ABSTRACTS

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ANDERSON, JAY F.*, PETER J. REGITNIG and BRYAN R. AVISON, Lantic Inc., 5405 - 64 Street, Taber, Alberta, T1G2C4 **Spring nitrogen application strategies in sugar beets in Alberta.**

Significant sugar beet stand loss has been observed after spring broadcast applications of urea prior to seeding in previous Alberta sugar beet trials. Four years of testing was conducted between 2013 and 2016 to further evaluate crop safety and production when various spring nitrogen strategies were used. Pre-plant incorporated (ppi) and post-emergence (post-e) nitrogen fertilizer was applied in the form of granular urea (46-0-0), Environmentally Smart Nitrogen (ESN) (44-0-0) or urea ammonium nitrate (UAN) (28-0-0) to experimental plots. A total nitrogen rate of 120 or 150lbs N/acre was targeted for individual treatments based on soil tests. Treatments consisted of entirely one form, two-form blends or split-timing nitrogen fertilizer applications. In 3 out of 4 years, plant stand was reduced significantly by up to 23%when urea was applied ppi 1 to 3 days prior to planting at a 120 or 150lbs N/acre rate, compared to an untreated check; the same rate of ppi ESN resulted in no significant reduction in plant stand. Blending nitrogen forms or splitting urea ppi/post-e also tended to improve plant stand significantly. Urea applied entirely ppi or post-e had the greatest potential to reduce vigour. Environmentally Smart Nitrogen alone, a blend of ppi ESN/urea or a split application of ppi/post-e urea resulted in optimum early season vigour and the most consistent root yield over all the years of testing. Except for quality reductions with in-furrow UAN, none of the spring nitrogen application strategies had any consistent effect on extractable sugar per tonne (EST). In general results suggest that blending nitrogen forms or splitting urea applications are the recommended strategies for improving crop safety and overall production with spring nitrogen fertilizer applications.

BERNHARDSON, DUANE*, ELKE HILSCHER, HEIKO NARTEN and STEFAN MELDAU, KWS SAAT, 1500 South 40th Str. Grand Forks, ND 58201 **Heterogeneity of sugarbeets – challenge for recoverable sugar analysis of grower's field samples.**

To obtain reliable sugar percentage results for a given sugar beet sample (e.g. a truckload of sugar beets) many samples from many beets should be taken. The most error- prone process in sugar beet quality analysis is the preparation of Brei. Investigations of more than 50 years show, that sugar content not only varies within one beet but also between beets. Over this time, the average in sugar content increased from 15% to 18% in Germany which influenced the heterogeneity of beets. For variation of sugar content and impurities within beets, results are shown from two varieties of sugar beets – a higher tonnage variety and a higher sugar content variety. Results for sugar percentage of more than 400 subsamples of one truckload are also presented and shows the variability between beets. The results indicated the importance of sampling, sample size and sample preparation for reliable quality analysis of sugar beets. The common method in sample preparation and analysis requires a central lab, a logistics system for samples and trained employees; it causes chemical waste and takes time before a result is obtained. An innovative approach to analyze the full heterogeneity of sugar beets in 20 seconds is presented. This technology is based on a diode array-NIRS- spectrometer, works automatically, is mobile and can be implemented in sugar factories. The method consists of a chopper which chops the 20-40 kg of sugar beets in a few seconds in small, uniform pieces, a NIR- spectrometer scans the surface of chopped beets in flow in 20 seconds, and more than 400 measurements are made per sample and the whole heterogeneity of the beet samples are captured. Chemometric methods were used to analyze spectral data and correlate it with conventional methods of sugar beet analysis in the quality laboratories of KWS. Multivariate calibration models were developed to predict recoverable sugar. The predictive performance of the NIR calibration models will be discussed on examples of sugar beet growing areas worldwide.

BISCHER, DENNIS, Michigan Sugar Co., 122 Uptown Drive, Suite 300, Bay City, MI 48708 **Alternaria Leafspot, Control Measures and Fungicides.**

Alternaria leafspot has become a significant disease for the Michigan growing area. Various fungicides were applied to a susceptible variety to test each for their efficacy on Alternaria leafspot. Sugarbeet leaves from the various treatments were rated for their Alternaria leafspot damage. The results indicate that some fungicide classes differ in their efficacy for Alternaria leafspot control.

BLOOMQUIST, MARK W.*[1] and ANDREW W. LENSSEN[2], [1]Southern Minnesota Beet Sugar Cooperative, [2]Dept. of Agronomy, Iowa State University, [1]83550 County Road 21, Renville, MN 56284, [2]Ames, IA 50011 **A replanting guide for sugar beet production in southern Minnesota.**

Establishing an adequate population of sugar beets is one of the first challenges of sugar beet production. Reduced sugar beet emergence due to soil crusting, low temperatures, insect damage, or wind damage results in a decision between a lower than desired plant population or replanting the field. The objective of this study was to determine the plant population that warrants replanting a field to maximize extractable sugar per acre and revenue. The study was conducted in three environments during the 2016 and 2017 seasons. Two planting dates and six plant populations were utilized in each environment. The two planting dates were separated by 19 or 20 days to simulate a replant situation. Sugar beets in each planting date were hand thinned to six plant populations of 17800, 23800, 29700, 35600, 41600, 47500 plants per acre. Planting date and plant population did not significantly affect sugar concentration. Planting date and plant population did significantly affect yield, extractable sugar per acre, and revenue per acre. Extractable sugar per acre and revenue per acre was maximized with the first planting date and plant populations of 41600 and 47500 plants per acre. A plant population of 23800 plants per acre in the first planting had similar extractable sugar per acre and gross revenue per acre to second planting date plant populations of 35600, 41600, and 47500 plants per acre.

GUZA, COREY and JAMES STEWART, Michigan Sugar Company, 133 Uptown Dr., Suite 300, Bay City, Mi 48708 **Evaluating Sticker Spreaders for Leafspot Control.**

Sticker Spreader adjuvants were evaluated over three years for the effectiveness in improving leafspot control with fungicides. Generally, the adjuvants improved leafspot control.

KAFFKA, STEPHEN* and RON THARP. 1Department of Plant Sciences, University of California, Davis, CA 95616; 2Spreckels Sugar, Brawley,CA. **Yield Progress, Yield Gaps and Resource Use in Sugarbeet Production in the Imperial Valley of California.**

The Imperial Valley (IV) is a low desert ecosystem with mild, sunny winters and hot summers. It receives the largest amount of sunlight of any location in the United States. Most soils are high in pH and calcareous, with large amounts of naturally occurring gypsum. The majority of fields are tile drained at 2m in depth. Subsurface drainage maintains positive salt balances in the IV soils. Season-long irrigation is necessary for the beet production season from September to mid-July. Crop ET_C is approximately 1200 to 1500 mm for a 10 month crop. Beet harvest starts at approximately 180 days in early April and continues to mid-July (260 days). Starting in the 1990s, root yields rose at the rate of ~ 1.9 t/ha/y, and sugar yields by approximately 0.4 t/ha/y, while sugar concentration has varied around a stable mean, which declines with each month of harvest, as does root quality. Monthly dry matter accumulation during the April to June period has increased significantly during this period compared to earlier periods. Yield increases are attributed to a variety of interacting factors: 1. improved performance of new hybrids, including improved rhizomania resistance; 2. reduction in losses to lettuce infectious yellows virus starting in the early 1990's; 3. better control of weeds; 4. the adoption of newer style harvesters allowing for harvest from moister soil, (also permitting irrigation closer to harvest); 5. better management and timing of late season irrigations during the hottest weather; 6. improved seed quality and stand establishment practices; and 6. a partial shift to production on better quality soils in recent years. Individual field-scale root and gross sugar yield records continue to be observed for full season beet crops (9 to 10 months). Averages for the 8 largest contracts during 2015 and 2016 crop years were: (2015) 173 t/ha roots and 25.6 t/ha sugar, and (2016) 160.7 t/ha roots, 24.0 t/ha sugar. The largest yield observed at a field scale (30 ha) to date was 199.2 t/ha roots and 27.2 t/ha sugar in 2015. These high yields are similar to those observed from the leading sugar beet varieties in tests in the IV so the yield gap between potential and actual yield in the IV is declining.

