122 Uptown Dr. Suite 300, Bay City, Mi 48708. **How crop records can provide valuable information for developing a successful cercospora leaf spot management program.**

Managing cercospora leaf spot appears to be a moving target from year to year. What worked last year or even in specific fields may not be effective in another year. Crop records can be a very effective tool to evaluate which management programs were either effective or ineffective for leaf spot management. The Michigan Sugar crop record program allows us to sort out inputs and production practices so we can evaluate the many variables involved in developing an effective leaf spot management program. Growers fields were rated by agronomist and agriculturalist using a scale of 1-9 for leaf spot severity into the on line record keeping system. We were then able to sort records by the leaf spot rating and look at many of the different variables that can affect a leaf spot management program. This method allowed us to identify some key inputs and or methods that were either effective or ineffective for leaf spot management. This information will be very valuable as we adjusted leaf spot management recommendations for 2017.

TARKALSON, DAVID D. [1]*, Bradley A. King[1], and Dave L. Bjorneberg[1]. [1]USDA-ARS Northwest Soils and Irrigation Research Laboratory, Kimberly, ID. **Effects of Deficit irrigation on Sugar Beet Production in the Northwest U.S.**

Increased water demands and drought have resulted in a need to determine the impact of tillage and deficit water management practices in irrigated sugarbeet production. Two studies were conducted to assess these factors at the USDA-Agricultural Research Service, Northwest Irrigation and Soils Research Laboratory in Kimberly, ID on a Portneuf silt loam soil. Study 1 was conducted in 2012, 2013, and 2015. Treatments consisted of two tillage treatments (strip tillage [ST] and conventional tillage [CT]) and four water input treatments (approximately 100%, 75%, 50% and 25% of model estimated crop ET [ETd]). Estimated recoverable sucrose (ERS) yield, root yield, and sucrose and brei nitrate concentrations were statistically the same for ST and CT across all water input levels. However, there was a significant tillage by water interaction for root yield in 2012. The significant interaction was a result of ST at the W3 (≈57% ETd) water input level

having a higher root yield (72 Mg ha^{-1}) compared to the CT treatment (63 Mg ha^{-1}). Water input had significant effects on ERS and root yields. In general, as water input increased, yields increased. Estimated recoverable sucrose and root yields in 2012, 2013, and 2015 were maximized at the ETd rates of 75%, 97% and 58%, respectively. Data from this study supports the use of ST in sugarbeet production. This support is based on equal yield potential as compared to CT, tillage cost savings compared to CT, and agronomic and environmental benefits associated with increased soil surface residue. Study 2 was conducted in 2011, 2012, and 2016. The treatments consisted of end of season cumulative estimated crop evapotraspiration (ET_c) rates combined with irrigation application timing. Treatments were: (1) 100% even - 100% ET_c evenly throughout the growing season; (2) 60% even - 60% ET_c evenly throughout the growing season; (3) 60% early - 100% ET_c from emergence to end of June, 55% ET_c from end of June to harvest; (4) 60% late - rain-fed from emergence to end of July, 100% ET_c from end of July to harvest; (5) 35% even - 35% ET_c evenly throughout the growing season; (6) 35% early - 100% ET_c from emergence to end of June, 25% ET_c end of June to harvest; and (7) 35% Late - rain-fed from emergence to mid August, 100% ET_c from mid August to harvest, and (8) rain-fed - no post emergence irrigation. All ET_c percentages were based on crop needs without water stress. Results showed that under deficit irrigation, higher yields were obtained when water was applied evenly throughout the season (even treatments) or 100% of ET_c was applied early with deficit irrigation later in the season (early treatments). Sugarbeet with severe water stress early in the season (rain-fed) followed by 100% ET_c later (late treatments) had lower yield.

TARKALSON, DAVID D. [1]* and DAVE L. BJORNEBERG[1]. [1]USDA-ARS Northwest Soils and Irrigation Research Laboratory, Kimberly, ID. **Effect of past manure and fertilizer history on sugar beet production**

Manure applications can have both positive and negative effects on crop production and the environment. The effects of past manure applications on sugarbeet production needs to be assessed in the Magic Valley area in southern Idaho where large manure resources are produced and land applied. A study was conducted by USDA-ARS scientists in Kimberly, Idaho in 2014 and 2016 to assess the effects of manure application history and N rates on sugarbeet production. From 2004 to 2009, manure was applied to large field plots either every year (M1), every two years (M2), or no manure (M0). The M0 plots only received commercial fertilizer based on soil tests and published recommendations. Each manure treatment was replicated three times in a randomized block design. The M1 and M2 treatments received 471 Mg/ha and 269 Mg/ha, respectively. From 2010 to 2013 entire study area received the same rate of commercial fertilizer based on soil samples and recommendations from the M0 plots. In 2014 and 2016 commercial fertilizer N rate treatments were superimposed on top of the past manure treatments. In 2014 and 2016, N rates were: 0, 34, 63, 86, 112, 158, 202, and 227 kg N/ha. The study was arraigned in a randomized block split-plot design with manure history as the main plot and N rate as the subplot. During both years of the study, N rate did not affect sugarbeet yields, but plots receiving past manure applications had higher sugarbeet root yields compared to plots receiving no manure (commercial fertilizer only). Averaged across all N rates, root yields from both manured treatments were 12% and 36% greater than the non-manured treatment in 2014 and 2016, respectively. The greater root yield difference in 2016 was likely exasperated by a hail storm that occurred in June that reduced the plant leaf area more in the non-manured treatment than in the manured treatments. During both years of the study, the manured plots had greater leaf area early in the season compared to the non-manured plots. Manure applications can potentially increase sugarbeet root yields for an extended period of time after manure applications have ceased.

TARKALSON, DAVID D.[1]* and DAVE L. BJORNEBERG[1]. [1]USDA-ARS Northwest Soils and Irrigation Research Laboratory, Kimberly, ID. **Improving Nitrogen Management in Pacific Northwest Sugarbeet Production**

Nitrogen (N) management is critical in sugarbeet production to optimize yield and quality. Although, past research has been critical to improving and understanding sugarbeet N nutrition, continued research is needed to evaluate evolving varieties and management practices. From 2005 to 2010, studies from 14 locations (14 site-years) were conducted by agronomists from The Amalgamated Sugar Company (TASCO) and scientists at the USDA-ARS Northwest Irrigation and Soils Research Laboratory to evaluate the effect of N supply (fertilizer N + spring soil residual N [Nitrate N (NO_3-N) + Ammonium N (NH_4-N)]) on sugarbeet production in the Pacific Northwest. At each site-year, the effect of various levels of N supply on estimated recoverable sucrose (ERS) yield, root yield, sucrose concentration, brei nitrate concentration, and nitrogen use efficiency (NUE) were assessed. Nitrogen supply significantly affected ERS yield for 6 of the 14 site-years. For the 8 non-responsive sites, the maximum ERS yield was assumed to be the lowest N supply. The average nitrogen requirement (Nr) at maximum ERS yield across all site-years was 2.25 kg N Mg^{-1} beet (5 lbs N ton^{-1} beet) and ranged from 1.4 to 3.7 kg N Mg^{-1} beet (2.8 to 7.4 lbs N ton^{-1} beet). Thirteen of the 14 site-years had an Nr at or below 2.8 kg N Mg^{-1} beet (5.6 lbs N ton^{-1} beet), substantially less than current recommendations of 3.5 to 4.0 kg N Mg^{-1} beet (7 to 8 lbs N ton^{-1} beet). Nitrogen requirements can be reduced in the Pacific Northwest sugarbeet production area compared to past recommendations resulting in reduced N fertilizer applications and significant cost savings.

Section A – Agronomy
Poster Presentations

ALDER CLARKE G.[1], AND OLIVER T. NEHER[2], AND GREG DEAN[2]. [1]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Nampa, ID 83687. [2]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Boise, ID 83709. **Sugarbeet response to partial season water availability.**

Raising crops in irrigated soils almost always presents challenges, and sugarbeets are no exception. Over the past several years, growers in the Treasure Valley of Western Idaho have experienced lower than normal rainfall resulting in drought conditions over much of the growing area. Some growers have been forced to choose between which crops to grow as a result. For some, giving up sugarbeets for a season or two is not an option and the thirst for information of the moisture needs for the crop is high. This trial looked at differing water "cutoff dates" to illustrate how a particular variety would react under varying drought conditions.

ALDER CLARKE G.[1], JONATHAN SHURTLIFF[2], AND OLIVER T. NEHER[3]. [1]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Nampa, ID 83687. [2]The Amalgamated Sugar Company LLC, Agriculture Department, Paul, ID 83347. [3]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Boise, ID 83709. **Sugarbeet response to variable timings of nitrogen.**

The debate over adequate nitrogen inputs and timings has been visited many times over the course of the last several decades. As a result the fertility recommendations for our growers continue to be refined and are becoming more precise as time goes on. The recommended timing for nitrogen applications in the Treasure Valley of Western Idaho has been before 4-6 true leaves. This trial was repeated in two very different locations and looked at various timings of a urea fertilizer from preplant to row closure.

ALDER CLARKE G.[1], NANCY CUTLER[2], AND OLIVER T. NEHER[3]. [1]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Nampa, ID 83687. [2]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Nyssa, OR 97913. [3]The Amalgamated Sugar Company LLC, Department of Sugar Beet Quality Improvement, Boise, ID 83709. **Sugarbeet response to the timing and quality of weed control.**

Weeds continue to be ever present in row crops worldwide. Growers spend an enormous amount of time and money in an effort to keep their farms clean and their crops healthy through weed control. With many of our Roundup Ready® crops relieving some of the pressures and costs of weed control, the tendency of some growers to spray less and pay less attention to weeds has contributed to the increased spread of herbicide resistance. In addition, beet yields and sugar content are not what they truly could be with adequate weed control. This trial is the third in a series of simple, basic, but necessary trials in the Treasure Valley of Western Idaho that help illustrate the importance of timely and effective weed control and it its effects on yield and sugar, and consequently, the farmer's bottom line. Several timings of weed control combined with several control quality treatments ranging from 25%-100% control were issued to help illustrate this point.

BELLES, DAVID S.[1]*, KRIS PAUNA[1], DANA STUBBENDECK[1], BRUCE BATTLES[1], MARTY SCHRAER[1], PETE FORSTER[1], BRETT MILLER[1]. [1]Syngenta Crop Protection LLC., 410 Swing Road, Greensboro, NC 27409. **Managing *Rhizoctonia solani* in sugar beets with Vibrance seed treatment.**

Rhizoctonia root rot, caused by *Rhizoctonia solani*, is one of the most common soil-borne diseases of sugar beet (*Beta vulgaris* L.). *Rhizoctonia solani* causes pre- and post-emergence damping-off and seedling blight, resulting in stand and yield reduction. Vibrance is a new commercial seed treatment that was recently registered by Syngenta Crop Protection for seed treatment use on sugar beet. The active ingredient of Vibrance, sedaxane, belongs to the succinate dehydrogenase class of fungicides (SDHI) FRAC group 7. The use of Vibrance seed treatment helps manage *R. solani* to get optimum plant stand establishment and increase yield. The benefits of Vibrance on sugar beet from the control of *R. solani* in trials conducted in several locations in 2015 and 2016 are presented.

GROULX, BRIAN J. * and JAMES F. STEWART, Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706 **Influence of Harvest Date on Sugarbeet Yield and Quality**

Sugarbeet yields in Michigan have increased by approximately 25 percent during the past fifteen 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 late March. Small plot replicated trials were conducted from 2010-2016 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. Temperatures and soil moisture levels were favorable for sugarbeet growth during the harvest period in each year. Averaged over six years (2010-2015), sugarbeet yields in small plot replicated trials increased by 1.35 tons per week and sugar content increased by 0.43 points per week. Recoverable sugar per ton increased by 7.8 pounds per week, and recoverable sugar per acre increased by 572 pounds per week. Control of diseases throughout this period is critical to achieve the continued yield and sugar increases. Michigan Sugar Company applies an early harvest premium to the crop harvested prior to permanent pile to incentivize grower participation. Early harvest has also proven to maximize grower income by distributing the fixed costs of campaign over a longer time period, as well as reducing pile storage losses. Data from 2016 trials will also be included when results are available.

MORISHITA, DON W. [1]*, JOEL FELIX[2], AND PRASHANT JHA3. [1]University of Idaho, Kimberly R&E Center, 3806 N. 3600 E. Kimberly, ID 83341, [2]Oregon State University, Malheur Experiment Station, 595 Onion Ave., Ontario, OR 97914, [3]Montana State University, Southern Ag Research Center, 748 Railroad Hwy, Huntley, MT 59037. **Survey for glyphosate resistant weeds in eastern Oregon and Southern Idaho sugar beet growing areas.**

Glyphosate resistant weeds are a major concern in the US where sugar beet, corn, and soybean are grown. In the eastern Oregon and southern Idaho sugar beet growing areas, glyphosate resistant kochia has been

confirmed and glyphosate resistant Russian thistle and common lambsquarters has been reported. A survey was conducted in 2015 and 2016 in an attempt to determine the presence and extent of glyphosate resistant weeds in this geographical area. A field bioassay plant collection kit was put together following a published procedure. However, rather than using petri plates, cuttings of suspected plants were placed in 45 ml centrifuge tubes filled with 30 ml of agar mixed with glyphosate. A protocol for sampling areas and collecting plants was shared with The Amalgamated Sugar Company Crop Advisors to assist with the plant collection in 2015 and 2016. None of the samples collected in 2015 were confirmed resistant to glyphosate. Samples collected in 2016 are in the process of laboratory confirmation. One sample in south central Idaho has confirmed resistance to glyphosate, and other samples are continuing to be analyzed. Preliminary results from the bioassay kits indicate glyphosate weed resistance is spreading in eastern Oregon and southern Idaho. The need for growers to implement stronger resistance management practices continues to increase.

NEHER OLIVER T.[1*], GREG DEAN[1], and CLARKE ALDER[1], [1]The Amalgamated Sugar Company LLC, Boise, ID 83709. **Foliar applied products for increased sugar content.**

Commercially available sugar beet varieties grown in Idaho provide tonnage but fail to provide an acceptable sugar content. To overcome this deficiency, a new seed approval policy is implemented to encourage the increase of average sugar content to 18.10% by 2020. Meanwhile, Idaho growers and growers in other growing regions try to improve their sugar contents by using soil or foliar applied products. This poster will present an ongoing study comparing multiple "sugar enhancers" and discuss their efficacy.