KNISS, ANDREW R.*[1], LAWRENCE, NEVIN C.[2] and ADJESIWOR, ALBERT T.[1], [1]University of Wyoming, [2]University of Nebraska, [1], [1] **HerbDiv – A Web Application to Quantify Herbicide Program Diversity for Herbicide Resistance Management.**

LAMICHHANE, JAY-RAM*, JULIE CONSTANTIN, JEAN-NOEL AUBERTOT and CAROLYNE DÜRR, INRA, UMR 1248 AGIR, F-31326 Castanet-Tolosan, France **Will climate change affect sugar beet crop emergence of the 21st century? Insight from a simulation study.**

Climate change will result in increased mean temperature, precipitation variability and altered frequency of extreme temperature events in many regions of the globe, including Europe. While many studies focused on evaluating the impacts of climate change on crop yields, there is less detailed information about the potential effect of climate change on crop establishment, although it is a crucial stage of the annual crop cycles. This prevents stakeholders from mobilizing adaptation strategies which may be helpful to attenuate climate change effects. Rather small adjustments (e.g. changes in varieties, sowing date and density, tillage or pest management) in contrast to more systemic changes (e.g. changes in crop sequences; moving from dryland to irrigated systems or from spring to autumn sowings) may ensure successful crop establishment. Exploration of adaptation strategies to climate change using process-based models allows crop-level evaluation and adaptations of existing cropping systems. Here we used a model-based framework, to evaluate changes in germination and emergence as well as bolting rates of sugar beet crop related to climate change in Northern France. We used the most pessimistic IPCC scenario (RCP 8.5) to generate soil temperature and water content of the seedbed using the STICS crop model. We used the data obtained to feed the SIMPLE crop emergence model. A total of 810 sugar beet emergence simulations were performed for a period 2020-2100, taking into account five sowing dates (mid-February,1st March, mid-March, 1st April and mid-April) and two sowing depths (normal and superficial). First, our results provided information on the changes

that will occur in future sowing conditions. The predicted cumulative rainfall for 30 days after sowing will be increasingly variable over time especially for the earlier sowings (Feb – March), with an increasing frequency of values lower than 20 mm and over 80 mm after 2050. The average maximum air temperature of the 30 days post-sowing will increase from 10°C to 12°C for the earliest sowing (mid-Feb.), with frequent values over 12°C after 2050. Second, despite the increased average temperatures, the simulated sowings indicate that the risk of reduced seed germination will remain high, with final germination rates lower than 50%, for the earlier sowing dates: 16 and 12 years out of 81 simulated for crop sown on the 15th February and 1st March, respectively. However, the use of primed seeds can alleviate this risk. The predicted bolting rates will remain very low, even for the earliest sowing dates. Overall, our results indicate that, in the future, sugar beet crop can still be sown earlier in spring than what occurs nowadays, but the risk of establishment failure will remain quite high. These simulation results are useful to visualize the sowing conditions of the coming decades and pinpoint adaptive strategies for farmers. This analysis could not be possible without simulation models.

LARSON, EMMA L.*[1], MICHAEL S. METZGER[1], THOMAS J. PETERS[2] and ALEXA L. LYSTAD[2], [1]Minn-Dak Farmers Cooperative, [2]North Dakota State University and the University of Minnesota, [1]7525 Red River Road, Wahpeton, ND 58075, [2]NDSU, Dept 7670, PO Box 6050, Fargo, ND 58108-6050
Sugarbeet Sensitivity To Dicamba At Low Dose.

Dicamba-tolerant soybean were planted at increasing frequency in close proximity to sugarbeet fields in Minnesota and North Dakota. There is currently insufficient knowledge available to advise sugarbeet growers of the effects from off-target movement of dicamba. The purpose of this experiment was to evaluate sugarbeet sensitivity and to measure for accumulation of residues in leaf and root from dicamba off- target movement to a neighboring sugarbeet field, separated by 12-, 24-, 48-rows, and beyond. Experiments were conducted at two locations in 2017 and 2018 using a randomized complete block design with up to six replications at each location. Treatments were 1/10, 1/33, and 1/100 of the labeled dicamba rate for soybean application. Results indicate that conventional soybeans are more susceptible to dicamba as compared to sugarbeets. Regardless of application rate, sugarbeet leaves were prostrate to the ground a few hours after pesticide exposure and leaf petioles exhibited varying levels of epinasty. Symptomology in younger plants (4-6 leaf stage) included fused petioles and 'trumpeting'. At the highest concentration, leaves did not recover and remained prostrate to the ground for the remainder of the growing season. New leaf growth generally resumed around six to ten days after exposure, with the new leaves having crinkled leaf margins, parallel veins, or leaf strapping. Assessments of canopy density indicated a 45% and 30% reduction when subjected to the 1/10

rate, respectively. Residue analysis of sugarbeet tissue indicated the active ingredient was present in early leaf samples but was not detected at harvest. Pesticide residues were not detected in root samples at either sampling period. Root yield, recoverable sugar content, and purity decreased as dicamba dosage increased.

LAUDINAT, VINCENT, ITB (Institut technique de la betterave), 45 rue de Naples 75008 Paris (France) **Syppre project: design cropping systems to meet European agricultural challenges by 2025.**

Syppre project's, launched in 2014, primary aim is multiperformance, i.e. improving the productivity of arable farming systems while meeting the quality criteria required by the markets, improving their profitability and robustness to cope with meteorological and economic fluctuations, ensuring downstream industrial activity, and environmentally caring practices expected by our civil society and government. The project's core is, by totally rethinking our crops and their rotations at regional levels, the setting of long term experimental devices to test innovative crop systems in real conditions, and at full scale, after a first step of reflexion and conception within regional expert groups. The issue is to design industrial crop systems that can meet the Syppre objectives of global production improvement, economical sustainability, reduction of pesticide treatment frequency index (TFI) by 50%, decrease of mineral nitrogen inputs by 20% and increase of soil organic matter. Sugar beet cropping takes place in two French regional implementations of the Syppre project, in Picardie and Champagne. Syppre is a cooperative project, set up and carried out by the three French field crop technical institutes, Arvalis-Institut-du-vegetal (cereals), Terres-Inovia (oilseeds) , ITB (sugarbeet), at a national scale. These institutes have expertise on individual crops that they pool to offer knowledge and innovation at crop system's level, which can be extended up to a 10 year cycle. The first step of Syppre program is achieved. The conception and multi criteria evaluation methodology will be shortly overviewed. Several innovative sugar beet crop systems that have been designed will be described and multi criteria evaluation results will be presented. The first data from crop systems field trials will be analysed.

LAWRENCE, NEVIN, C., Clint W. Beiermann. University of Nebraska-Lincoln, 4502 Avenue I, Scottsbluf, NE 69361 **Glyphosate-resistant Palmer amaranth: what can we do for control in sugar beet?**

Glyphosate-resistant Palmer amaranth has been increasing in abundance within the sugarbeet growing area of Western Nebraska. Multiple trials have been ongoing in Scottsbluff, NE to evaluate existing and potential novel PRE and POST herbicides products for control of Palmer amaranth. Initial trial work has shown promising results form group 15 herbicides applied as layby treatments POST. However, effective PRE and POST herbicides have not been identified. Desmedipham and phenmedipham have shown promise in controlling Palmer amaranth in other regions of the US, however field trials in Nebraska have indicated possible metabolic resistance to both herbicides.

LYSTAD, ALEXA*[1], PETERS, THOMAS[1] and SPRAGUE, CHRISTY[2], [1]North Dakota State University, [2]Michigan State University, [1]Plant Sciences Dept. 7670, PO Box 6050, Fargo, ND 58108-6050, [2]Dept. of Plant, Soil, and Microbial Sciences, 1066 Bogue St., Room 466, East Lansing, MI 48824-1325 **Sugarbeet tolerance and rotational crop safety from ethofumesate 4SC applied postemergence.**

Willowood USA received regulatory approval to increase Ethofumesate 4SC rates up to 4.2 kg ha-1 postemergence in sugarbeet in 2017. Ethofumesate 4SC at greater rates, tank-mixed with glyphosate, may increase burndown and season-long control of broadleaf weeds in sugarbeet including waterhemp (Amaranthus tuberculatus). Experiments conducted in 2017 in North Dakota, Minnesota, and Michigan determined sugarbeet growth and development when ethofumesate application was timed to calendar dates representing 9, 10, and 11 month intervals between sugarbeet and crops planted in sequence with sugarbeet. Sugarbeet growth, root yield, percent sucrose, and recoverable sucrose were not affected by ethofumesate or timing of ethofumesate application. Experiments conducted in 2018 evaluated corn, soybean, and wheat stand density, growth, flowering date, grain yield, test weight, and moisture percentage of grain at physiological maturity. There was no corn, soybean or wheat injury during vegetative growth and preliminary harvest data indicates soybean and wheat were not affected by previous crop treatment.

MAHARJAN, BIJESH*, HERGERT, GARY and PANDAY, DINESH, University of Nebraska-Lincoln, 4502 Avenue I, Scottsbluff, NE 69361 **Coal Combustion Residue from a Sugar Factory: A Potential Soil Amendment.**

Coal Combustion Residue from a Sugar Factory: A Potential Soil Amendment. In western Nebraska, crops are often grown in fields that have been leveled for irrigation, intensively farmed or have been affected by wind and water erosion, all of which can decrease soil organic matter (SOM). Lack of SOM is a significant indicator of a degraded soil. When grown on degraded soil, plants are prone to less vigorous foliar growth, chlorosis, poor root development, and poor emergence due to soil crusting. Furthermore, lighter colored soils low in organic matter warm up slower and have less potential to produce nutrients from mineralization. Many intensively cultivated soils in the Great Plains have lost 30 to 50% of the original SOM level. Soil organic matter affects many soil physical, chemical, and biological processes and properties. Increased SOM reduces compaction risks and improves soil structure, water holding capacity, cation exchange capacity, and microbial activity. Soil organic matter loss can be particularly negative in coarse-textured soils like many of those in western Nebraska. Restoring SOM lost is a high priority to enhance crop production in general. Proper management of SOM may increase crop yields and reduce N losses since it affects soil properties and N cycling. There is a wide range of SOM management practices, including direct addition of high C content materials to the soil. Multiple field research projects are under way to evaluate effects of high C content char application to cropping system that includes sugar beet, corn and dry bean. The char is a coal combustion residue from a local factory in Scottsbluff, NE and it contains around 30% C by weight. Five different rates of char at 0, 3.4, 6.7, 13.4, and 20.2 ton C ha-1 were applied. Laboratory experiment was also conducted to evaluate char effects on environmental nitrogen losses in fertilized soil. This paper will present field and laboratory research data on effects of different rates of char on soil properties, crop yields and nutrient losses.

METTLER, DAVID, Southern Minnesota Beet Sugar Cooperative, 83550 County Rd 21 **Fall seeded cover crop species and establishment timing following Beta vulgaris in southern Minnesota.**

Soil erosion and nutrient loss, particularly nitrogen (N), during the non-crop production part of the year is a wide spread problem across most agricultural production areas in the United States. Areas with short growing seasons, such as the Upper Midwest, struggle to establish cover crops that are affective at controlling soil erosion and nutrient losses. The objective of this study was to determine the best suited cover crop species and planting date to establish a ground cover after sugar beet harvest to reduce erosion and recover N from the soil. Four cover crop species were established at three timings starting the second week of September, the fourth week of September, and the second week of October. The cover crop species used include winter wheat (Triticum aestivum L.), winter rye (Secale cereale L.), and oat (Avena sativa L.) plus an oilseed radish (Raphanus sativus L.). The cover crops were broadcast and incorporated via a field cultivator. Ratings were taken to assess the percent ground cover in the fall. Biomass was harvested to determine yield and N content. Soil samples to a depth of 2 feet were also taken at cover termination in the spring and analyzed for nitrate-N. Of the cover crop species, winter rye produced the greatest amount of above ground biomass (945 lbs/a) and the largest biomass nitrogen content (26 lbs/a). The plots planted to winter rye also had the least amount of nitrate-N in the soil with 26 lbs/a in the surface two feet. All cover crop species had satisfactory establishment when planted in September, but the October plantings were found to be inadequate to prevent erosion or in recovering a significant amount of N from the soil.

METZGER, MICHAEL S.*, EMMA L. LARSON and BRADLEY L. SCHMIDT, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075 **Utilization of Plant Growth Regulators for Suppression of Sugarbeet Root Yield.**

During the last decade, the sugar industry in the Red River Valley of Minnesota and North Dakota has seen a steady upward trend in overall crop yield and quality. These average annual gains are a reflection of the introduction of glyphosate-tolerant cultivars, the agronomic advancements in technology, efficiency and production practices adopted by the region's beet sugar producers. On average, commercial fields grown for Minn- Dak Farmers Cooperative from 2008 to 2017 have experienced an increase in total root yield per harvested acre of 0.98 tons per acre per year. On occasion, these root yield increases have resulted in commercial acres remaining unharvested due to the overall crop volume (tonnage) exceeding the limitations of the cooperative's storage infrastructure and factory processing capabilities. Trials conducted from 2016-2018 investigated the use of two commercially-available plant growth regulators (PGRs) as candidates to suppress late- season sugarbeet root growth without sacrificing overall sugar content or purity. Experiments were arranged in a split-plot randomized complete block design with six replications. Foliar applications of PGRs Ethophon and Atrimmec served as whole-plot treatments and were applied 30 days prior to harvest at their labeled rates of 9 fl oz/A and 2.5 pt/A, respectively. Rates ten-fold of the highest labeled rate for each product were also evaluated. Sub-plot treatments consisted of two commercially-available cultivars per experiment with a total of four cultivars (ACH 352, ACH 830, Hilleshog 4062 and Hilleshog 4302) being evaluated between the three growing seasons. Phenotypic damage (leaf speckling) from the foliar treatments of Ethophon was noted on all cultivars evaluated and a reduction in canopy height was evident across all treatments of Atrimmec. Results indicated sugarbeet tonnage could be significantly reduced utilizing the ten-fold rate of Ethophon and both the labeled and ten-fold rate of Atrimmec. Root yield suppression exceeded four tons per acre in several treatments. Even though the sugar content and purity percentage were both negatively affected by the application of these PGRs, the final sugarbeet yield and quality were such that it would still be economically feasible to harvest and process, resulting in an alternative to leaving a portion of the crop unharvested.