SPRAGUE, CHRISTY L.*, Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Status of herbicide-resistant weed issues in Michigan sugarbeet**

The evolution of herbicide-resistant, including glyphosate and multiple-resistant, weeds continue to threaten U.S. growers, especially as they move into the sugarbeet production regions of the U.S. The increasing number of glyphosate-resistant weeds and the loss of herbicides that were once used in sugarbeet production will make it more of a challenge for sugarbeet growers to manage these weeds. In Michigan, populations of horseweed (marestail), Palmer amaranth, waterhemp, and more recently common ragweed have been confirmed resistant to glyphosate. In fact, some of these populations are also resistant to the ALS-inhibiting herbicides, making them even more difficult to manage. Over the last several years we have conducted field trials to evaluate several herbicide programs for the management glyphosate-resistant horseweed and Palmer amaranth in sugarbeet. Several different herbicide tank-mixtures and application timings were evaluated for control of these weeds. Control of glyphosate-resistant horseweed was dependent on clopyralid rate and the number of applications. Control of glyphosate-resistant Palmer amaranth was more variable over the years and many times needed multiple applications of the older herbicide, phenmedipham plus desmedipham at a minimum rate of 0.56 kg ai ha^{-1} with the inclusion of an acetanilide herbicide like acetochlor. Due to the extended emergence patterns for both of these weeds, 100% control in sugarbeet with herbicides alone is likely not possible.

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. **Enhanced efficiency fertilizers in Michigan sugarbeet production.**

Enhanced efficiency fertilizers are products aimed at reducing nutrient losses and increasing plant nutrient availability thus improving both environmental and economic efficiencies. In 2010, Michigan Sugar Company began an initiative to increase beet quality with a statewide mean goal of 19% sugar. To accomplish incremental increases in beet quality and maintain or increase root yield, improved management practices including refined N management strategies were one consideration. Previous research showed that 40 lbs. N/A applied as a 2x2 application at planting continued to be an efficient, effective method of getting early N to the sugarbeet plant.

However, growers are also looking to reduce the number of passes over a field during the season which has raised producer interest in one-pass spring N applications. The objective of this study was to determine if enhanced efficiency fertilizers affect root yield and quality, beet N accumulation, and other plant characteristics. Multiple studies were conducted in the Michigan Sugar growing area and arranged as a randomized complete block with four replications. A lack of excessively wet conditions limited N losses and the usefulness of these products. While many of these products did not improve sugarbeet root yield and quality and reduced quality similar to urea, enhanced efficiency fertilizers did not inhibit or restrict plant growth and development. Rainfall variability may affect widespread adoption of these fertilizer technologies but environmentally vulnerable production regions may want to consider usage over the long-term.

STEVENS, W. BART*, JAY D. JABRO and WILLIAM M. IVERSEN, USDA, Agricultural Research Service, 1500 North Central Avenue, Sidney, MT 59270. **Sugarbeet response to seed position relative to fertilizer band in a strip tillage system.**

Fertilizer is often banded under the seed row when strip tillage is performed. When strip tillage and planting occur in separate operations it can be difficult to consistently plant seed in the optimal position relative to the fertilizer band. Our objective was to evaluate sugarbeet plant growth and yield when the seed row is offset laterally relative to the fertilizer band. The study was conducted from 2011 to 2013 on a sandy loam soil in western North Dakota using overhead sprinkler irrigation. Seed was planted 3 cm deep and 0, 7.5, 15, or 22.5 cm to the side of the fertilizer band. A control treatment with no fertilizer applied was also included. In the fall, urea (145 kg N ha^{-1}) and monoammonium phosphate (12 kg N and 56 kg P_2O_5 ha^{-1}) fertilizers were placed in a single band at a depth of 10 cm using a semi-parabolic shank strip tillage implement. In all three years, plant dry matter (PDM) 40 days after emergence (DAE) was from 0.6 to 3 g $plant^{-1}$ when seed was placed 22.5 cm to the side of the fertilizer band. This was indistinguishable from the control suggesting no significant fertilizer uptake occurred during the first 40 days of plant growth. Excessive precipitation in 2011 leached N from the root zone and limited response. In 2012 and 2013, PDM at 40 DAE was greatest when sugarbeet was seeded directly over the fertilizer band (0-cm offset) and was only marginally (9 to 15%) lower when offset by 7.5 cm. When the seed row was offset by 15 cm, PDM at 40 DAE was 20 to 55% less than where the offset was 0 cm. In 2012, end-of-season sucrose yield was similar (12262 to 12367 kg ha^{-1}) for the 0-, 7.5- and 15-cm offset distances but was approximately 17% lower for both the 9-cm offset and control treatments. In 2013, sucrose yield was similar for the 0- (11841 kg ha-1) and 7.5-cm (10847 kg ha^{-1}) offsets and decreased by 19, 23 and 43% (compared to the 0-cm offset) for the 15- and 22.5-cm offset and control treatments, respectively. Results suggest that the lateral distance between sugarbeet seed and the fertilizer band should be 7.5-cm or less.

TARKALSON, DAVID D. [1]* and BRADLEY A. KING[1]. [1]USDA-ARS Northwest Soils and Irrigation Research Laboratory, Kimberly, ID. **Irrigated Sugar Beet Sucrose Content in Relation to Growing Season Climatic Conditions in the Northwest U.S.**

The potential effects of changing climate on world food production have become a political and scientific focus. This study was conducted to investigate linkages between seasonal climatic conditions and sugarbeet sucrose content in southern Idaho and eastern Oregon. Sucrose content of irrigated sugarbeets delivered to 74 receiving stations in southern Idaho and eastern Oregon from 1997 through 2014, and daily climate data (growing degree days [GDD] and accumulated alfalfa reference crop evapotranspiration, maximum air temperature, minimum air temperature and mean air temperature, global solar radiation, accumulated growing degree days, and mean relative humidity) from regional weather stations were collected and analyzed using various regression techniques to investigate linkages between climate variables and sugarbeet sucrose content. Ninety-nine climatic parameters were analyzed with 34 having correlations with sugarbeet sucrose content > |0.3|. The most important climatic parameter related to mean sucrose content was early stage sugarbeet growth (late April to

mid-May). In general, as temperature and GDD increased sucrose content decreased. Results indicate increases in both early season and mid-season temperatures will lead to decreases in sugarbeet sucrose concentrations. However, if sugarbeet root yields increase due to increasing temperatures and GDD accumulation, the sucrose yield changes would be buffered.

Section B Physiology, Genetics, and Plant Pests
Oral Presentations

BOEHM, DAVID[1]*, HENDRIK TSCHOEP[2], ALAIN TOSSENS[2], FRANCOIS SUIVENG[2], NICOLAS HENRY[3], & GERHARD STEINRUECKEN[2]. [1]SESVanderHave USA, 5908 52nd Ave South, Fargo, ND 58104, [2]SESVanderHave, Soldatenplein, Z2, nr 15, B-3300 Tienen, Belgium, and [3]SAS Florimond Desprez Veuve & Fils, BP 41, 59242 Cappelle-En-Pevele, France. **Post-Harvest Storability in *Beta vulgaris*; research and perspectives from SESVanderHave.**

There are numerous factors that affect the loss of sucrose in sugar beets during storage, such as disease infection during the growing season, respiration, frost and physical damage by handling. Recently, there have been increasing discussions about the role variety development may play in selecting for beets that have better genetic disposition to maintaining sucrose under these and other conditions. SESVanderHave has made considerable research efforts to understand the major factors causing post-harvest sugar losses and developed methods to screen its germplasm for storage quality. SESVanderHave explored various methods to evaluate damage and subsequent sucrose losses and technologies to evaluate beet storage quality. Significant correlations were found in damage and pathogen induced root rot towards sucrose loss. This was used to discover variation within SESVanderHave germplasm that can then be exploited within a commercial breeding program to improve beet storage for the sugar industry and growers and therefore increase competitiveness of the sugar beet crop.

BOETEL, MARK[1*], ALLEN SCHROEDER[1], JACOB RIKHUS[1], AMITAVA CHATTERJEE[2], AND NORMAN CATTANACH[2], [1]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108, [2]Soil Science Department, North Dakota State University, Dept. 7180, P.O. Box 6050, Fargo, ND 58108. **Seed Lubricant Impacts on Plant Stands and Yield: Implications for Insecticidal Seed Treatment Use.**

Recently published research suggests that seed-flow lubricants (e.g., talcum) used in row crop planter hopper boxes can abrade neonicotinoid seed treatment insecticides (e.g., Poncho Beta, Cruiser, and NipsIt Inside) from seed coatings, with the resulting insecticide-laden dust being released into the air from vacuum-based planters and causing pollinator kills. This has raised questions as to whether talcum or other seed flow lubricants are necessary during sugarbeet planting. If lubricants are not needed in sugarbeet planting, or if a less-abrasive alternative to talcum could perform as well as talcum without negatively impacting seed delivery and seedling establishment, it may provide evidence to support continued federal registration of neonicotinoid seed treatment insecticides for use in sugarbeet production. This research was conducted in 2015 and 2016 to determine if seed-flow lubricants impact seed delivery, seedling establishment, sugarbeet yield parameters, or revenue. The experiment was arranged in a split-plot design with four replications. Seed size (i.e., miniature pellets [~9/64-inch diam.] and extra-large pellets [~12.5/64-inch diam.]) served as the main-level treatments, and lubricant (i.e., talcum, graphite, talcum/graphite mixture, Fluency Agent®, and a no-lubricant control) were sub-level treatments. In 2015, there were no significant differences in plant stands at 14, 21, or 39 days after planting among seed lubricants or between any seed lubricant and the no-lubricant control. Similarly, there were no significant impacts of any seed lubricant on recoverable sucrose yield, root yield, or percent sucrose

content. Also, the main-level factor of seed size (i.e., Pro200 vs. regular pellet) had no significant effect on stand establishment or yield. Results and conclusions from both years will be discussed.

BOLTON, MELVIN D., USDA – ARS, Northern Crop Science Laboratory, 1605 Albrecht Blvd. N, Fargo ND 58102-2765. **Cercosporin biosynthesis 2.0 – the new and improved cercosporin biosynthesis cluster from *Cercospora beticola*.**

Cercosporin is a light-activated secondary metabolite effector produced by many *Cercospora* species that contributes to fungal virulence. The metabolic pathway for cercosporin production has been well-characterized and was previously thought to consist of eight cercosporin toxin biosynthesis (*CTB*) genes. By comparing genome sequences of several ascomycetes, we found that the *CTB* cluster has experienced a number of horizontal transfers across a spectrum of plant pathogenic fungi during evolution. Surprisingly, we noticed that these species also harbored an additional complement of genes on one flank of the established *CTB* cluster. Extensive microsynteny outside of the established cercosporin cluster prompted us to test whether the flanking genes in *C. beticola* are also required for cercosporin biosynthesis. Gene disruption of three genes led to the inability of the fungus to produce cercosporin. Taken together, our findings suggest that the *CTB* cluster includes more genes than previously known. A detailed characterization of these novel genes will be reported.

BRANTNER, JASON R.* and ASHOK K. CHANDA, Department of Plant Pathology, University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **Benefit of supplemental spent lime added to previously limed soils for control of Aphanomyces root rot on sugarbeet.**

Application of sugarbeet factory spent lime to soil in fields infested with the soilborne oomycete pathogen *Aphanomyces cochlioides* has been shown to decrease disease and increase sugarbeet yield in Minnesota and North Dakota. Sugarbeet growers are inquiring about the need to reapply lime in fields where lime has previously been applied. In a field trial where lime had originally been applied in April 2004 at 0, 2.7, 5.3, 8, and 10.6 tons dry wt A^{-1}, plots were split and 3.5 tons dry wt lime A^{-1} was added to half of each plot on October 31, 2014. In the spring of 2015 and 2016, sugarbeet was sown and data was collected on plant stand, Aphanomyces root rot, and sugarbeet yield and quality. In 2015, there was significant interaction between supplemental and original rates of lime for plant stand, root rot ratings, and yield ($P \leq 0.05$). At 4 and 7 weeks after planting, sugarbeet stands were higher in plots that received supplemental lime where original lime rates were 0 and 2.7 tons A^{-1} ($P \leq 0.05$), but not where original lime rates were 5.3 tons A^{-1} or higher. Supplemental lime reduced Aphanomyces root rot and increased sugarbeet yield only in plots where lime had not been previously applied ($P \leq 0.05$). In 2016, a second successive year of sugarbeet and high rainfall combined to provide severe Aphanomyces pressure. There were no significant interactions between supplemental and original rates of lime. Original lime rate had a significant linear effect ($P \leq 0.05$) on plant stand, Aphanomyces root rot, and sugarbeet yield and quality. Supplemental lime resulted in increased plant stands and root yields and decreased Aphanomyces root rot ($P \leq 0.05$). Results demonstrate a benefit from adding lime to fields previously limed at low rates under normal conditions and fields previously limed up to 10.6 tons dry wt A^{-1} under severe Aphanomyces conditions

CAMPBELL, LARRY G. USDA, ARS, Northern Crop Science Laboratory, 1605 Albrecht Blvd. N., Fargo, ND 58102-2765. **Potential of host plant resistance to the sugarbeet root maggot in an integrated pest management system.**

The performance of a hybrid with a sugarbeet root maggot (*Tetanops myopaeformis* von Röder) resistant pollinator was compared to the performance of an adapted susceptible hybrid at a location with root maggots present (St. Thomas, ND) and a location with no root maggots (Fargo, ND) in 2015 and 2016. The trial was replicated eight times within each location by year combination. The 2-year average root maggot damage rating

on the susceptible hybrid at St. Thomas was 7.0, on a 0 to 9 scale where higher numbers indicate more damage, compared to an average damage rating of 3.8 for the hybrid with the resistant pollinator. At Fargo, the 2-year average stand loss during the growing season was 15.6% for the adapted hybrid and 14.8% for the hybrid with the resistant pollinator. At St. Thomas the stand loss for the hybrid with the resistant pollinator was 19.5%, compared to 41.8% for the adapted susceptible hybrid. There was less than a 1 Mg ha^{-1} difference between the root yields of the two hybrids at Fargo. In contrast, the 2-year average root yield of the susceptible adapted hybrid was 66% of the root yield of the hybrid with the resistant pollinator at St. Thomas, the location with root maggot present.