MORISHITA, DON W *[1], JOEL FELIX[2], ALEXIS THOMPSON[1], REBECKA HENDRICKS[1] and JOEY ISHIDA[2], [1]University of Idaho, [2]Oregon State University, [1]Kimberly R&E Center, 3808 N. 3600 E., Kimberly, ID 83341, [2]Malheur Experiment Station, 595 Onion Ave., Ontario, OR 97914 **Evaluating the potential hormetic effect of herbicides on sugar beet.**

Hormesis is a term used by toxicologists to refer to a response of a subject to a sub-lethal dose some kind of introduced agent that results in a positive reaction. It is a phenomenon that has been observed in humans, other animals and plants. With plants, hormesis is the response to an environmental agent characterized by a low dose stimulation or beneficial effect and a high dose inhibitory or toxic effect. The use of this phenomena might be beneficial to sugar beet production if the hormetic effect boosts sugar beet yield or better yet, boosts sugar yield without increasing sugar beet root biomass yield. Field studies were established at the Oregon State University Malheur Experiment Station near Ontario, Oregon and the University of Idaho Kimberly Research and Extension Center near Kimberly, Idaho in 2017 and 2018. The objective of these studies were to evaluate multiple herbicides applied at sub-lethal rates during the growing season to determine if any possess hormesis potential. Hormetic response was determined by measuring sugar beet yield and quality response to the herbicides and applied rates. The treatments selected for this study represented four herbicides from two mechanism of action herbicide groups. Rimsulfuron and florasulam are acetolactate synthase (ALS) inhibiting herbicides. MCPA LVE and fluroxypyr are growth regulator herbicides. The selection of these herbicides was based on a review of the literature where these herbicides or herbicides with the same mechanism of action have demonstrated some level of growth stimulation or increased sucrose accumulation in other crops. The normal use rate for rimsulfuron in potato is 17.5 grams active ingredient per hectare; for florasulam in turf it is 14.7 g ai/ha; for MCPA LVE in small grains it is 370 g ae/ha; and for fluroxypyr in small grains it is 196 g ae/ha. These herbicides were applied at 5 rates equivalent to 10, 1.0, 0.01, 0.001 and 0.0001% of the normal use rate. The study included an untreated control for comparing injury, root and sucrose yield, and quality. The herbicides were applied 30 days before harvest. Visual crop injury was rated two times 7 and 14 days after application. Sugar beet was harvested with a two-row plot harvester. Sugar beet quality samples were determined by the Amalgamated Sugar Company Tare Laboratory. Some visual injury was observed at Kimberly and Ontario with the higher rates of f fluroxypyr and some injury was observed at Kimberly with the highest rate of florasulam. Sugar beet root yield 2017 was not different among treatments at Kimberly, but was different between the control and fluroxypyr and florasulam rates at Ontario. Estimated recoverable sucrose yield in 2017 was higher with one of the rimsulfuron rates and two highest MCPA rates at Kimberly. ERS was also slightly increased with rimsulfuron, MCPA and florasulam at Ontario. Results from 2018 have not yet been analyzed, but will be presented.

PETERS, THOMAS, North Dakota State University, Dept 7670, PO Box 6050, Fargo, ND 58108-6050 **Sugarbeet tolerance and weed suppression with acifluorfen.**

Sugarbeet growers attending the 2018 technical seminars and participating in the Turning Point survey of weed control and production practices reported waterhemp (Amaranthus tuberculatus) as their most important weed control challenge on 237,600 acres or 35% of sugar beet fields in Minnesota and eastern North Dakota. The standard weed control program for fields with waterhemp is application of a preemergence herbicide followed by split application of chloroacetamide herbicides postemergence. There are occasions when 90% or greater waterhemp control is not realized with this waterhemp control program. Desmedipham & phenmedipham or triflusulfuron are effective postemergence herbicides, however, desmedipham & phenmedipham will be phased out and there are biotypes of triflusulfuron resistant waterhemp. Sugarbeet tolerance with acifluorfen at 0.28 kg ha- 1 plus crop oil concentrate at 1.75 L ha-1 was evaluated in 2016, 2017 and 2018 near Horace, ND. Sugarbeet necrosis and growth reduction injury occurred in each environment following acifluorfen, however, root yield and recoverable sucrose reduction was dependent on environment. Waterhemp control was greatest when acifluorfen was applied to weeds less than 15-cm tall. However, common lambsquarters (Chenopodium album) control was poor across application timing suggesting acifluorfen would be tank-mixed with glyphosate for broad-spectrum control. These data suggest that sugarbeet and waterhemp growth stage along with environmental conditions should be taken into consideration with acifluorfen application to achieve effective waterhemp control and sugarbeet safety.

POON, GARY, Vive Crop Protection, 6275 Northam Drive, Suite 1, Mississauga, ON, Canada, L4V 1Y8 **Effect of in-furrow applications of AZteroid FC with starter fertilizer on plant stand and yield.**

AZteroid FC is an azoxystrobin fungicide with best-in-class fertilizer mixing capabilities that allows growers to apply both azoxystrobin and starter fertilizer in-furrow simultaneously, providing reliable disease control and optimizing farming efficiency. Due to the sensitive nature of seed and seedlings, crop safety issues can arise when using crop inputs in-furrow. We conducted trials in 2017 and 2018 to evaluate the crop safety of AZteroid FC applied in-furrow with starter fertilizer. Sugar beet were planted on May 2, 2017 at the University of Minnesota-Crookston Northwest Research and Outreach Center in Crookston, MN. Stand counts were not statistically different between any of the treatments after 22 days indicating that stand establishment was unaffected by in-furrow treatments. There were no statistical differences in the number of plants harvested, recoverable sugar and yield. To evaluate the effect of different starter fertilizers mixed with AZteroid FC, we compared the crop safety of 10-34-0 to Redline (6-12-2), a premium low-salt fertilizer. Sugar beet were planted on May 2, 2018 at the University of Minnesota- Crookston Northwest Research and Outreach Center in Crookston, MN. We found that treatments receiving AZteroid FC and Redline had significantly higher stand count than any of the treatments that received 10-34-0, including the untreated control. These results demonstrate that AZteroid FC has good crop safety when applied in-furrow especially when it is paired with a low-salt starter fertilizer like Redline.

REGITNIG, PETER J.* and BRYAN R. AVISON, Lantic Inc., 5405 - 64th Street, Taber, Alberta, T1G 2C4 **Phosphorus fertilization in sugar beets.**

Broadcast and in-furrow phosphorus fertilizer applications have generally resulted in some level of sugar beet root yield response in southern Alberta soils that are moderately P deficient. Broadcast granular P rates of 60 lbs P2O5/acre resulted in sugar beet root yield increases from 8 to 20% in 4 trials conducted between 2003 and 2007. Planting time in-furrow 10-34-0 applications of 3 US gallons/acre resulted in increases from 2 to 13% in the same trials, with broadcast/in-furrow combinations producing root yield increases from 10 to 25%. Trials were conducted in 2013 and 2014 that included the evaluation of liquid P application under the seed row and an assessment of the P supplying power of precipitated calcium carbonate (PCC) from the Taber sugar factory. Two of four trials had significant root yield responses to applied P, with one trial showing a 13% increase with P applied under the seed row and an 8% increase with PCC application. In 2015 and 2016 an opportunity arose to conduct trials on soil that was very deficient in P. In-furrow P applications of 2 US gallons 10-34-0/acre increased sugar beet root yield from 11 to 34% and yield was increased from 36 to 75% by broadcast granular P applications of 50 lbs P2O5/acre. Broadcast/in-furrow combinations or under the row liquid P applications of 50 lbs P2O5/acre were not significantly different than broadcast granular P alone in these tests on very P deficient soils. Spring applied PCC displayed similar P supplying power as P fertilizer sources in the 2015 and 2016 trials. Root yield increases compared to an unfertilized check treatment ranged from 39 to 85% when PCC was applied at 2.8 and 5.5 ton/ac rates.

SHARMA, VIVEK, University of Wyoming, 747 Road 9, Powell WY 82435
Impact of Irrigation and Nitrogen Management Strategies on Sugarbeet Yield, Evapotranspiration, and Crop Water productivity.

Sustainability of sugarbeet production in arid to semi-arid regions of the Western U.S. including Wyoming is dependent on the irrigation and nutrient management [Nitrogen (N) Application]. As the Wyoming growers are facing significant management (sprinkler vs. surface irrigation) and environmental (spatio-temporal climatic variability) change, improved understanding of interaction of water and nitrogen management and its impact on crop evapotranspiration and crop water productivity (CWP aka. Crop Water Use Efficiency (CWUE)) are needed. Field experiments were carried out in 2016 and 2017 growing season under GPS guided lateral move sprinkler irrigated field at

Powell Research and Extension Center (PREC), near Powell Wyoming. In 2016, two nitrogen application rates of 246 kg/ha (112 kg/ha pre-plant and 134 kg/ha side-dressing) and 168 kg/ha (112 kg/ha pre-plant and 56 kg/ha side-dressing) under three irrigation regimes i.e. fully irrigated (FIT), 75% FIT and 50% FIT were evaluated. However, in 2017 five nitrogen application rates of 112 kg/ha, 135 kg/ha, 201 kg/ha, 246 kg/ha and 280 kg/ha were evaluated under same irrigation treatments (including 112 kg/ha pre-plant for all treatments). The seasonal (April to September) rainfall amount in 2016 and 2017 were 112 mm and 114 mm, compared to long term average of 108 mm. Irrigation was scheduled based on the FIT and 246 kg N/ha treatment. The total season irrigation of 508 mm and 457 mm were applied for FIT treatment. As expected, sugarbeet root yield increased with increasing level of irrigations. In 2016, sugarbeet yields varied from 43 t/ha for 50% FIT and 246 kg N/ha treatment to 68 t/ha for FIT and 246 kg N/ha treatment. Maximum and minimum sugar content of 15.29% and 14.08% was observed for limited irrigation treatment of 75% FIT and 168 kg N/ha treatment and FIT and 246 kg N/ha treatment, respectively. The maximum percentage of sugar loss to molasses (SLM, %) of 1.87 was observed 75% FIT and 246 kg N/ha treatment. In 2017, maximum and minimum sugarbeet yield of 63 t/ha and 26 t/ha was observed for FIT and 280 kg N/ha and 60% FIT and 134 kg N/ha treatments, respectively. Sugar content ranged from 15.26% for 75% FIT and 201 kg N/ha to 13.8% for FIT and 280 kg N/ha treatment. Our results indicate that there is an optimal N level for each irrigation regime, and in general, lower N application rates are required to produce acceptable tonnage and maximum sucrose content at limited irrigation compared to FIT. This is an on-going study and author is still in process of analyzing the effect of varying irrigation and N rates on crop evapotranspiration and crop water productivity.

STEINKE, KURT* and ANDREW CHOMAS, Michigan State University, Dept. of Plant, Soil, and Microbial Sciences, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824 **Modern or Conventional: Comparing Nitrogen Application Strategies for Sugarbeet.**

Nitrogen management strategies have been one focal point within sugarbeet nutrient management research since Michigan Sugar Company began an initiative to improve statewide sugarbeet quality to 19% sugar. In rain-fed production systems with low organic matter soils (i.e., Michigan), minimal N overwinters within the soil for early-spring uptake. Increased spring and summer climate variability influences sugarbeet N response and has prompted growers to seek out alternative N management strategies that increase application efficiency and apply N closer to the plant. Two separate studies were designed to investigate the effect of N strategy on sugarbeet yield, quality, and in-season plant response for 30 inch row sugarbeet. The first field study evaluated six N application methods including pre-plant incorporated, coulter-inject sidedress

(SD) 15 inches from the beet row, Y-Drop surface application SD adjacent to the plant, surface-band SD (layby) 4- 6 inches from the row with a urease inhibitor, streamer nozzle (e.g., raindrop) SD, and stream bar SD. A second field study focused on streamer nozzle N application and investigated this strategy at two N rates, two SD timings, and two carrier volumes. Preliminary results thus far from these studies include: 1) N placement 2 inches beneath and 2 inches beside the furrow provided yield consistency across variable spring and summer weather conditions, 2) dry mid-summer soil conditions limited N movement resulting in few differences in 2017 N strategies, 3) N placement closer to the plant resulted in similar root yield and sugar as coulter-inject N applications, 4) at 2-4 leaf stage, less foliar damage was evident where UAN was blended with water using streamer nozzles however root yield and RWSA decreased where UAN was blended with water as compared to straight UAN, and 5) success of a specific N strategy may depend upon the amount of risk a grower wishes to assume and precipitation frequency and intensity soon after N application.

TARKALSON, DAVID D.*[1], DAVID L. BJORNEBERG[1] and GREG DEAN[2], [1]USDA-ARS, [2]Amalgamated Sugar Company, [1]3793 NORTH 3600 EAST Kimberly, ID 83341- 5076, [2]1951 S. Saturn Way, Suite 100 Boise, Idaho 83709**Evidence for Static Nitrogen Management in Northwest U.S. Sugarbeet Production.**

Nitrogen (N) management is important in sugarbeet production. This paper presents data to support additional research to evaluate a new N management approach in the Northwest U.S. Evaluation of historic data suggest that static N management (fixed N supply independent of yields) may have advantages compared to yield goal-based N management in the Northwest U.S. From early 1970's to 2011, the amount of N supply needed to maximize yields in research studies was within a narrow N supply range of 179 to 204 kg N ha-1. Recommended N supplies (179 to 204 kg N ha-1) have not increased as yields have increased. Evidence suggests that following the past recommendations under current yield levels will likely over supply N. Based on this analysis, a region-wide project has been started to determine if a static N management approach is appropriate.

Agronomy
Poster Presentations

ALDER, CLARKE and Evan Sonderegger. The Amalgamated Sugar Company, 138 West Karcher Road Nampa, ID 83687 **Sugarbeet roots – a deeper look.**

The depth of sugarbeet roots has always been a subject of fascination among scientists and farmers alike. Beginning in spring 2017, the Sugarbeet Quality Improvement Department of The Amalgamated Sugar Company LLC dug two root pits, one at the Dry Lake – Nampa, ID location and one at the Suchan – Paul, ID location. In 2018, four more root pits were dug across the state of Idaho. The objectives of the pits were 3-fold:

Gain and provide education for growers on the potential for sugarbeet roots to grow very deep during a single season through visual demonstration,

Provide an educational view of a representative soil profile for the particular growing area where the pits were dug,

Help provide and understanding of the potential for water and nutrient movement and uptake in a sugarbeet crop. Results from all digs were enlightening. Depending on the area and soil profile, roots ranged from 27 inches to as deep as 47 inches only 60 days after planting. Late in the season, roots extended as deep as 72+ inches, demonstrating the potential of a sugarbeet to forage for nutrients deep within the profile.

ALDER, CLARKE*[1], NANCY CUTLER[2] and [2], [1]The Amalgamated Sugar Company, [2], [1]138 West Karcher Road, Nampa, ID 83687, [2] **Effects of the timing and quality of weed control on yield and sucrose content of sugarbeet.**

Weeds continue to be ever present in row crops worldwide. Growers spend enormous amounts of time and money in efforts 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 for some to spray less in order to pay less attention to weeds has contributed to increased spread of herbicide resistance. In addition, sugarbeet yields and sucrose contents also suffer as a result. This trial is the final replication over three years of simple, basic, but necessary trials in the Treasure Valley of Idaho that help illustrate the importance of timely and effective weed control and its effects on yield, sugar, and ultimately a grower's bottom line. Several timings of weed control, coupled with several control quality treatments ranging from 25-100% control were applied to 6 replications in order to address the hypothesis of this experiment.

ALDER, CLARKE*[1], OLIVER NEHER[2] and GREG DEAN[2], [1]The Amalgamated Sugar Company, [2], [1]138 West Karcher Road, Nampa, ID 83687, [2]
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.