CHANDA, ASHOK K.* and JASON R. BRANTNER, Department of Plant Pathology, University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **Integrated management of Rhizoctonia on sugarbeet: resistant varieties, at-planting and postemergence fungicides**

Rhizoctonia damping-off and root rot caused by *Rhizoctonia solani* have been the most common root diseases on sugarbeet in MN and ND. A field trial was established to evaluate an integrated management strategy consisting of a resistant, moderately resistant and a susceptible variety with seed treatments (penthiopyrad and sedaxane) compared with in-furrow azoxystrobin alone and in combination with a postemergence azoxystrobin band application. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (35 kg ha^{-1}). By 5 weeks after planting, plant stands were highest for the resistant variety, followed by the moderately resistant, and lowest for the susceptible variety. In all varieties, seed treated with penthiopyrad or sedaxane, or with in-furrow azoxystrobin application resulted in higher emergence and stand establishment over 9 weeks than the untreated control. There were significant (P = 0.05) variety by at-planting treatment interactions on yield and significant (P = 0.05) variety by at-planting by postemergence treatment interactions on root rot rating and recoverable sugar A^{-1} (RSA). Resistant and moderately resistant varieties had lower root rot ratings and higher number of harvested roots and RSA compared to the susceptible variety. Plots treated with azoxystrobin in-furrow had lower root rot ratings and higher number of harvested roots, yield, and recoverable sucrose than untreated controls, while plots with penthiopyrad and sedaxane seed treatments were not significantly different from untreated controls. There were no significant differences between untreated control and postemergence azoxystrobin application on any harvest parameters. Choosing a variety with at least a moderate level of resistance should be a primary disease control strategy.

EUJAYL, IMAD A.* and CARL A. STRAUSBAUGH, USDA-ARS-Northwest Irrigation and Soils Research Laboratory, 3793 N. 3600 E. Kimberly, ID 83341. **CRK8 Gene family expression is upregulated in Beet Curly Top Resistant sugar beet line.**

Resistance to *Beet curly top virus* (BCTV) is an essential trait for cultivars to be grown in arid and semi-arid areas worldwide. Currently neonicotinoid insecticides are used to compensate for low to moderate levels of resistance in cultivars. USDA-ARS publicly releases germplasm with economically important traits such as the line KDH13 (PI663862) which has exceptional resistance to BCTV. KDH13 has been further utilized to identify genes regulating resistance via gene expression profiling (RNA-sequencing). KDH13 was subjected to 7 treatments: an un-infested control treatment, a second control with non-infectious leafhoppers, and leafhoppers infested with one of three BCTV strains (California/Logan, Worland, and Severe) or a combination of the three strains. The transcriptomic sequence data from KDH13 was digitally analyzed against sequence of susceptible line (K19-19) that was infected with the three strains. The sequences were aligned to the reference genome sequence (RefBeet-1.2). Based on 28 pair-wise comparisons, the differentially expressed transcripts/genes were identified at threshold of False-Discovery-Rate (FDR) of <0.05 and a LogFC (fold change) >±2.0. The analysis revealed that Cysteine-rich Receptor-like protein Kinase-8 (CRK8; AT4G23160) was the most differentially expressed transcripts in the comparisons between the two lines. In KDH13, 4 transcripts/members of the CRK8 super-family showed consistent overexpression caused by and infection with the three BCTV strains at LogFC

of 2.3 and FDR <1.0^{-4}. The sequence of CRK8 were used to design quantitative PCR analyses. The qPCR validated these 4 CRK8 transcripts are a key regulator of CT resistance through overexpression as a defense system and can be used to screen progenies for BCTV resistance.

FUGATE, KAREN KLOTZ[1*], ABBAS M. LAFTA[2], JOHN D. EIDE[1], GUOLONG LI[3], AND MOHAMED F.R. KHAN[2], [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58102, [2]Department of Plant Pathology, North Dakota State University, Fargo, ND 58108, and [3]College of Agriculture, Inner Mongolia Agriculture University, Hohhot, China 010018. **Effect of methyl jasmonate on seedling tolerance to drought and cold temperature stress.**

Environmental conditions are rarely optimal for plant growth, and nearly all plants experience some degree of abiotic stress during production. Commonly caused by inadequate water availability or unfavorably low or high temperatures, environmental stresses cause growth to slow or cease, reduce net photosynthesis, generate reactive oxygen species that can alter metabolism and damage cells, and reduce crop stands if sufficiently severe. Environmental stress can occur at any time during production, but is most common during early development when plants are most sensitive to cold and have small root systems with a limited ability to extract water from all but the upper soil profile. In other plant species, exogenous application of methyl jasmonate has been found to mitigate the negative effects of abiotic stresses. Methyl jasmonate responses, however, vary between plant species and have not been tested in sugarbeets. The ability of exogenous methyl jasmonate to alleviate the negative effects of drought stress or cold temperature stress in sugarbeet seedlings was determined. Seedlings were treated with 0, 0.01, 0.1, 1, or 10 µM methyl jasmonate, and stressed by a cessation of watering or exposure to 4 °C for up to seven days. The effects of these stresses on fresh weight accumulation, dry weight accumulation, photosynthetic parameters, and cellular membrane damage, in treated and untreated sugarbeet seedlings were quantified at multiple times after the initiation of the stress which allowed methyl jasmonate's ability to mitigate the negative effects of water stress or cold stress to be evaluated under mild, moderate, and severe stress conditions.

FUNK, ANDY[1] and MITCH McGRATH[2], ([1] Michigan State University and [2]USDA-ARS, 1066 Bogue Street, 494 PSSB, Michigan State University, East Lansing, MI 48824). **Organization of a resistance gene cluster containing the rhizomania resistance locus (*rz1/rz2*) in sugar beet.**

Genetic resistance to the sugar beet virus rhizomania has been in use for over 40 years, but characterization of the molecular basis for susceptibility and resistance has proved challenging. Here we describe the region around the *Rz1* and *Rz2* loci in the sugar beet genome using whole-genome sequencing, RNA sequencing, molecular markers, and resistance gene modeling. Nucleotide-binding leucine-rich-repeat-containing (NB-LRR) genes have been implicated in numerous gene-for-gene resistance interactions. Twenty tentative nucleotide-binding (NB) sequences were identified in 16 MB of Chromosome 3 encompassing the *Rz1* and *Rz2* loci. These NB-like sequences were identified using a hidden Markov model derived from resistance gene NB domains and provided tentative locations for NB-LRR loci. These sequences exhibit spatial clustering correlated with their phylogenetic clustering, which suggests evolution through gene duplication. Comparing two populations sharing a common parent, we describe variation at these 20 NB-ARC sequences. This includes the presence of segregating transposable elements in or adjacent to 16 of the 20 predicted NB-LRR sequences. Transcript evidence is given for the expression of eight of these NB loci in root tissue of the common parent C869, with trace transcript evidence for an additional seven (15 putatively expressed loci in total in C869).

GLYNN, NEIL C*., KUHN PAUL, J and RUPPAL DOUG, *Syngenta, 7145 58th Avenue, Vero Beach, FL, 32967. **Evaluation of Graduate A+ for post-harvest disease control in sugar beet.**

Storage loss is a major factor influencing productivity in sugarbeets. Losses up to 17% over a 100-day period have been estimated and occur due to respiration and as a result of fungal infections. Although maintaining a healthy sugarbeet crop in the field through best practices (varietal resistance, fungicide applications and cultural practices) mitigate such losses, approaches that can reduce fungal colonization of beets during storage are recieving more attention. Many of the pathogens which colonize sugarbeets in storage are ubiquitous in nature, cause infections of other crops and/ or stored products and have fungicides registered for their control in the field. In this study, we explored the efficacy of Graduate A+, a fungicide comprised of Fludioxonil (1.99 lb/gal) + Azoxystrobin (1.99 lb/gal) for the control of storage rot pathogens and its potential to preserve sugar content during storage. Sugarbeets were produced and harvested using standard growing practices in Idaho and Michigan. Fungicide applications were made at a spray volume of 0.5 gal/ton and beets were stored in controlled conditions simulating those in commercial sugarbeet storage piles. Sugar analysis and estimates of fungal colonization were performed on a representative sample of beets taken before storage, on a sub-sample taken after ~1-3 months in storage and at the conclusion of the trials after ~3-4 months in storage. Sugar contents were greater in the Graduate A+ treated samples at both times and pest severities of known storage rot pathogens *Botrytis* sp. and *Penicillium* sp. were reduced compared to the untreated check.
These data highlight the potential of fungicide application to sugarbeets prior to storage as a means of mitigating sugar losses and provide a platform for further studies aimed ultimately at developing directions for use for Graduate A+ in commercial sugarbeets.

HANSON, LINDA E*[1]., QIANWEI JIANG[2], HANGHANG WU[2] and J. MITCH MCGRATH[1]. [1]USDA-ARS and [2]Michigan State University, East Lansing, MI 48842.**Alternaria leaf spot of sugar beet: factors associated with risk**

Recently, increased incidence and severity of Alternaria leaf spot has been observed in Michigan and other growing regions. In the past, Alternaria leaf spot in sugar beet has been a minor foliar disease issue in the United States and management of this disease usually has not been required. If severe, there is a potential to cause yield loss due to defoliation. The aim of this work was to examine disease management implications. Testing included screening Alternaria leaf spot susceptibility in sugar beet germplasm as well as testing the response of *Alternaria* spp. (all in the *A. alternate* species complex) from beet to foliar fungicides. Over 70% of the recent isolates (last two years) were resistant to quinone outside inhibitor (QoI) fungicides, with EC50 values greater than 60 ppm. Over 90% of the isolates showed tolerance to organotin, with EC50 values between 5 and 10 ppm. Sugar beet germplasm with differential reaction to *Alternaria* are being screened in the greenhouse, which includes a detached leaf assay and a mist chamber assay.

KHAN, MOHAMED F.R.[1*], AND PETER HAKK[1], [1]North Dakota State University & University of Minnesota, Soil Science Department, Fargo. **Managing *Cercospora beticola* resistant to fungicides.**

Cercospora leaf spot (CLS) caused by *Cercospora beticola* is one of the most damaging foliar diseases of sugarbeet worldwide. The objective of this study was to evaluate the efficacy of fungicides used alone or in mixtures for controlling to *C. beticola* resistant to tertraconazole (demthylation inhibitor - DMI) and pyraclostrobin (quinone outside inhibitor - QoI) fungicides. Studies were conducted at Foxhome, MN in different years. Each plot comprised of 6 22-inch wide rows, 30 feet in length. All experiments were arranged in a randomized complete block design with four replicates. Sites were inoculated with known tetraconazole and pyraclostrobin resistant populations of *C. beticola*. Treatments were applied with 4-nozzle boom sprayers calibrated to deliver 17 gal/acre of solution at 60 psi pressure to the middle 4-rows of plots at 14 d intervals. Cercospora leaf spot severity was assessed throughout the season. The middle 2-rows of plots were harvested and root yield and quality were determined. Disease severity was high resulting in death of older leaves and leaf regrowth in the non-treated check in all studies. In the *C. beticola* resistant to tetraconazole study conducted in 2009 and 2010, tetraconazole did not provide effective control of CLS resulting in recoverable sucrose per acre (RSA) which were not significantly different from the non-treated check. However, newer DMIs including

prothioconazole, and difenoconazole and propiconazole mixture provided significantly better disease control and resulted in significantly higher RSA than tetraconazole. Triphenyltin hydroxide (TPTH) (inhibitor of oxidative phosphorylation) and pyraclostrobin (QoI) both provided effective control of tetraconazole resistant *C. beticola* and resulted in significantly higher RSA than tetraconazole and the non-treated check. In the *C. beticola* resistant to pyraclostrobin study conducted in 2016, the DMIs in mixtures with TPTH provided the most effective disease control and resulted in significantly higher RSA than the non-treated check and the pyraclostrobin + fluxapyroxad treatment.

KHAN, MOHAMED F. R.[1]. [1]Plant Pathology Department, North Dakota State University and University of Minnesota, Fargo, ND 58108-6050. **The making of an epidemic.**
Minnesota and North Dakota produce 57% of the United States sugar beet, *Beta vulgaris*. The most devastating foliar disease for sugar beet is Cercospora leaf spot (CLS) caused by the fungus *Cercospora beticola*. The pathogen destroys the leaves and adversely impacts the photosynthetic capability of the plants. This disease results in significant reduction in root yield and increases concentration of impurities which results in reduced recoverable sucrose and higher processing costs. In 1998, American Crystal Sugar Company reportedly lost $45 million because of a CLS epidemic. Since 1999, growers have adopted research based recommendations in using fungicides in rotation and in mixtures to control CLS and Manage fungicide resistance. Growers used an integrated approach of better CLS resistant varieties, crop rotation, planting away from previously infected fields and timely application of fungicides to manage CLS. Fungicide usage was reduced by 52% from an average of 3.74 applications in 1998 to 1.79 applications in 2014 resulting in and average saving of $14 million annually. Growers who considered Cercospora leaf spot as their worst production problem decreased from 36% to less than 1% and 94% of growers reported excellent or good Cercospora leaf spot control with fungicides and growers surveyed that year indicated Cercospora leaf spot as their worst production problem. Then came 2016 with early planting and early row closure as a result of adequate moisture from rainfall and favorable growing degree days. Cercospora inoculum present from the 2015 crop quickly resulted in reported symptoms in late June with growers starting fungicide application in late June and early July. Most growers used demethylation inhibitors (DMI) and triphenyltin hydroxide(TPTH) early in the season quinone outside inhibitors (QoI) later in the season, typically in August. CLS field failures from using fungicides were reported in August from where a QoI was used in the first application. Laboratory testing confirmed *C. beticola* resistance to pyraclostrobin from the affected field. Many growers reported field failures after application of a QoI application in the latter part of August and many fields had brown, necrotic leaves in early September. Sampling and evaluation of *C. beticola* from fields sprayed with fungicides but with severe CLS indicated resistance to Qoi fungicide. It was estimated that more than 80% of fields in southern and central Minnesota had severe CLS which would have adversely affect yield and reduced sucrose concentration. An integrated approach using more resistant varieties and a mixture of effective fungicide chemistries will be needed to significantly reduce overwintering populations of *C. beticola* resistant to fungicides for the economical production of sugar beet. METZ, NICHOLAS J.* and

LI, HAIYAN*, LINDA E. HANSON and ANN C. SMIGOCKI, USDA-ARS Molecular Plant Pathology Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705. ***Rhizoctonia* resistance conferred by a sugar beet polygalacturonase-inhibiting protein gene in genetically modified tobacco.**
Polygalacturonase-inhibiting proteins (PGIPs) are cell wall leucine-rich repeat (LRR) proteins recognized as having a role in plant defense. PGIPs inhibit fungal polygalacturonase (PG) enzymes that break down the polygalacturonate chain in plant cell walls to initiate disease development. The interaction between PGs and plant PGIPs favors the accumulation of oligogalacturonides which elicit a wide range of plant defense responses. We cloned sugar beet *PGIP* (*BvPGIP*) genes to characterize their function in resistance mechanisms. *BvPGIP1*, unique to a sugar beet root maggot resistant germplasm, and *BvPGIP2* that differs from *BvPGIP1* in eight amino acids, were reconstructed for constitutive expression and introduced separately into *Nicotiana benthamiana*. Independently derived transgenic plants were identified by genomic PCR,

Southern blot and RT-PCR analyses. Plants exhibiting high levels of expression were infected with either *Rhizoctonia solani* AG2-2 or AG4, isolates that cause many plant diseases in a wide range of commercially important crops. Two weeks post-inoculation with fungal-colonized barley grains, disease symptoms (stem rot and subsequent seedling death) were severe on control plants but were limited or greatly reduced in transgenic *BvPGIP1* and *BvPGIP2* plants. With AG2-2, seedling death was significantly reduced by 70% - 82% in *BvPGIP1* and *BvPGIP2* plants compared to the controls. With AG4, seedling death was reduced by 50% in *BvPGIP1*, whereas, *BvPGIP2* plants did not show enhanced resistance as compared to the control. This varied response between the two AG isolates has been observed with other tests that point to independent resistance for these pathogens. Our initial results demonstrate that sugar beet *BvPGIP* genes play an important role in plant defense and could provide an approach for controlling fungal diseases in sugar beet and other crops

METZ, NICHOLAS*, MELVIN D. BOLTON, USDA – ARS, Northern Crop Science Laboratory, 1605 Albrecht Blvd. N, Fargo ND 58102-2765. **Augmenting fungicidal activity of tetraconazole with chemosensitization agents for Cercospora leaf spot management.**

Cercospora leaf spot (CLS) caused by *Cercospora beticola* is one of the more destructive foliar diseases of sugar beet. Management strategies for CLS rely on timely fungicide application. CLS management fungicide repertoire often include the application of fungicides in the sterol demethylation inhibitor (DMI) class. The reliance on DMIs has led to the emergence of resistance in *C. beticola* populations. Co-application of certain natural compounds may increase efficacy of DMIs through a process called chemosensitization. Chemosensitization can be accomplished by combining the chemosensitization agent (CA) with a commercial fungicide where, alone, neither compound would be effective. This process may reduce the probability of resistance development and may lead to higher fungicide efficacy. The CAs used in this experiment (thymol, octyl gallate, cinnamaldehyde, salicylaldehyde, kojic acid, carpropamid, fenoxanil, pyroquilon, 2-hydroxy-4-methoxybenzaldehyde (2H4), and 3,5- dimethoxy-4-hydroxy-acetophenone (3,5 DH)) were identified from other experiments that had showed promise in managing other fungal plant pathogens. To investigate their potential, seven strains of *C. beticola* with high resistance (EC_{50} ~10.0 µg ml^{-1}) to the DMI fungicide tetraconazole were collected from throughout ND and MN. *C. beticola* spores were collected and adjusted to the concentration of 10^3 spores ml^{-1} before being inoculated into a 96 well micro-titer plate. The strains were grown in non-amended media, media amended with tetraconazole at 1.0 µg ml^{-1}, and media amended with tetraconazole at 1.0 µg ml^{-1} and a CA with varying concentrations (10.0, 1.0, 0.1, and 0.01 mM). Fungal growth was measured using a microplate reader. Initial results showed that the most effective CA in fungal growth reduction was octyl gallate at 0.1 mM. Thymol, salicylaldehyde, pyroquilon, cinnamaldehyde, and 2H4 are also good candidate CAs at 1.0 mM. The remaining CAs showed no difference in growth reduction.

METZGER, MIKE [1,2]*, Viviana Rivera[1], Robert Brueggeman[1] and Gary Secor[1]. [1]Department of Plant Pathology, North Dakota State University, Fargo, ND 58102 and [2]Minn-Dak Farmers' Cooperative, 7525 Red River Road, Wahpeton, ND, 58075 Pectobacterium ***brasiliense*** **as a cause of soft rot decay of sugar beet**

A soft rot decay of sugar beet was observed in commercial fields in North Dakota and Minnesota from 2012 to 2015. Symptoms resemble those reported for bacterial vascular necrosis and rot caused by *Pectobacterium betavasculorum* including soft decay of internal root tissues, reddening of affected tissue, blackening of petiole vascular bundles, half-leaf yellowing and frothing. The disease causes serious yield losses in the field and economic losses in the factory due to contamination by invert sugar that reduces sugar quality. Bacteria were isolated and used to produce symptoms in greenhouse trials. Bacterial DNA was extracted from 46 isolates pathogenic to sugar beet using and analyzed by restriction-associated DNA genotype-by-sequencing. Partial sequences of five genes previously used in *Pectobacterium* subspecies phylogenetic analysis showed 99.76% nucleotide sequence identity on average across all five genes to the *P. carotovorum* subsp. *brasiliense* reference sequences. *Pectobacterium carotovorum* subsp. *brasiliense* is a new cause field soft rot decay of sugar beet in North America distinct from *Pectobacterium betavasculorum* that causes similar symptoms.

PANELLA, LEE*, ANN L. FENWICK, TRAVIS VAGHER AND MARK S. WEST, USDA, Agricultural Research Service, 1701 Center Avenue, Fort Collins, CO 80526. **Analyses of rhizoctonia screening nursery results over 15 selected years from 1980 to 2015**.

The USDA-ARS has had a research program at Fort Collins focused on breeding for resistance to Rhizoctonia crown and root rot (Rcrr) since the late 1950s. By 1980, current resistant and susceptible checks were in use. All individual roots from each plot were lifted and rated on a disease index (DI) scale of 0 (healthy, no disease) to 7 (dead, or missing). Their scores were averaged to provide a plot mean, used for analyses. Full data (individual root DIs in plots) from 119 experiments ranging over 15 years between 1980 and 2015 were labeled by type (commercial hybrid, ARS release, Plant Introduction [genebank accession], or seed company experimental line) and source (cooperative, ARS research program, or seed company). Resistant and susceptible checks were labeled by name and by seed lot. Because each year and each experiment is a different environment (temperature, rainfall, position in the field, etc.), DI scores will vary making it difficult to compare sugar beet varieties across experiments and years. We examined a number of questions. Do DI scores from susceptible and resistant checks, when compared to DI mean scores from trials, allow us to understand the potential restrictions of DI values with increasing disease pressure? Along those lines, we asked how consistent our checks preformed over years, experiments, and seed lots. We were very interested in finding good ways to compare results over years and among experiments within years? We also were interested in looking at commercial hybrids over the past 20 years to see if their average resistance had increased or decreased over time. One of the most important purposes of our screening nursery is to identify Plant Introductions with resistance to Rcrr. Therefore, we examined if plot variance among individual roots could indicate accessions that may be segregating for resistance to Rcrr, and how we best could compare our results over years, when most accessions are screened in only one year.

REGITNIG, PETER J.*and BRYAN R. AVISON, Lantic Inc., 5405 – 64th Street, Taber, Alberta, T1G 2C4. **Assessing variety improvements in Alberta.**

Historical seed production for Alberta involved an internal company breeding program that continued until 1977. The last variety released from this program was an open-pollinated variety named CS43 that was used until 1980. Several bags of this seed were kept in storage and in 1993 a fresh increase of seed of CS43 was produced in order to compare performance with the best commercial varieties at that time. A small quantity of this 1993 seed was again kept in storage. Germination was 74% when CS43 seed was tested in 2015. A small plot study was conducted in 2015 and 2016 to measure improvements in variety performance by comparing this 1970's variety to a current Roundup Ready variety. CS43 was overplanted and thinned to ensure sufficient stand was achieved in these trials. There was an average gain of 52% in extractable sugar per acre (ESA) when comparing a current Roundup Ready variety sprayed with Roundup WeatherMax herbicide to the 1970's variety sprayed with conventional herbicide. When the current Roundup Ready variety and the 1970's variety were both sprayed with conventional herbicide the average gain in ESA was 40% for the Roundup Ready variety. Trials conducted in 1994 and 1995 showed a 22% gain in ESA when current commercial varieties were compared to CS43, suggesting similar rates of varietal improvement before and after the mid 1990's when herbicide setback was not taken into account. Significant plant growth setback was observed for varieties sprayed with conventional herbicides in the 2015/2016 trials. When a Roundup Ready variety was sprayed with Roundup WeatherMax, ESA was 8% higher than the same variety sprayed with conventional herbicides. Plant growth setback from conventional herbicide reduced root yield by 2.3 tons per acre, but had little effect on sugar beet quality.

REKOSKE, M. M.[1*], MILLER, J. [1], and LOOCK, A[2]. [1]Betaseed, Inc. 1325 Valley View Road, Shakopee, MN 55379 and [2]KWS SAAT SE, Grimsehlstrasse 31, 37555 Einbeck, Germany. **Field performance advantage of Roundup Ready® sugar beet hybrids in North America.**

The sugar beet Event H7-1 responsible for glyphosate tolerance in sugar beet was developed by Monsanto and KWS SAAT SE. The first commercial fields were planted in 2007 and by 2009 the adoption rate in North America (N.A.) was over 85%. Since then sugar beet production has increased by 21% from 25.9 to 31.4 tons per acre based on USDA ERS data. Research results indicate the use of the Roundup Ready® (RR) system of weed control in sugar beet resulted in up to a 6.5% increase in performance when compared to traditional herbicide weed management systems. Roundup Ready sugar beets entered the market subject to the same approval criteria for sugar content, yield and disease tolerance as established for non-GM beets. Since the introduction of RR sugar beet hybrids, breeding gain has continued at a high rate while concurrently, tolerance to Cercospora leafspot, Aphanomyces root rot, Fusarium root rot, Rhizoctonia, rhizomania, curly top, powdery mildew, nematode and sugar beet root aphid also greatly improved. In contrast, the frequent use of glyphosate on rotational crops such as corn and soybean resulted in the development of resistant weeds in many N.A. growing areas. Since additional herbicides are or will likely be needed for weed control in sugar beet, the development of a new weed control system would be extremely beneficial to N.A. growers.

RICHARDSON, KELLEY L.*, JEFF WASSON, LINDA PAKISH, AND MARIA MEZA, USDA, Agricultural Research Service, 1636 E. Alisal Street, Salinas, CA 93905. **Identification and characterization of broad-spectrum sugar beet resistance to rhizomania, caused by *Beet Necrotic Yellow Vein Virus*.**

Rhizomania is a devastating disease of sugar beet (*Beta vulgaris* subsp. *vulgaris* L.) in production areas around the world. It is caused by *Beet Necrotic Yellow Vein Virus* (BNYVV) and vectored by *Polymyxa betae*. In the absence of effective control measures, infection results in 50-60% losses in root yield and negative effects on sugar yield and processing quality. Most control of rhizomania is achieved using resistant varieties. The most widely used source of resistance is the qualitative gene, *Rz1*. In the last 15 years, sugar beet fields around the world, planted with *Rz1*-resistant commercial varieties have been observed with severe rhizomania symptoms, suggesting *Rz1* is compromised. Novel sources of quantitative, multi-gene resistance must be identified to develop commercial sugar beet varieties with durable protection against rhizomania. Here, we report on evaluation of six rhizomania-resistance introgression lines, representing the five named genes (*Rz1*-*Rz5*) and a sixth, unnamed gene (*Rz?*) each introgressed into a susceptible background. The introgression lines and check entries were grown in soil infested with the *Rz1* resistance-breaking strain of BNYVV and virus titer was measured with ELISA and qPCR. Multiple individuals per line were evaluated and genotyped with 384 SNP. Individuals with *Rz1*, *Rz4*, or *Rz5* resistance genes showed the highest virus titers, and *Rz2*, *Rz3*, and *Rz?* had the lowest. qPCR results directly correlated with ELISA values. Population structure analysis grouped all *Rz1*, *Rz4*, and *Rz5* individuals together, in three respective groups, and all remaining individuals in a single group. Deeper analysis of remaining individuals put the *Rz?* individuals into one group, and *Rz2* and *Rz3* individuals in a second group.

STEWART, JAMES F.[1]*, BRIAN J. GROULX[1], and DAVID V. PRATT[2], [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, [2]Michigan Sugar Company, 122 Uptown Drive, Suite 300, Bay City, MI 48708. **Control of *Cercospora beticola* and other leaf spot diseases in Michigan sugarbeet production – New Challenges.**

Cercospora leafspot has been difficult for Michigan sugarbeet growers to control for the past two seasons. In 2015, weather conditions in September were unusually warm and wet and created infection periods which growers were not prepared for. In 2016, a six to eight-week drought affected much of our region and when rains came in mid-August Cercospora infections increased rapidly. *Alternaria* and *Bacterial* leafspot also infected the crop after the drought at damaging levels that we have not experienced before. Results from numerous research trials show that Inspire and Topguard provide the best Cercospora leaf spot control in Michigan. Proline, Eminent and Enable are slightly less effective. Super Tin is less effective than the triazoles

but more effective than EBDCs and Coppers. The efficacy of Chlorothalonil (not a registered fungicide) falls between Super Tin and the EBDCs. Strobilurin and benzimidiazole fungicides have widespread resistance problems in Michigan. Research also illustrates the benefits of proper fungicide application timings (BEETcast predictive model) and tank mixing a protectant with triazole fungicides for increased efficacy and resistance management. Recent work has documented storage losses due to Cercospora infections.