BERNHARDSON, DUANE*[1], ELKE HILSCHER[2], HEIKO NARTEN[2] and STEFAN MELDAU[2], [1]KWS SAAT, [2]KWS SAAT SE, [1]1500 South 40th Str., Grand Forks, ND 58201, [2]Grimsehlstr 31, Einbeck, Germany 37555 **KWS BEETROMETERF400 TM, a mobile device for measuring sugar beet quality.**

The analysis of quality traits in sugar beet needs to be simple, fast, specific and cost- effective. In addition, these methods need to operate in high throughput to allow breeders and sugarbeet processors to measure an increasing number of samples. The existing methods used for quality measurements in the sugarbeet industry over the last 40 years are laborious and time-consuming. Current procedures for sampling and analyzing sugar beets consists of following steps: beet samples are collected to produce brei and treated with aluminum sulfate (sometimes lead acetate) for clarification. Several components are measured on this clarified juice to allow the calculation of recoverable sugar percentage. This whole process requires a central lab, a logistics system for samples and trained employees; producing chemical waste and it takes time. Near Infrared Spectrometry (NIRS) is a suitable method that can replace traditional procedure for sugarbeet quality analysis in sugar factories and breeding companies. Based on this technology KWS has developed the KWS BEETROMETERF400 ™ that allows measuring the highly variable sugar content of sugar beets. Sugar content not only varies within one beet, but also between beets. The presented innovative device consists of a sugarbeet chopper, which cuts 20-40 kg of sugarbeets in small, uniform pieces. A NIRS scans the surface of chopped beets in flow and performs 400 measurements per sample within 20 seconds. More than ten years of calibration development with conventional methods in the quality laboratories of KWS and samples from sugarbeet growing areas across the world have yielded a high accuracy for measuring recoverable sucrose concentration differences via NIRS on freshly chopped beets. The fully automated KWS BEETROMETERF400 ™ (F stands for the possibility to use it as an integral part in the sugarbeet processing factory and 400 stands for the average number of measurements per sample) also be used on mobile devices in the field or installed wherever sugarbeets need to be analyzed. This system offers the possibility to measure recoverable sugar content automatically outside of the laboratory (e.g. in the field or at sugarbeet storage facilities) or increase the sampling number for incoming sugarbeet trucks at sugar factories.

CHOMAS, ANDREW*[1], SETH PURUCKER[1], BRIAN J. GROULX[2] and KURT STEINKE[1], [1]Michigan State University, [2]Michigan Sugar Company, [1]Department of Plant, Soil, and Microbial Sciences, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824, [2]Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706 **Plant Population, Nitrogen Rate, Row Spacing, and Subsurface Banded Nitrogen Interactions on Sugarbeet.**

Growers in Michigan have been concerned about how plant populations, nitrogen (N) rates, row spacing, and subsurface banded N may influence optimal yield and quality of sugarbeet. Management practices and strategies have changed as beet tonnage has steadily increased over the last decade yet climatic variability continues to influence sugar production. As row spacing has decreased, growers question whether starter N applied 2 inches beneath and 2 inches beside the furrow is necessary. More intensive sugarbeet management involving greater plant densities, greater N rates, and narrower row spacing have some questioning disease occurrence and economic feasibility. Two separate studies were established to investigate the interaction amongst multiple agronomic factors. The first field study evaluated interactions between plant population, N rate, and subsurface banded N applied at-planting. Two plant populations (50,000 and 60,000 plants per acre), four N rates (0, 80, 160, and 240 lbs. N per acre), and with or without 40 lbs. N per acre applied in 2×2 at-planting were evaluated. In a second field study row spacing and subsurface banded N were evaluated together. Row spacing included 22 inch and 30 inch sugarbeet rows both with and without 40 lbs. N per acre applied 2×2 at-planting. Preliminary results from these studies include: 1) at 4 and 7 weeks after planting, 2×2 N applications appeared to have a greater impact on canopy development for 22 inch row beets than 30 inch row beets, 2) the disadvantages of utilizing a 2×2 N application may be outweighed by the early season root and canopy growth responses, and 3) the concept of "Start Right to Finish Well" that emphasizes early-season plant nutritional needs may impart a greater impact to growers moving forward as more variable growing season conditions are encountered in rain-fed sugarbeet production regions.

KAFFKA, STEPHEN1*, Kahled Bali2, Oli Bachie3 and Ali Montizar3 1Department of Plant Sciences, University of California, Davis; 2University of California Division of Agriculture and Natural Resources- Kearney Agricultural Research Center, Parlier, CA; 3University of California Cooperative Extension, Imperial Valley, California. **Comparison of surface furrow and subsurface drip irrigation systems in the Imperial Valley for root yield and quality, water use and susceptibility to late- season root rots.**

Improving irrigation management is essential for sustaining desert agriculture, including sugar beet production in the Imperial Valley (IV) of California. Traditional surface irrigation practices have led to the highest sugarbeet yields in the world there but competing demands for irrigation water for urban and environmental uses mean that less water will be available for irrigation in the future. Subsurface drip irrigation (SDI) can conserve water and has been adopted extensively elsewhere in California for both annual and perennial crops, but there has been no drip irrigation work on sugarbeets to date and relatively few reliable reports internationally. Starting in early October, 2016, one large block (0.5 ha) of surface irrigated beets and two large blocks with subsurface drip irrigation lines (at 30 cm depth, using 75 cm centers) were compared at the UC Dessert Research and Extension Center in Holtville, California. Surface irrigated beets and one block of drip irrigated beets were allocated 100% of estimated water use (ET_c) for the crop. The second drip irrigation block was irrigated at 75% of estimated ET_c. Irrigation requirements were estimated using automated commercial sensors relying on crop-based, surface renewal (SR) methods (Tule: https://www.tuletechnologies. com/). Soil water depletion was measured using tensiometers. Water applied was compared to predicted water requirements based on weather data and the use of a standard FAO model for sugarbeet water use, based on the standard equation: $ET_c = ET_o*k_c$). Beets were planted in early October. Crop water use was compared during the growing season and at harvest and root yield, sugar content, and purities (extractable sugar) were compared at harvest in late June. Root rots were estimated visually at 5 weeks after harvest in early August based on continued irrigation through the middle of July. Root and sugar yields were: ($Furrow_{ET100}$: 115 Mg/ha, 21.3 Mg/ha ; SDI_{ET100} : 105 Mg/ha, 18.8 Mg/ha ; SDI $_{ET75}$ 100 Mg/ha, 18.1 Mg/ha). Root nitrate contents were lower in $Furrow_{ET100}$treatments than either drip treatment, but purities were similar. Surface irrigated plots had a larger number of roots infected by diverse rots than SDI plots in early August, but overall root rot indices were more similar and differences were not significant. Measured pan evaporation (ET_o) from an adjacent weather station was 1570 mm during the cropping period. Based on Tule sensor data from within the crop, $Furrow_{ET100}$ beets received 900 mm irrigation, SDI_{ET100} 830 mm, and SSD_{ET75} approximately 620 mm of irrigation water. ET_c estimates based on weather data and the FAO model were approximately 20 % greater than those based on in-crop measurements using SR methods. Similarly, season average crop coefficient values (K_C) were lower for SR derived measurements than those predicted by the FAO model (Surface: K_C =0.7; SSDET100 K_C = 0.64, FAO Surface K_C = 0.97). SR methods used in this trial suggest that standard irrigation practice may over water beet crops, but additional field scale observations are needed using these techniques to confirm these initial observations. Additional trials in growers' fields are underway.