VARRELMANN, MARK[1]* and LAUFER, MARLENE[1] and [1]Institute of Sugar Beet Research, Holtenser Landstrasse 77, 37079 Goettingen, Germany. **Interaction of Beet necrotic yellow vein virus with Beet soil-borne virus in different host plants.**

Beet soil-borne mosaic virus (BSBMV) and *Beet necrotic yellow vein virus* (BNYVV) possess a similar genome organisation with 4-5 ssRNA genome components, high sequence homology and a similar host range. Both species cause diseases in *Beta vulgaris* with variable symptom expression and tissue affinity. In the US, both viruses occur in mixed infection, but information about interaction between both species is limited. In order to understand the interaction with the hosts and between virus species, co-infection and reassortants experiments were performed. Initially, natural isolates of both species were used for mixed infection experiments in sugar beet by means of mechanical root infection, resulting in suppression of BNYVV by BSBMV. Further, infectious cDNA clones of BSBMV and BNYVV (A-type) were used for reassortants experiments in *N. benthamiana* and *Beta macrocarpa*. RNA1+2 reassortants were viable and displayed systemic movement in *N. benthamiana* but symptoms occurred delayed and were less pronounced. The RNA3 components of both species were transreplicated, mediated long-distance movement in *B. macrocarpa* and were exchangeable between species. Both virus clones were fluorescently labeled (GFP, mRFP) by replacement of the coat protein-readthrough open reading frame. Differentially labeled isolates of the same species as well as the two-virus species were spatially separated and displayed co-infection exclusion in the host tissue in *N. benthamiana*. Separation of one species from an RNA1+2 reassortant showed that a specific genome component combination was not required for this effect. In contrast, mixture of both benyvirus species with either *Tobacco rattle virus* or *Potato virus X* displayed co-infection of the same cell. Generation of deletion mutants need to be performed to decipher the molecular basis for this effect.

VARRELMANN, MARK [1]*, ANIKA BARTHOLOMÄUS[1], SASCHA SCHULZE[1], STEFAN MITTLER[2], HEINZ-JOSEF KOCH[1], BERNWARD MÄRLÄNDER[1] and [1]Institute of Sugar Beet Research, Holtenser Landstrasse 77, 37079 Goettingen, Germany and [2]Syngenta Agro GmbH, Am Technologiepark 1-5, 63477 Maintal. **Real-time PCR-based quantification of Rhizoctonia solani (AG 2-2 IIIB) in soil extracts and the effect of different factors like plant cultivar and fungicide treatment on pathogen concentration in field soils.**

Rhizoctonia solani (anastomosis group 2-2 IIIB) is the causal agent of Rhizoctonia root and crown rot in sugar beet cultivation world-wide. Here, a direct soil DNA extraction method was applied for detection of *R. solani* from samples of 250 g soil using a real-time PCR assay. The assay is specific to the AG 2-2 IIIB and standard curves originated from three different field soils spiked with sclerotia gave evidence of its valid quantification with a detection limit of 2 mg sclerotia per kg soil. Different independent field trials with artificial inoculation were conducted to study the effect of plant cultivar, crop rotation and fungicide treatment on the pathogen concentration in the soil. The results showed that the amount of quantified DNA in the soil at harvest correlated with the rated disease severity of Rhizoctonia root and crown rot. Additionally, a strong effect of the sugar beet genotype was observed. At harvest, the amount of *Rhizoctonia* DNA was significantly increased in plots cultivated with a susceptible sugar beet genotype compared to a resistant one. The results also indicate, that depending on the initial inoculum, the effect of the resistant genotype varies, keeping it on a steady level at a lower disease pressure, but tend to propagate the inoculum if the disease pressure was high.

The application of fungicides significantly reduced the pathogen concentration in the soil, as well as the cultivation of the non-hosts winter rye. This fast and reliable quantification method represents an applicable tool to study the long-term development of the pathogen concentration in soils in the future.

WEBB, KIMBERLY M.[1*], STEPHEN J. DELGROSO[2], MARK S. WEST[3], CLAIRE FREEMAN[1], and TAMMY BRENNER[1], [1]USDA-ARS, Soil Management and Sugar Beet Research Unit, 1701 Centre Ave., Fort Collins, CO 80526; [2]USDA-ARS, Soil Management and Sugar Beet Research Unit, 2150 Centre Ave., Bldg. D, Fort Collins, CO 80526 and [3]USDA-ARS, Plains Area Office, 2150 Centre Ave., Bldg. D, Fort Collins, CO 80526. **Influence of environment, crop age, and variety on the development and severity of Fusarium yellows in field-grown sugar beet.**

Fusarium yellows, caused by multiple *Fusarium* spp., is an important disease of sugar beet in many production regions and leads to considerable reductions in root yield, sucrose percentage, and juice purity. Due to the increasing incidence of Fusarium yellows and the potential impacts of climate change on plant disease development, a better understanding of how the environment contributes to disease severity would provide additional strategies for managing losses due to Fusarium yellows. However, little is known about what environmental factors are most influential for the development and severity of disease in the field, nor how sugar beet responds to these abiotic stresses. Therefore, the occurrence of Fusarium yellows in a susceptible, moderately susceptible, and a resistant variety of field grown sugar beet were monitored and correlated with the environmental conditions during the growing season over a four-year period. While Fusarium yellows, caused by multiple *Fusarium* spp., gradually increased during the field season with crop age, soil moisture appeared to be the environmental factor most correlated with Fusarium yellows severity throughout the growing season. Higher soil moisture content was generally associated with higher levels of Fusarium yellows particularly as the growing season progressed. During drier years disease severity was less, especially for the resistant variety. We also developed variety specific prediction models based on crop age and soil water content which explained 57-89% of the observed variability in disease severity based on these findings.

WINTERMANTEL, W.M.[1]*, L.L. HLADKY[1], A.A. CORTEZ[1], L.-F. CHEN[2], and R.L. GILBERTSON[2], [1]USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905 and [2]University of California, 1 Shields Ave., Davis, CA 95616. **Differential accumulation and transmission of traditional and emergent *Beet curly top virus* strains from of the western United States.**

Curly top disease, caused by various strains of *Beet curly top virus* (BCTV), causes significant economic losses for sugarbeet throughout the western United States. Recent surveys in California and the Pacific Northwest identified a rapid shift in the predominant strains of BCTV impacting agriculture, with new emergent strains supplanting traditional strains of the virus in both regions, resulting in some changes in severity and affected host plants that may reflect the prevalence of the new strains over traditionally common strains. To identify factors leading to emergence of new strains, competition studies were conducted in which sugarbeet and other host plants were inoculated with new and traditional BCTV strains as single or co-infections using agroinoculation of cloned viral DNA. Some infections were established using leafhopper transmission due to difficulty in obtaining viable infection with clones of specific strains with the agroinoculation method. After four weeks, test plants were evaluated for virus accumulation using qPCR, and used for leafhopper transmission to new test plants, followed by determination of which strains were transmitted most effectively. Results demonstrated preferential accumulation of some strains in a host plant-specific manner. This indicated that some BCTV strains are better adapted to some host plants than others, and that host plants may have a substantial influence on emergence and dominance of BCTV strains. Secondarily, these studies also suggested that BCTV strains that have difficulty in establishing infections from cloned DNA cannot be compared reliably using agroinoculation, because these strains are at a selective disadvantage in establishing infections. Results

have implications for virus propagation for curly top nurseries, and begin to clarify factors influencing emergence of new BCTV strains.

Section B Physiology, Genetics, and Plant Pests
Poster Presentations

FUGATE, KAREN KLOTZ[1*], LARRY G. CAMPBELL[1], JOHN D. EIDE[1], MIKE S. METZGER[2], ABBAS M. LAFTA[3], AND MOHAMED F.R. KHAN[3], [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58102, [2]Minn-Dak Farmers Cooperative, Wahpeton, ND 58075, and [3]Department of Plant Pathology, North Dakota State University, Fargo, ND 58108. **Effect of methyl jasmonate on sugarbeet yield and storage properties.**

Methyl jasmonate is an endogenous plant hormone that induces plant defense mechanisms against environmental stresses and pathogens. Applied exogenously, methyl jasmonate provides protection against a wide array of pathogens and environmental stresses in a variety of crop plants and plant products. Beneficial effects of exogenous methyl jasmonate treatment, in the absence of stress, have also been documented, including increased tuber weight of potatoes, enhanced sugar content of raspberries, and reduced shoot growth and sugar losses in stored radishes. To determine whether methyl jasmonate application has any beneficial effects on production or storage properties for the sugarbeet crop, field studies in which methyl jasmonate was applied to the crop at different stages of development were conducted in 2014, 2015, and 2016. Methyl jasmonate was applied at concentrations of 0.01 or 10 µM as a single treatment in June, July or August. Plots additionally received a 0 or 9 oz acre^{-1} Headline™ treatment, applied approximately 30 days before harvest, to allow interactions between methyl jasmonate and Headline, a fungicide with purported hormone-like properties, to be evaluated. At harvest, root yield, sucrose content, recoverable sugar per ton, recoverable sugar per acre, and sucrose loss to molasses were determined. Storage properties including respiration rate, sucrose loss in storage, recoverable sugar loss in storage, and invert sugar accumulation were also determined using roots stored at 5 °C and 95% relative humidity for up 90 days

GOODWILL, THOMAS R., LINDA E. HANSON, USDA-ARS-Sugarbeet and Bean Research Unit, 1066 Bogue Street, Room 494, Plant and Soil Sciences Building, East Lansing, MI 48824. **A rapid storage method for long-term storage of *Cercospora beticola*.**

Cercospora beticola, cause of Cercospora leaf spot in sugarbeet, is a slow growing fungus that can be very time consuming and somewhat difficult to store long-term. Long-term storage is needed for consistent isolates to use in studies on pathogen diversity and changes in factors such as fungicide sensitivity. Previous storage methods could take two or more weeks to get the isolates of *C. beticola* stored. The new method uses a liquid shake culture of the fungus in half-strength V8 media and produces small fungal balls of *C. beticola* in four to five days. The fungal balls are harvested, rinsed with sterile distilled water, and air dried in a 100x10mm petri dish overnight in a biosafety cabinet. The dried fungal balls are stored in 1.5 mL screw cap tubes and kept at either -20C or -80C. Fungal isolates that had been stored for more than five years in these storage conditions were tested for viability and pathogenicity on sugarbeet. All isolates were able to grow on V8 media and caused lesions on sugarbeet leaves in high humidity greenhouse conditions. The new fungal ball storage method greatly reduces the time and resources spent on storing *C. beticola*, which is a big boost in productivity for people in the lab.

GALEWSKI, PAUL [1] and MITCH McGRATH[2], ([1] Michigan State University and [2]USDA-ARS, 1066 Bogue Street, 494 PSSB, Michigan State University, East Lansing, MI 48824). **Phenotypes, genome wide markers, and structured genetic populations: A means to understand economically important traits in *Beta vulgaris* and to inform the process of germplasm enhancement.**

Populations are the operational unit of beet improvement and thus characterizing populations is critical for gene discovery and deployment of traits to growers. Several -omics technologies are being deployed to: 1) Catalog and compare the molecular variation found within *Beta vulgaris* crop types, 2) Generate genome wide markers from 22 varieties/ germplasm representing beet crop type diversity and important phenotypic characters, and 3) Partition the phenotypic variation resulting from divergent crosses between sugar beet and crop type against the respective genome squence. To date, 982,190 high-information-content SNPs have been identified that discriminate within and among crop types. Characterization of private variation (SNP/INDELS) found only within one population or crop type is producing evidence of global and local genome differentiation resulting from selection for end use and genetic drift within the breeding program. Global pairwise Fst for inter-crop type populations C896 and W357B was 0.29 versus and an Fst of 0.12 for populations of the same crop type C869 and L19. The MSR is an F7 inbred population derived from sugar crossed with table beet (C869 X W357B) and represents a large degree of phenotypic variability for economically important characters (i.e. percent sucrose, percent water, biomass accumulation). Locating these traits to genomic regions using genotype/ phenotype associations and leveraging additional data regarding local genome differentiation and gene expression to gain better resolution of the genetic architecture of these traits is providing a useful tool to identify genes for any phenotype of interest.

HANSON, LINDA E.*, MINIER, DOUGLAS H.[1], [2] , MARINA L. RAMON[3] and FRANK N. MARTIN[3], [1]PSM, Michigan State University and [2]USDA-ARS, 1066 Bogue St., East Lansing, MI 48824, [3]USDA-ARS, 1636 E. Alisal St., Salinas CA 93905. **Identification and validation of microsatellite markers for SSR genotyping of *Rhizoctonia solani* AG2-2.**

Rhizoctonia solani (Kühn) AG2-2 is an important, soilborne pathogen of sugarbeet (*Beta vulgaris*) as well as a number of other crops. An improved understanding of the diversity and population structure of this pathogen could benefit management practices. Microsatellites have become an invaluable tool for these types of studies; so in order to develop a set of useful microsatellite markers, we utilized an *in-silico* approach to identify potential loci. One isolate from each of three distinct phylogenetic groups was sequenced on a HiSeq4000 and assembled using CLC Genomics Workbench. Loci that were at least trinucleotide and of a suitable repeat length were selected from isolate Rs850. These preliminary loci were compared to the other two isolate assemblies to determine if there were differences in repeat length, there were no indels in the flanking regions and conserved primers could be developed. We generated 33 potential marker loci that were tested on isolate Rs850 for PCR amplification using a single annealing temperature and $MgCl_2$ concentration. Those that amplified well under these conditions were then tested on eight additional isolates, which represented the three distinct phylogenetic groups. Sixteen primer pairs amplified all nine isolates and showed probable polymorphisms in fragment length. These primer sets were paired based on suitability for multiplexing and labeled with either Hex or 6-Fam fluorescent dyes for automatic size detection on an ABI 3730 sequencer. Those that appear to be suitable markers will be further screened on 22 additional isolates to confirm sufficient variation. We expect that the effort invested by sequencing multiple isolates and developing markers from those assemblies will increase the probability that preliminary SSR marker selections will be successful.

MACRAE, IAN [2].* CHANDA, ASHOK[1], NATE RUSSART[2], TIMOTHY BAKER[2], JASON BRANTNER[1], AND [1]Department of Plant Pathology, [2]Department of Entomology, University of Minnesota Northwest

Research & Outreach Center, 2900 University Ave, Crookston, MN 56716. **Remote sensing for detection of Rhizoctonia crown and root rot of sugarbeet.**

Rhizoctonia crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2, is becoming more frequent and widespread in the sugarbeet growing regions of Minnesota and North Dakota. In this region, symptoms of RCRR typically begin at about 8 weeks after planting and continue to develop until harvest. Infected plants occur sporadically or in large portions of the field. Early detection of RCRR may offer opportunities for remedial fungicide applications, mapping distribution of the pathogen in fields, application of integrated management strategies (partially resistant varieties, cultural practices, and fungicides) for the next sugarbeet crop, or for estimates of RCRR for crop insurance.

Advances in remote sensors and vehicle platforms have regenerated interest in within-season remote detection of RCRR. However, research approaches have not reliably identified diagnostic reflectance values or vegetative indices. In an effort to identify baseline data, hyperspectral reflectance data associated with RCRR disease severity in partially resistant and susceptible sugarbeet varieties was obtained. Each variety was inoculated with 0, 20, 40, or 60 kg ha^{-1} *R. solani* AG 2-2-infested barley grain incorporated into soil prior to planting or two infested barley grain per root near canopy closure. Mean root rot ratings were 0, 1.6, 1.3, 2.2, and 5.5 for the partially resistant variety and 0.1, 1.8, 4.1, 3.7, and 6.3 for the susceptible variety inoculated with 0, 20, 40, and 60 kg ha^{-1} and two grains per root, respectively. A hyperspectral spectroradiometer was used to assess canopy reflectance values twice weekly after plots were inoculated with *R. solani*. These data were used to create reflectance curves which were compared to assess effects of infection and variety.

MARTIN, FRANK N* AND SMITH, BRETT USDA-ARS, 1636 East Alisal St., Salinas, CA 93905. **A real-time PCR and digital droplet PCR assay for quantification of *Polymyxa betae* in sugar beet roots.**

Polymyxa betae is an obligate pathogen capable of vectoring several viruses of sugar beet that can cause large losses in production. In the past, quantifying *P. betae* infection levels required time-consuming staining and visual examination using light microscopy. A new species-specific quantitative real-time PCR assay that allows for rapid quantification of *P. betae* infection levels in sugar beet roots has been developed. The assay has been designed to target the *P. betae* internal transcribed spacer (ITS) region of the genomic rDNA using sequence data from forty isolates. To achieve species-specificity, the assay primers and probe were designed against nineteen *Polymyxa graminis* ITS sequences from GenBank. In practice, the assay has demonstrated species-specificity in all fifteen *P. betae* isolates tested and has not amplified *P. graminis* isolates. Three internal plant controls, two targeting single copy nuclear genes and one targeting the ITS region of the rDNA, have been multiplexed with the pathogen assay to standardize quantification results across samples. Further, the assay has also been optimized for digital droplet PCR, which allows for more precise quantification of minor differences in infection levels than conventional real time PCR. These tools will allow for more efficient quantification of *P. betae* infection levels in experimentation evaluating host resistance, variation in aggressiveness among isolates and virus transmission studies.

MCGRATH, MITCH [1]*, PAUL GALEWSKI[2] and ANDY FUNK[2], ([1] USDA-ARS and [2] Michigan State University, 1066 Bogue Street, 494 PSSB, Michigan State University, East Lansing, MI 48824). **A reference genome assembly for sugar beet germplasm EL10.**

A high-quality reference genome sequence is required for genetic context and clarity surrounding the myriad varietal and environmental effects on beet sugar production from sugar beet, from seed to seed. To this end, the self-fertile ARS germplasm release C869 (PI 628754) was inbred for five generations by single seed descent with selection for seedling vigor and agronomic performance, and one of these lineages to be released as EL10 was subject to a range of nucleotide sequencing and assembly technologies that included short-reads from the Michigan State University genomics facility (125 bp paired end reads, 149X coverage Illumina technology), *in vitro* crosslink mate-pair (150 bp Hi-Rise, 75X; Dovetail Genomics, Santa Cruz, CA), long-reads (80X; PacBio technology done at Los Alamos National Lab, Los Alamos, NM), a physical map (279 kb

average single molecule, 1.2 million mapped fragments; BioNano Genomics, San Diego, CA), and *in vivo* crosslink mate-pair (80 bp proximity library, 40X; Phase Genomics, Seattle, WA). The 'best' result was obtained using PacBio reads >40 kb assembled with the Falcon Assembler (resulting in 938 scaffolds), upon which was superimposed a physical map using the BioNano two-enzyme hybrid assembly protocol (reducing the scaffold number to 86), and finally collapsing the resulting assembly to 9 scaffolds using the Proximity Guided Assembly approach. The resulting assembly contains nine scaffolds with a mean scaffold size of 63 million bases (Mb) and a total length of 566 Mb, similar to the RefBeet genome size. Genome size estimates of EL10 were refined using fluorescently stained nuclei from 22 progeny and determined to be 716 Mb (± 28 Mb).

NEHER OLIVER T.[1*], GREG DEAN[1], CLARKE ALDER[1], and JAMES D. BARBOUR[2], [1]The Amalgamated Sugar Company LLC, Boise, ID 83709, [2]University Of Idaho, Parma, ID 83660. **Miticides – solutions for a fluctuating problem?**

Two-spotted spider mites (TSSM) are ubiquitous in Idaho crops and historically have rarely caused significant damage to sugar beets. In recent years, the TSSM infestations of sugar beet fields have at times reached levels causing economic losses. Changes in cropping practices, crop rotation, TSSM resistance to registered chemistries and changes in climactic conditions (prolonged periods of elevated temperatures and reduced relative humidity) forced TSSM from surrounding crops into sugar beets. Insecticides such as Lorsban or Mustang used to control leafminers or black bean aphids lead to an increase in TSSM shortly after application. This observation was related to the broad activity of these products which not only controlled TSSM but also beneficial insects. In recent years EPA and ISDA approved a Section 18 for the use of Onager, a miticide controlling eggs and immature stages as well as viable adult mites. Onager is a highly effective product, but growers are limited to only one application per growing season. However, TSSM are a fluctuating problem and their population increase strongly depends on environmental conditions (temperature and relative humidity) and the developmental stage of surrounding crops. This provides a challenge for Idaho growers to correctly time their miticide applications. This poster will discuss the challenges of miticide applications and potential alternatives and companion products to Onager.

STRAUSBAUGH, CARL A.[1*], IMAD A. EUJAYL[1], and WILLIAM M. WINTERMANTEL[2], [1]USDA-ARS NWISRL, 3793 N. 3600 East, Kimberly, ID 83341, and [2]USDA-ARS CIPRU, 1636 East Alisal St., Salinas, CA 93905. ***Beet curly top virus* strains associated with sugar beet in Idaho, Oregon, and a survey collection.**

Curly top of sugar beet is a serious yield limiting disease in semi-arid production areas caused by *Beet curly top virus* (BCTV) and vectored by the beet leafhopper (*Circulifer tennellus*). The primary means of control for BCTV is host resistance, but effectiveness of resistance can vary among BCTV strains. BCTV variation was last investigated in Idaho and Oregon during a 2006-2007 survey, but changes in disease severity suggested a need for reevaluation. Therefore, 406 leaf samples symptomatic for curly top were collected from sugar beet plants in commercial sugar beet fields in Idaho and Oregon from 2012 to 2015. DNA was isolated and the BCTV strain composition was investigated based on polymerase chain reaction (PCR) assays with strain specific primers for Severe (Svr) and California/Logan (CA/Logan) strains and nonspecific primers that amplified Worland (Wor)-like strains. The 2006-2007 ID/OR BCTV positive samples from sugar beet included the following strains: 87% Svr, 7% CA/Logan, and 60% Wor-like. BCTV strain distribution in the new survey averaged 2% Svr, 30% CA/Logan, and 87% Wor-like. Whole genome sequencing (GenBank accessions KT276895 to KT276920 and KX867015 to KX867057) with overlapping primers, suggests that the Wor-like strains included Wor, Colorado (CO), and a previously undescribed strain designated Kimberly1 (Kim1). The Kim1 strains have 2929 to 2933 nucleotides with seven open reading frames encoding proteins homologous to those of other curtoviruses. The most closely related BCTV strain to Kim1 is LH71, a strain now emerging in California. Analysis reveals a shift in the composition of BCTV strains in Idaho from Svr being a dominant strain in commercial sugar beet fields in 2006-2007 to having greatly reduced prevalence in recent years.

STUMP, W.L.[1]*. STEPHAN C. GEU[1], M.W. WALLHEAD[1], G. SBATELLA[1] and [1]Plant Sciences Dept, University of Wyoming, Laramie, WY 82071 **Management of Rhizoctonia root and crown rot disease in sugar beet with a fungicide-glyphosate tank-mix to improve farm efficiency**

Rhizoctonia root and crown rot disease (RRCR) caused by the fungus *Rhizoctonia solani* has been identified as the major disease problem affecting sugar beet by growers of the Western Sugar Cooperative. Growers typically resort to fungicides to effectively manage this disease with fungicide treated seed being the first line of defense. Seed treatments have been found under our conditions to be effective for up to six weeks after planting, at which point, foliar applications of fungicide are necessary. Although research has demonstrated under severe disease pressure fungicides applied in a foliar band to be more efficacious than a broadcast application, many growers broadcast fungicide for RCRR management. This methodology seems to work for producers under low to moderate disease pressure conditions. Since this fungicide application typically occurs around the time the second application of glyphosate would be applied to the beet crop; research was conducted at two sites in Wyoming to investigate the potential of tank-mixing separate treatments of azoxystrobin (Quadris®), fluxapyroxad + pyraclostrobin (Priaxor™) and prothioconazole (Proline®) fungicide along with glyphosate under both a low and moderate RRCR disease pressure scenario. Parameters measured included treatment effects on Rhizoctonia disease management, weed control, crop safety and beet root yield. Results from the two sites revealed that when glyphosate was co-applied with the various fungicides in a tank-mix there were no effects on both herbicide and fungicide efficacy and no evidence of crop injury. RRCR disease suppression was similar between the various fungicide-glyphosate tank-mixes and crop yields with fungicide-glyphosate treatment under inoculation, were similar to that of the non-inoculated glyphosate-only check. The results indicate that growers under moderate disease pressure can manage weeds and RRCR disease with a combined broadcast application thereby improving production efficiency with less trips across the field and maximizing yields and farm profitability.

WEBB, KIMBERLY M.[1*] and COREY D. BROECKLING[2]. [1]USDA-ARS, Soil Management and Sugar Beet Research Unit, 1701 Centre Ave., Fort Collins, CO 80526 and [2]Proteomics and Metabolomics Facility, Colorado State University, C130 Microbiology, Fort Collins CO 80523. **Elucidation of Rhizoctonia crown and root rot disease response in sugar beet during infection with *Rhizoctonia solani* AG 2-2 IIIB.**

Sugar beet can be significantly impacted by Rhizoctonia crown and root rot caused by *Rhizoctonia solani* AG 2-2 IIIB. The molecular processes that mediate compatible and incompatible sugar beet interactions with R. solani are largely unknown and identifying the metabolites associated with *R. solani* infection may provide evidence for important biological pathways involved with resistance or susceptibility. The metabolic changes that occurred during susceptible and resistant *R.* solani interactions were compared with mock inoculated treatments and characterized using a non-targeted metabolomics workflow spanning primary and secondary metabolism products. Preliminary experiments revealed clear distinctions between tissue type and genotype, and more subtle changes in response to inoculation that was dependent on genotype by 7 days after inoculation (dai). To gain additional information, later stages of the infection process were investigated. Metabolites were extracted from infected and healthy root tissue at 0, 7, 14, and 21 dai to best reflect the *R. solani* infection process. Again, data revealed clear differences in metabolites between genotype, but also additional differential metabolite expression based on time after inoculation and infection with *R. solani*. In contrast to the previous study, GC-MS appeared to be more sensitive than UHPLC-MS, therefore more primary metabolites were differentially expressed. However, several of these metabolites are of unknown nature. Interestingly, most of the significantly changing metabolites occurred in the susceptible genotype after 14-21 days after infection. Several phytolexins, terpenes, and alkaloids, were identified in all treatments indicating some that have roles in host defense even during susceptible interactions. Several biochemical pathways appear to be involved during susceptible and resistant interactions with *R. solani*, and indicate a complex role of primary and secondary metabolites in sugar beet during fungal interactions.

WINTERMANTEL, WILLIAM M. [1]* and KIMBERLY M. WEBB[2] [1]USDA-ARS, 1636 East Alisal St., Salinas, CA 93905 and [2]USDA-ARS, 1701 Centre Ave., Ft. Collins, CO 80526. **Advantages of using 'omics' technologies and bioinformatics for analyzing the impact of pathogens on sugarbeet.**

Throughout the history of American sugarbeet production, research has proceeded hand-in-hand with the emergence of new diseases, and sugarbeet scientists have used the technologies available to improve disease management and crop yield in the face of the emerging disease pressures. Many traditional methods will always remain important for disease management, including host range studies, and pathogen isolation and inoculation of sugarbeet to confirm causative nature of the pathogen. In the late 20th Century the advent of molecular biology revolutionized plant pathology, leading to DNA and RNA based detection methods. The development of methods for analysis of the complete sequence of the genome (total DNA), transcriptome (RNA produced from DNA), proteome (all expressed proteins), and metabolome (total biochemical compounds produced) now allow scientists the ability to essentially begin putting together a systemic analysis of how sugarbeet responds to pathogen infection. While the technology is complex, the end result can be used to decipher how sugarbeet responds to pathogen attack. Studies by our laboratories have addressed changes in sugarbeet using proteome and metabolome analysis to understand the effects of Rhizomania and Rhizoctonia crown and root rot on sugarbeet, while others have used transcriptome and genomic analysis. The advantage of such methods is that they can be used to obtain both knowledge of gene expression by healthy sugarbeet as well as when sugarbeet is impacted by a pathogen at the molecular level. This information can facilitate targeted strategies, leading to improved control. By integrating omics technologies into traditional sugarbeet pathology, we can advance our ability to protect sugarbeet from disease and environmental stresses.