POWELL, GARY E.* MICHAEL A. PROBST, CHRISTY L. SPRAGUE, Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Response of sugarbeet to low level tank-contaminations of 2,4-D and dicamba.**

The recent registrations of soybean varieties resistant to dicamba and 2,4-D will lead to an increased risk of sensitive crop exposure to these herbicides through tank- contamination. This is concerning to sugarbeet growers, as they typically require multiple herbicide applications for effective weed control each year. Field experiments were conducted in 2016 and 2017 in Richville and East Lansing, Michigan to evaluate the effects of dicamba and 2,4-D tank-contamination on sugarbeet growth, yield, and quality. Dicamba and 2,4-D were applied to sugarbeet at rates equivalent to 0.125, 0.25, 0.5, 1, and 2% of the field use rate of 1.12 kg ha^{-1}. Herbicide injury to sugarbeet was detected from dicamba and 2,4-D at rates ranging from 2.8 to 22.4 g ha^{-1} at all application timings. Symptomology was typical of plant growth regulator herbicides, consisting of leaf crinkling and malformation and twisted, elongated petioles. At 14 DAT, the effective dose for 20% injury (ED_{20}) for 2,4-D ranged from 0.79-1.01% at Richville and 0.64-0.78% at East Lansing, averaged across all application timings. The ED_{20} values for dicamba 14 DAT ranged from 0.86-0.89% at Richville and 0.45-0.78% at East Lansing. While results from field experiments did not provide a clear answer as to which herbicide caused greater injury to sugarbeet, results from greenhouse experiments indicate that 2,4-D caused greater injury to sugarbeet than dicamba. Canopy closure was slowed by the 1% rate of dicamba and 2,4-D at the 2-leaf stage and by the 2% rate of both herbicides applied at the 6- and 14- leaf stages. The interaction between herbicide rate and application timing was not significant for sugarbeet yield and recoverable white sucrose ha^{-1} (RWSH). Yield was reduced 28% at Richville and 20% at East Lansing by 2% rate of 2,4-D. Similarly, the 2% rate of dicamba reduced yield 17% at Richville. No yield reductions were detected at any other rates. Similar to sugarbeet yield, RWSH was only reduced by 2% rate of both herbicides. Despite these low residue concentrations at harvest, improper spray system cleanout could result in rates of dicamba or 2,4-D high enough to reduce sugarbeet yield or RWSH. This further stresses the importance for proper cleanout in order to make sure exposure to dicamba and 2,4-D does not result in sugarbeet yield or RWSH reductions.

SANTIAGO, ISRAEL*[1], MARK BLOOMQUIST[2] and JOHN LAMB[3], [1]Spreckels Sugar Company, [2]Southern Minnesota Beet Sugar Cooperative, [3]University of Minnesota, [1]95 West Keystone Rd. Brawley, CA 92227, [2]83550 County Road 21, Renville, MN 56284. MN 56201, [3]439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108 **What Plant Populations Do Varieties Need in the Imperial Valley?**

Currently, in southern California, the recommended plant stand for 30 inch rows, is between 3.0" – 5.5", or plant populations of 36,000 – 70,000 plants/acre with a number of the Brawley growers using seed spacings of 2 3/8 – 3 ½ inches (Santiago, I., Personal communication, 2014). With the recent introduction of Round-Up Ready technology, producers are curious if an increased plant stand will result in a change for either sugar beet yield and/or sugar concentration. The objective of this study is to determine the yield and quality response of recently introduced Round Up Ready varieties to varying plant stands. A study was conducted in the Imperial Valley of California with seven site years from 2015 to 2018. Three Round-Up Ready varieties (Beta 5499, Beta 52RR45, and SV2014) were used at each site with three established plant populations, 2, 3.5 and 5 inches between plants in 30 inch wide rows (104544, 59739, and 41818 plants per acre, respectively). In general, decreasing the density of plant population either did not affect or increased root yield and extractable sucrose per acre, while extractable sucrose per ton was not affect by plant population. When extractable sucrose per acre was greater than 15,000 lb per acre the increased distance between plants in the row was beneficial.

SPRAGUE, CHRISTY L.*, Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Research experiences with managing herbicide-resistant weeds in Michigan.**

Glyphosate and multiple-resistant, weeds continue to threaten U.S. farmers, especially as they move into the sugarbeet production regions of the U.S. The increasing number of these weeds and the loss of herbicides that were once used in sugarbeet production have made it more of a challenge for sugarbeet growers to manage these weeds. In Michigan, populations of horseweed (marestail), Palmer amaranth, waterhemp, common ragweed, and more recently giant ragweed have been confirmed resistant to glyphosate. In fact, some of these populations are also resistant additional herbicides including the ALS-inhibiting herbicides, making them even more difficult to manage. For several years we have conducted field trials to evaluate several herbicide programs for the management glyphosate-resistant horseweed, Palmer amaranth and more recently waterhemp in sugarbeet. Several different herbicide tank-mixtures and application timings were evaluated for control of these weeds. Glyphosate-resistant horseweed management has often been dependent on clopyralid rate, the number of applications, and timing. 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. These acetanilide herbicides are also key to managing glyphosate- and multiple-resistant waterhemp. However, even with some initial control of these species the extended emergence patterns of many of these weeds makes it nearly impossible for 100% season-long control in sugarbeet with herbicides alone.

STEVENS, W. BART *, JAY. D. JABRO, WILLIAM M. IVERSEN, UPENDRA M. SAINJU and BRETT L. ALLEN, USDA-ARS, 1500 N. Central Ave., Sidney, MT, 59270 **Direct-Seeded Sugarbeet in Two Crop Rotations.**

Increased labor and tillage costs during the past decade have led to increasing interest in reduced tillage among sugar beet (*Beta vulgaris* L.) growers. Direct-seeding (DS), where seed is planted without any preplant tillage, offers potential cost and soil conservation benefits but potential challenges as well. A field study was conducted in North Dakota, USA to evaluate the performance of DS sugar beet grown in 2-year (sugar beet/barley [*Hordeum vulgare* L.]) or 4-yr rotations (sugar beet/corn [*Zea mays* L.]/soybean [*Glycine max* L.]/barley) with overhead sprinkler irrigation. Intensive tillage practices were performed just prior to seeding in the spring on subplots in each of the rotations as a control. Seedlings emerged more quickly with DS, presumably due to better soil moisture conditions than when following spring tillage. Early season plant growth with DS was consistently about 50% of that with full tillage. This may be due in part to cooler soil temperatures where there was no tillage. In one of four study years, sucrose yield was 1523 kg ha^{-1} lower with DS than with intensive tillage regardless of rotation and in another year DS resulted in a sucrose yield 1837 kg ha^{-1} lower than with intensive tillage. In the other two study years, yield was unaffected by tillage or rotation diversity. Root sucrose concentration was 4.5 g kg^{-1} lower with DS regardless of rotation in one study year but was not affected by either tillage or rotation in the other three years.

TARKALSON, DAVID D.*, BRADLEY A. KING and DAVE L. BJORNEBERG, USDA-ARS, 3793 NORTH 3600 EAST Kimberly, ID 83341-5076 **Yield Production Functions of Irrigated Sugarbeet in an Arid Climate.**

Increased water demands and drought have resulted in the need to provide data to guide deficit water management decisions in irrigated sugarbeet (Beta vulgaris L.) production. The objective of this study was to quantify the yield response of sugarbeet to water input and actual crop evapotranspiration (ETa) on a soil type (silt loam) common to sugarbeet production in the Northwest U.S. These relationships are valuable to understanding sugarbeet response over a range of water availability and in developing tools to assess future production under water shortages. This paper consolidates data from three studies consisting of ten site-years from 2009 to 2016. The studies were at the USDA- Agricultural Research Service facility in Kimberly, ID on a Portneuf silt loam soil. Treatments consisted of varying levels of cumulative seasonal Kimberly-Penman ET model estimated crop evapotranspiration (ETc) rates ranging from rain-fed to 125% of ETc. Irrigation methods consisted of surface drip irrigation (3 site-years), linear/pivot overhead sprinkler (6 site-years), and solid-set sprinkler (1 site-year). Irrigation frequency was consistent for all studies with applications occurring 2 to 3 times per week depending on ETc demand. Estimated recoverable sucrose (ERS) yield and root yield were measured, and soil water contents were measured. Across all site-years, quantitative relationships between both actual crop ET (ETa) and water input, and sugarbeet yield and quality variables were developed. Significant (0.05 probability level) positive linear relationships were found between ETa and sugarbeet ERS and root yields (r2 = 0.78). Estimated recoverable sucrose and root yields increased at rates of 19.4 kg/ha/mm ETa and 0.13 Mg/ ha/mm ETa, respectively. When ETa depths of 719 and 729 mm were reached by the crop, root and ERS yields were maximized, respectively. When water input (irrigation + precipitation) depths of 598 and 605 mm were applied root and ERS yields were maximized, respectively. The quantitative relationships between both ETa and water input, and sugarbeet yields can be used to quantify sugarbeet production under deficit irrigation conditions (data derived from pivot/linear, drip, and solid set irrigation types), which may arise due to water shortage scenarios, or when drought occurs in non-irrigated areas.