Section C, Processing
Oral Presentations

BITTNER, NILS[2*] LEHNBERGER, ANDREAS[1], and SILKE STIEGERT[1], [1]BMA Braunschweigische Maschinenbauanstalt AG, Am Alten Bahnhof 5, 38122 Braunschweig, Germany and [2]BMA Automation GmbH, Am Alten Bahnhof 5, 38122 Braunschweig, Germany. **Updated automation on batch and continuous centrifugals.**

Automation systems for batch and continuous centrifugals have to adapt to the current state of the art control philosophy in factories. (1) The operation of a battery of batch centrifugals is commonly realized by hardwired interlock. This prevents batch centrifugals from simultaneous operation but has limited flexibility: operator interaction is required if one centrifugal is stopped and restarted after regular cleaning or maintenance. (2) The introduction of Managed Sequencing allows an automatic and flexible operation of the batch centrifugal sequence. Intelligent pause management includes filling interlock, discharge interlock and acceleration and deceleration ramp control for optimized centrifugal sequencing. The optimization can be focused on maximum throughput or on reduced power peak loads. (3) Continuous centrifugals in high raw and low raw service have commonly poor automation installations because of the continuous process with low variation. Each adjustment to the process requires operator action at the machine. (4) PLC control solutions are now inexpensive enough to replace the discrete controllers and indicators. A touch panel provides up-to-date human-machine communication. This update in the control system of the continuous centrifugal allows additional functions for optimized massecuite processing: a non-linear control function is now realized for the magmatizing of the separated sugar and speed adjustment by a VFD is easily possible. Communication with a DCS system is implemented for extended supervision

BLACK, DANIEL R.. American Crystal Sugar Company, 1020 Business Hwy 2 East Grand Forks, MN 56721
Using X-ray Fluorescence Spectrometry to Investigate Metal Found with Magnets and Metal Detector

X-ray fluorescence (XRF) spectrometry is used as a tool for examining metal found in metal detector rejects and magnet findings with finished product sugar. This metal is scanned for elemental composition and concentration to determine alloy type. This information is then used in conjunction with previously scanned processing and conveying equipment. By cross referencing the metal detector or magnet location in our system, the XRF scans of processing and conveying equipment and the XRF scans of metal found from the metal detector reject or magnet findings we are able to better to direct our resources to areas matching the metal found on our metal detectors and magnets. This process is call positive material identification (PMI). American Crystal Sugar East Grand Forks has reported an 82.7% decrease in the number of cars placed on hold due to metal from FY14 to FY16.

BOUCHE CATHERINE, ITECA SOCADEI, 445 Rue Denis Papin, 13592 Aix-en-Provence, France. **Optimization of White Sugar color management through the utilisation of on-line color cameras**

Ensuring a factory can produce white sugar that meets the solution color demands of its customers' is a key focus for any sugar factory operation. Managing the process to minimise the financial impact of those demands is always challenging and the default position tends to be to over wash the sugar, thus allowing for variations within the process as a consequence of reacting to laboratory generated data.

The paper describes how on-line ITECA color cameras are used to reduce process variability around a pre-defined color set point to guarantee that the final product always remains within specification. It also presents financial savings achieved by optimizing the wash water volumes, detecting out of specification production and reducing the amount of remelted sugar.

BRICHANT, DAMIEN*[1] and BHATT, JOHN[2], [1]Novasep Inc, 23 Creek Circle, Boothwyn PA 19061. **NRS: Thin Juice Softening by Ion Exchange and it's success in Europe**

The NRS (New Regeneration System) process has been used worldwide for more than 30 years with more than 100 systems in operation, especially in Europe. It is the very first choice of the beet sugar manufacturer when a new deliming plant is installed. Well proven technology, NRS systems are environmentally friendly, with no dilution, no sugar losses and no waste. NRS systems are easy to operate, quite forgiving and require very little maintenance, out of campaigns. No acids are used and there are no additional water requirements. With NRS, we will especially focus on strong acid cation resins which present the unique feature of salt conversion reactions and the thin juice softening. The salt conversion process is based on selective affinities for different ionic species. The decalcification of beet thin juice is a necessity in order to avoid evaporator scaling by calcium carbonate, oxalate or silicate resulting in high energy consumption, while it offers additional benefit of significantly lowering sugar turbidity. Different techniques have been used to reduce the scaling. The most common ones are the use of anti-scaling agents and more frequently cationic ion exchange resins. The industry has developed several routes using ion exchange resin and NRS environmental friendly process has been by far the most successful in Europe.

CARLSON, JEFFREY L, Southern Minnesota Beets Sugar Cooperative, 83550 County Road 21, P.O. Box 500, Renville, MN 56201. **Applying Control Charts to Beet Sugar Factory Operations.**

Control charts can be a powerful tool for achieving and maintaining statistical control of a process, identifying important causes of variation, running process capability studies and achieving a better understanding of a process. However, there are several problems in applying them inherent to beet-sugar factory operations. These include the high variability seen in the beet juices and in production conditions, the difficulty in choosing the appropriate sampling plan for large vessels, the cost of analyses, and how to deal with batch pans. This paper reviews the literature and discusses potential solutions for these problems including rational subgrouping, control charts without subgrouping, X and moving range for batch processes and moving averages. Some beet sugar examples are given.

CARLSON, JEFFREY L* AND JAMES SCHUELLER, Southern Minnesota Beets Sugar Cooperative, 83550 County Road 21, P.O. Box 500, Renville, MN 56201. **Ammonia nitrogen sources, treatment and discharge at Southern Minnesota Beet Sugar Cooperative.**

Increased scrutiny on nitrogen in the Mississippi watershed and proposed new nitrogen limits discharges to water requires a thorough understanding of nitrogen sources and treatment options in beet sugar production. A survey of nitrogen sources at Southern Minnesota Beet Sugar Cooperative revealed the nitrogen was initially coming from the beets, from the biocide ammonium bisulfite and the pH modifier, ammonium hydroxide. The ammonia, nitrate and glutamine-glutamic acid concentrations were measured in the process and waste streams including discharges from the wastewater treatment. Ammonia created from glutamine amide nitrogen hydrolysis was 95% complete through evaporation. The ammonia-N concentration on RDS increased throughout purification. Over 95% of the ammonia in the juice was lost during evaporation with over 75% of it being transferred to the condensates. The ammonia transferred to the condensate was treated through land application or nitrification in the SMBSC activated sludge system.

CHUDASAMA, ARVIND, International Sugar Journal, Agribusiness Intelligence, Informa, Christchurch Court, 10-15 Newgate Street, London, EC1A 7AZ, UK **Investment activity in the global sugar sector during 2013 to 2016**

Consensus from the industry analysts is that the demand for sugar is expected to top 200 million tonnes by 2020 from the current (2016/17) 175 million tonnes. Brazilian sugar industry, which was meant to supply bulk of the rising demand has been crippled by debt, with some 80 factories closing down and quite a few seeking bankruptcy protection. In the recent past, the key driver for new investment activity has been in regions structurally deficit in sugar - namely Africa and Asia. With the abolition of sugar quotas in the European Union in September 2017, quite a few of the progressive, large companies are gearing up expansion in sugar production. This paper provides an overview of investment trends in the global sugar industry over the past few years gleaned from news reports.

EMERSTORFER, FLORIAN[1*] , KOHOUT, CORDULA K. [1], ,REBEKKA R. REINER [1], CHRISTOPHER SHELSWELL [1],, JASON M. GRECH [2] and JOHN FORTE [3], [1]ARIC GmbH, Josef-Reither-Straße 21-23, 3430 Tulln, Austria, [2]BetaTec Hop Products Ltd, Stanford Park, Stanford Bridge, Worcestershire, WR6 6SG, England and [3]BetaTec Hop Products Inc. 5185 MacArthur Blvd. N. W., Washington, D.C. 20016. **Investigation of hop alpha acids for the use in the sugar factory.**

Microorganisms (MOs) can enter the process of sugar production through different ways and can lead to economically significant sugar losses and other problems. Hop acids, especially hop beta acids are already used in the sugar industry since 1994. Due to their similar antimicrobial activity, the upcoming question is if alpha acids can be used in the sugar industry as well. Therefore, three different hop products based on alpha acids provided from BetaTec were tested to evaluate their effect on the microbiological flora in the extraction area. In the next step their effect on the sensory integrity of the white sugar and the concentration in the white sugar after laboratory crystallization were determined.

All three tested products show an effect against microorganisms in raw juice with a difference in the required active concentration and the length of effectiveness. The concentration of all three hop products in laboratory produced crystalline white sugar was lower than the sensory relevant concentration. This concentration could not be recognized significantly in a 10 % sugar solution.

These lab scale results give a promising forecast for the application of hop alpha acids in the beet sugar industry.

HOLCOMB, TRENT D., Amalgamated Sugar Company, 138 W. Karcher Road, Nampa, ID 83686. **Proper operation and optimization of a continuous centrifugal through continuous inline monitoring of sugar color.**

Recycling of color bodies when processing low quality beets/juice needs to be limited in order to make high quality sellable sugar. There is always a balance between sugar color and molasses purity when the sugar is being returned to the standard liquor melter. The installation of a Neltec inline color monitor has given us the ability to reduce the variation of the sugar going to the melter and also allowed us to achieve the lowest possible color without sacrificing molasses purity. Standard deviations were decreased from 156 ICUMSA to 60 and 165 to 118 on the high raw and low raw sugars respectively. Lowering low raw sugar from 550 to 300 color will reduce the non-sugar recycle by 1.70% which is a reduction of 40%, with no adverse effects to molasses purity. The secondary benefit is the proper operation of the centrifugal allowing us to determine optimum feed rate and optimum application position for water and or steam addition, e.g. turbo, neck, bottom or top sprays. This optimization gives the best distribution of the massecuite on the centrifugal screen, which is also conveyed from the inline instrumentation.

HOWE, MIKE*, ROYCE, STEPHEN, RHOTEN, CHRIS, BLOWERS, ROBERT. Bury St Edmunds Sugar Factory, Hollow Road, Bury St Edmunds, Suffolk, IP32 7BB. **Factory Trial Dorr versus BMA65 .**

British Sugar uses Dorr Carbonatation as a method for beet raw juice purification. This purification technique has remained unchanged in British Sugar for many years whilst others have reviewed and installed classical purification processes. The classical purification process incorporates a 'hot liming stage' that results in juices of lower colour and increased thermostability however the downside is a loss of 'physical properties' namely settlement and filtration. British Sugar intend to carry out a trial that incorporates a 'hot liming' process using the BMA65 purification principles at their Bury St Edmunds factory during the 2016/17 Campaign with the objective to directly compare the two purification methods. The paper discusses the results and observations made during the trial.

HOWE, ROBERT*, ROWLAND, PHILIP, HAYNES, CARLTON, MOANE, ROBERT W. WISSINGTON Sugar Factory, College Rd, Stoke Ferry, Kings Lynn, Norfolk, PE339QG. **The Drive for Cossette Perfection.**

It is often said that the efficient manufacture of sugar from sugar beet all starts with cossette quality. Of course, theoretically that is correct but in reality, when you look at process efficiency it is fundamental pre-requisite. It is well known and researched that differences in the quality of cossettes can affect extraction losses, pulp pressing, energy and purification performance. Anyone who has worked in or managed beet sugar factory operations will have an opinion on what makes a good cossette and what good cossette quality should look like. Recognising this challenge, during the 2015/16 Campaign British Sugar, Wissington Factory embarked on a project to improve cossette quality. The initial problem statement was focussed around reducing energy usage through draft reduction, however this project would be just as relevant for identifying extraction benefits by means of changes to diffusion losses. It became apparent that cossette quality was extremely variable and also difficult to measure with any degree of accuracy. Lean Sigma tools and techniques were utilised to improve measurement systems, with a particular focus on slicer maintenance and setup, knife sharpening quality, Autowrench setup and knife position. This paper discusses the work that has been carried out in this area.As well as reducing variation in our measurement system, we have also introduced some additional KPIs that are helping us to better understand process interactions. These include cossette cross-sectional score to understand cossette 'V' formation, measurement to estimate average cossette length, monitoring of 74° fraising thickness of re-sharpened knives. Towards the end of the 2015/16 Campaign confidence in the data collected allowed for more aggressive slicer settings, and ultimately realised a 4% drop in draft ratio across the three diffusion

streams during this period. Although difficult to measure in such a complex process, we now feel that we have a process in place to effectively monitor and adjust our settings based on simple statistical process control.

HUENERLAGE, MICHAEL[1*]; OLIVER ARNDT[1]; FLORIAN REISSIG[1] [1]Eberhardt GmbH, Am Bauhof 21, 32657 Lemgo – Germany **Lime Kilns: Retrofit technologies and their advantages in the sugar industry**

Eberhardt GmbH, located in Germany, has a 155-year long experience in design and construction of lime kiln, milk of lime plants and surrounding equipment technologies. The company is globally active in lime, PCC, soda ash and – of course – in the sugar industry.

On the occasion of the ASSBT 2017 conference Eberhardt would like to present following topics to the audience: Inventions and improvements of retrofitting vertical mixed feed kilns focusing on a wide bandwidth of limestone fractions with a maximized planarity of the filling level by rotating or static distribution systems as well as optimized fuel distribution through new skip charging systems. Mechanical design and operation capabilities of hydraulic driven discharge equipment with its volumetric material movement. Review of the advantages in production and process in shaft kilns. Successfully implemented at Michigan Sugar - Bay City in 2016. Optimization of the exhaust gas CO_2 concentration in vertical lime kilns regarding to the demands of the sugar industry. How to gain 40%+ of carbon dioxide gas purity in mixed feed kilns. As well as achieve performance improvement through gas analysis. Successfully implemented at Rogers Sugar - Taber in 2014. Increasing the production and health safety of skip hoist systems by retrofitting an integrated state of the art control system to existing hoisting machines with different options like automated brake tests and conversion to frequency converter drives. Successfully implemented at American Crystal Sugar - Hillsboro in 2014.

HULLEY, SEAN and MOOR, BRUCE ST.C., Bosch Projects, 1 Holwood Park, 5 Canegate Rd, La Lucia Ridge Office Estate, PO Box 2009, Durban 4000, KZN, South Africa. **A compact horizontally configured vertical tube continuous pan for high grade beet and cane sugar**

The most common and successful continuous vacuum pans (CVPs) for high grade sugar massecuites are vertical tube units, either horizontally configured or a stacked series of stirred batch pans. Horizontally configured CVPs are widely preferred in the cane industry because of their better crystal uniformity, lower maintenance and lower energy usage (no pumping or mechanical stirrers), but beet factories have opted largely for stirred stacked pans – possibly because of their smaller footprint and/or facility of partial on-line cleaning.

To meet these demands, Bosch Projects has now developed a stacked arrangement of horizontally configured split CVPs. This paper describes their new twin stacked CVP, which offers a small footprint and limited massecuite pumping requirement while retaining the unique advantages of their well proven horizontally configured design. The compact arrangement enables sets of four (of sixteen) compartments to be taken off line for boiling out while continuing to operate with good plug flow through the other twelve.

Results are quoted of evaporation rates, exhaustions and sugar quality achieved in existing twin (split) pans of this type. These results give confidence that a stacked pair of such pans will meet all the requirements for both high and low grade boilings in the beet industry

KOCHERGIN, VADIM *, M. SCOTT BRANDON, STAN CASE, TRENT HOLCOMB, Amalgamated Research LLC, 2531 Orchard Dr. E., Twin Falls, Idaho, USA- **Troubleshooting Molasses Desugarization Installations Using Tracer Tests**

Most beet sugar companies in the USA operate one or several chromatographic installations for molasses desugarization. These large resins based systems (up to 20 ft in diameter) require very efficient fluid distribution across the columns to reduce dispersion of concentration profiles. Potential accumulation of fine suspended solids along with some mechanical issues may cause liquid maldistribution, resin clumping and channeling. Efficiency reduction sometimes happens gradually, and if not caught early enough, cause system

shutdown and resin backwash. Therefore, it is critical to evaluate the methods of early troubleshooting. Tracer (or pulse) testing has been successful for analyzing residence time distribution of liquids in various sugar industry unit operations: vacuum pans, clarifiers, crystallizers, reaction vessels. Tracer is not supposed to interact with separation media. The timing and shape of the response curves are indicative of the flow behavior as fluid passes through the resin beds. A method was developed that introduces a short pulse of concentrated food grade dye into a chromatographic column and measures the dispersion of the dye as it passes through fluid distributors, resin bed and collectors. The method was used for troubleshooting industrial chromatographic installations and proved to be useful for narrowing down. Resulting curves with a very high narrow peak, sharp peak top, and a short trailing edge can serve as an example of good fluid distribution. Several examples of method application for the commercial scale chromatographic and ion exchange systems will be discussed. Use of on-line color analyzer for rapid evaluation of the response curves will be described.

LARSEN, KASPER GEHL[1] and JENSEN, ARNE SLOTH[1], [1]EnerDry A/S, Kongevejen 157, 2830 Virum, Denmark. **Status of ongoing studies of beet pulp feed value improvements by steam drying and latest installations around the world**

Studies conducted by the University of Copenhagen, veterinarian depart of large animal section and EnerDry has proven that digestibility and thereby the feed value of beet pulp is improved significantly by steam drying. To analyze the feed value, the degradability of beet pulp and associated gas production in the rumen, has been analyzed. In order for the feed to be utilized it must be degraded before 12 hours, or it will be lost. The following was found:

The EnerDry steam drying process increased the degradability of sugar beet pulp over the pressed pulp (freeze dried) raw material during the early stages of fermentation (up to 6-12 hours), while the drum drying process did not or even tended to decrease degradability.

Sugar beet pulp dried by an EnerDry steam dryer has a more rapid rate of gas production and hence degradability during the first 6-12 hours of incubation (app. 40% higher) and reach a higher total degradability after 48 hours of incubation (app. 15%) compared to sugar beet pulp dried by drum drying. The Russian sugar industry is starting to introduce steam drying. The first sugar beet pulp steam dryer in Russia, was an EnerDry size H, which started operation in 2016. Furthermore 2 size J steam dryers will be installed summer of 2018. This will be the world's biggest beet pulp steam drying station with a total capacity of 142 t/h water evaporation

NELSON, MICHAEL L.[1]* and VIDYASAGAR SUNKAVALLI[2], USP Technologies, 900 Circle 75 Parkway, Suite 1330, Atlanta, GA 30339 and [2]SMBSC, 83550 County Road 21, Renville, MN 56284. **A review of SMBSC's hydrogen peroxide dosing program for hydrogen sulfide emissions control within condenser water and high-strength water stabilization ponds.**

SMBSC's facility is subject to a seasonal H_2S limit of 30 ppb along the property line, set by the Minnesota Pollution Control Agency. Complying with this limit presents a challenge since excess condenser and high-strength water from factory operations must be stored on-site for a period of time due to the facility's NPDES/SDS (National Pollutant Discharge Elimination System/State Disposal System) permit allowing only seasonal discharge of the treated water. Storing water with high organic loading could cause potential for H_2S generation. Due to the nature of industry (food), potential chemical H_2S control methods are limited to those designated Generally Recognized As Safe (GRAS) by the American Food and Drug Administration. Since 2014, hydrogen peroxide has been implemented as the primary control method, dosed across the surface of the ponds when needed using the Peroxidon™ program developed by USP Technologies. In this approach, a mixture of pond water and hydrogen peroxide is pumped across floating dosing lines spanning the entire length of the pond. With this oxygen-rich mixture distributed onto the surface of the pond, a layer of oxygenated zone (typically few inches) is maintained where sulfides are oxidized to elemental sulfur before they can volatilize into the air. Furthermore, hydrogen peroxide effectively decomposes into dissolved oxygen in the presence of naturally-produced catalase enzyme. Dosing rate decisions are guided by near daily data collected by

technicians on-site. Monitored parameters include liquid and vapor phase sulfides, dissolved oxygen, oxidation-reduction potential, iron, chemical oxygen demand, pH, water temperature, residual peroxide, precipitation, wind speed and direction, and air temperature. Applying this strategy and when the system is continually dosing, hydrogen sulfide emissions could be controlled and maintained below the limit.

REICHLING, JEAN-MARC, Solex Thermal Science, 250, 4720-106 Ave SE, Calgary, Alberta, T2C 3G5, Canada. **Case study: improved operation with solex technology in sugar cooling**

This paper details the installation and operation of a Solex Thermal sugar cooler that replaced an existing fluid bed cooler at the Polish Glinojeck sugar factory (Pfeifer & Langen Polska S.A.). The Solex cooler uses plate and frame technology with the sugar flowing en masse with no movement between sugar crystals. The plate and frame technology uses water and indirect heat transfer to cool the sugar. Since water is a much better heat transfer fluid than air which is used in rotary drum and fluidized bed technology, a significant reduction in energy consumption can be experienced. The results of this case study show that cooling with Solex Thermal technology uses only approximately 25% of the energy that was used with the fluid bed technology.

SCHOENFELDER, CARL J.*, DENTON, ROBERT J., Hydrite Chemical Company, 300 N. Patrick Blvd, Brookfield, WI 53045. **Improving Sugar End Vessel CIP Results with Specialty Chemical Additives.**

Conventional clean in place (CIP) regiments for high temperature syrup vessels in the beet sugar industry implement some variation of a caustic and/or acid addition protocol. While this protocol remains effective on its own, time constraints that impact plant efficiency and the presence of heavy, difficult deposits present challenges to the conventional approach. Using vapor pressure drop, temperature profiles, inline coupons, and other predictive markers, an accurate prognosis of the internal condition can typically be established without opening the equipment. With fouling severity of the vessel or heat exchanger understood, the CIP solution and protocol can be tailored to yield maximum effectiveness. Chemistries with multiple chelating agents have shown to provide further effectiveness, particularly with calcium carbonate and calcium oxalate. When aggressively targeting the scale, the CIP process is monitored to ensure a sufficient residual level of chelating agent is present, while remaining sensitive to the potential of stripping metal from the equipment being cleaned. In regularly monitoring the specialty chemical cleaning process, the CIP solution is adjusted to optimize deposit removal while still protecting the equipment being cleaned. Three trials at separate beet sugar cooperatives have been conducted in 2015-2016. The augmentation of these chelating chemistries, in conjunctions with improved application guidelines and testing methodologies, have yielded significant increase in the amount of material removed as well as the rate of removal of scale material. This has consequently negated or minimizing the need for high pressure water cleaning, as well as ensuring the equipment is returned to baseline service with minimal downtime.

SCHUELER, JOHN [2*], KLEIN, NICK[1], MICHAEL L. NELSON[2], and GARY WITZGALL[1], [1]Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI 48706 and [2]USP Technologies, 900 Circle 75 Parkway, Suite 1330, Atlanta, GA 30339. **Odor control of mud ponds using hydrogen peroxide dosing with the Peroxidon™**

Michigan Sugar's Bay City facility focuses on minimizing nuisance odors, employing many of the latest technologies and approaches. Wastewater first enters a clarifier, then a series of mud ponds, then an anaerobic digester, followed by a series of aeration ponds before final discharge. The mud ponds presented the greatest challenge for control due to the large surface areas, high solids concentrations, fluctuating loadings and different odorants present. The mud ponds were found to have a predominance of sulfur-based odorants, including hydrogen sulfide and mercaptans. USP Technologies evaluated a series of odor control agents and

selected 50 percent hydrogen peroxide as the most cost-effective option. Using the Peroxidon™ dosing apparatus a mixture of a small amount of hydrogen peroxide and 300 gallons/minute of pond water was continuously applied across the surface of the final mud pond. This established a zone of oxidation on the pond surface, through which compounds such as hydrogen sulfide and mercaptans could be oxidized. Furthermore, the catalase-induced decomposition of hydrogen peroxide provided increased dissolved oxygen concentrations, theoretically improving bio-mediated removal of other odorants. In the first stage of the trial continuous dosing of the final mud pond at a concentration of 36 mg/L of H_2O_2 reduced the amount of volatilized hydrogen sulfide by 96 – 100% and total mercaptans by 75 – 100 percent. With further optimization H_2O_2 dosed at 9 mg/L reduced the volatilized hydrogen sulfide concentration 98 percent and total mercaptans 100 percent.

WAMBOLT, CAROL L.[1], ALLA A. BAGRAMYAN[1] and DORIS C. FLEMING[1], [1]Amalgamated Research, LLC., 2531 Orchard Drive East, Twin Falls, ID 83301. **Comparison and application of near-infrared (NIR) and attenuated total reflection fourier transform infrared (ATR-FTIR) spectroscopy for determination of betaine in sugar factory samples.**

The use of secondary analytical methods, such as near-infrared (NIR) and attenuated total reflection fourier transform infrared (ATR-FTIR) spectroscopy, for the control of manufacturing processes and product quality, has increased dramatically in the past decade. The interest in these secondary spectroscopic techniques is due, in part, to the fact that they are simple, rapid (< 30 second analysis time) and provide levels of accuracy and precision, comparable to primary reference methods. For this study, NIR and ATR-FTIR spectroscopy was investigated and compared for predicting betaine content. 14 individual factory samples, with betaine concentration ranging from 0.2 - 50.0%, were sampled over a period of time. Each sample was analyzed with the primary analytical method, high performance liquid chromatography (HPLC), then NIR and ATR-FTIR spectra of the same samples were collected. Chemometric approaches were used to analyze spectral data, correlate it with primary method results and generate multivariate calibration models to predict betaine concentration. The predictive performance of the NIR and ATR-FTIR calibration models will be discussed.

ASSBT BIENNIAL MEETINGS THROUGH 2019

	Location	Dates
1	Salt Lake City, UT	January 11-13, 1938
2	Denver, CO	January 4-6, 1940
3	Salt Lake City, UT	January 5-7, 1942
4	Denver, CO	February 12-14, 1946
5	San Francisco, CA	January 12-15, 1948
6	Detroit, MI	February 6-9, 1950
7	Salt Lake City, UT	February 5-8, 1952
8	Denver, CO	February 2-5, 1954
9	San Francisco, CA	January 31- February 3, 1956
10	Detroit, MI	February 4-6, 1958
11	Salt Lake City, UT	February 2-5, 1960
12	Denver, CO	February 5-8, 1962
13	San Francisco, CA	February 3-6, 1964
14	Minneapolis, MN	February 21-24, 1966
15	Phoenix, AZ	February 19-23, 1968
16	Denver, CO	February 22-26, 1970
17	Phoenix, AZ	February 27 – March 2, 1972
18	San Diego, CA	February 24-28, 1974
19	Phoenix, AZ	February 22-26, 1976
20	San Diego, CA	February 26 – March 2, 1978
21	San Diego, CA	February 22-26, 1981
22	Phoenix, AZ	February 20-24, 1983
23	San Diego, CA	February 24-28, 1985
24	Phoenix, AZ	March 1-5, 1987
25	New Orleans, LA	February 26 – March 2, 1989
26	Monterey, CA	February 24-27, 1991
27	Anaheim, CA	March 3-6, 1993
28	New Orleans, LA	March 8-11, 1995
29	Phoenix, AZ	March 2-5, 1997
30	Orlando, FL	February 10-13, 1999
31	Vancouver, BC	February 28 – March 3, 2001
32	San Antonio, TX	February 26 – March 1, 2003
33	Palm Springs, CA	March 2-5, 2005
34	Salt Lake City, UT	February 28 – March 3, 2007
35	Orlando, FL	February 25-28, 2009
36	Albuquerque, NM	March 2-5, 2011
37	Anaheim, CA	February 27 – March 2, 2013
38	Clearwater, FL	February 23 – 26, 2015
39	Greenville, SC	February 27 – March 2, 2017
40	Anaheim, CA	February 25 – February 28, 2019