WILLBUR, JAIME F.*[1], BLOOMINGDALE, CHRIS[1], MINIER, DOUGLAS H.[1] and HANSON, LINDA E.[2], [1]Michigan State University, Department of Plant, Soil and Microbial Sciences, 612 Wilson Rd, East Lansing MI 48824; [2]United States Department of Agriculture – Agricultural Research Service, 612 Wilson Rd, East Lansing MI 48824. **Evaluation of azoxystrobin alternatives and Rhizoctonia solani sensitivity screening in Michigan sugar beets.**

Rhizoctonia root and crown rot (RRCR) is caused by R. solani Kühn and continues to be a major pest of sugar beets. In Michigan, Quadris (azoxystrobin) is widely applied to manage RRCR. Azoxystrobin, a quinone outside inhibitor (QoI), targets a single site to inhibit fungal respiration and so possesses a high risk of fungicide resistance development. Continued reliance on one to two applications of this product per season has prompted the evaluation of efficacious alternatives for RRCR management and preliminary fungicide sensitivity assays. In 2018, in-furrow and banded applications (made at the 6-8 leaf stage) of Serenade (Bacillus subtilis), Proline (prothioconazole), and Propulse (fluopyram+prothioconazole) were evaluated in an inoculated trial at the Saginaw Valley Research and Extension Center in Frankenmuth, MI. Treatments

significantly affected root rot index (P < 0.01), which combines severity and incidence, and yield (P < 0.05). Only treatments of Serenade, Proline, and Propulse used in a program with Quadris performed significantly better than the non-treated control. Notably, Serenade+Quadris in-furrow followed by a banded application of Proline significantly reduced root rot scores (-35%) and resulted in higher yields (+7 T/A) than the Quadris only program. No products tested individually performed significantly differently than the Quadris program. A complementary assay of azoxystrobin sensitivity is ongoing and will determine the status of Quadris efficacy in Michigan
R. solani populations.

Physiology, Genetics and Plant Pests
Oral Presentations

BOLTON, MELVIN*[1], REBECCA SPANNER[2] and GARY A. SECOR[2], [1]USDA - ARS, [2]North Dakota State University, [1]1616 Albrecht Blvd N, Fargo, ND 58102, [2]NDSU Dept. 7660, PO Box 6050, Fargo, ND 58108 **Use of genome-wide association to identify mutations involved with DMI-resistance in Cercospora beticola.**

Management of Cercospora leaf spot relies on the application of fungicides. A widely-used class of fungicides is the sterol demethylation-inhibiting (DMI) fungicides that inhibit the cytochrome P450 14α-demethylase CYP51. CYP51 is an enzyme that catalyzes a key step in fungal ergosterol biosynthesis, which is required for fungal survival. Quantitative resistance to DMIs has emerged in C. beticola populations due to their widespread use. To identify mutations responsible for DMI resistance, a genome-wide association study was undertaken using 200 isolates harvested from sugarbeet fields in the Red River Valley of ND and MN. Approximately half of the isolates were DMI-sensitive (EC50 value <1) while the other half were DMI-resistant (EC50 value ≥1). After next- generation whole genome resequencing, genome wide association identified three loci highly correlated with DMI-resistance. The results of this study will be reported.

BRANTNER, JASON R.* and ASHOK K. CHANDA, University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716 **Accurate diagnosis of sugarbeet root diseases is critical for driving disease management decisions.**

Accurate diagnosis of soilborne sugarbeet root diseases is not only critical for implementing effective disease management strategies but also useful in documenting prevailing diseases in a given year. Treatment applications in the current growing season and selection of variety, seed treatment, and fungicide applications for the next time the field is planted to sugarbeet all depend on knowing what pathogen(s) are present in the field. The objective of our field sample diagnosis is to identify root pathogens and provide information to growers. In the last ten years (2009-2018) the sugarbeet pathology lab at the University of Minnesota, Northwest Research and Outreach Center has diagnosed samples from 1088 fields from across the sugarbeet growing areas of Minnesota and North Dakota. Diagnosis is performed by gathering and assessing pertinent information from sample submitters followed by isolation of pathogens from infected tissues where appropriate and microscopic observation. The most common diseases were damping-off and/or adult root rot caused by *Rhizoctonia solani* (593 samples = 57%) and *Aphanomyces cochlioides* (332 samples = 27%). Diseases caused by *Fusarium oxysporum* or *F. secorum* have been found in 56 samples (5%) during this period. Other pathogens appearing infrequently are *Pythium* spp., and *Verticillium dahlia*. Chemical issues, mostly herbicide carryover or drift, have been suggested in 31 samples (3%). In the last four years, both *R. solani* and *A. cochlioides* have been isolated from 40 of 355 samples (11%) corroborating an increasingly common observation of co-existence of both diseases in many fields. There is much anecdotal evidence of misidentification of root diseases leading to inappropriate variety and treatment selection. Proper identification of root diseases in the field involves more than simple above-ground observation and should include digging up several intact roots with varying levels of symptoms around an infection focus or problem area, removing soil to better observe symptoms, and for some pathogens, cutting the roots to observe vascular tissue for presence of discoloration. At times, symptoms caused by *R. solani* and *A. cochlioides* can be difficult to discern and isolation of the pathogen or its DNA by a qualified lab is necessary. Proper samples for this procedure should include 4-8 roots with clear symptoms of active infection alongside healthy tissue. Completely rotten roots are usually not helpful as secondary organisms have taken over by that time. Accurate identification of pathogens in sugarbeet fields through proper sampling and diagnosis will give growers information to make better disease management decisions.

CAMPBELL, LARRY*[1], MARGARET REKOSKE[2], AND JAY MILLER[2]. [1]USDA- ARS, Northern Crop Science Lab., 1605 Albrecht Blvd. N., Fargo, ND 58102-2765. and 2Betaseed, Inc., 1325 Valley View Road, Shakopee, MN 55379. Resistance to sugarbeet root maggot as an alternative to complete dependence on insecticides. **Resistance to sugarbeet root maggot as an alternative to complete dependence on insecticides.**

Sugarbeet root maggot (*Tetanops myopaeformis* von Röder) is a major insect pest in many North American production areas. Host-plant resistance that ensured consistent control would provide an economically and environmentally favorable alternative to complete dependence on insecticides. Four germplasm lines with root maggot resistance; F1015, F1016, F1024, and F1043; were developed and have been released by USDA-ARS. In preliminary trials encompassing six environments, four root maggot resistant pollinators, and five cms lines, the yield loss attributed to root maggot feeding in hybrids with a resistant parent was substantially less than the corresponding yield loss in adapted susceptible hybrids. In one 3-year trial comparing a hybrid with F1024 to an adapted hybrid, there was a 1.5 Mg ha^{-1} difference in root yield between the adapted hybrid and the resistant hybrid in the absence of root maggot. The average root yield of the susceptible adapted hybrid was 17.5 Mg ha^{-1} less than the root yield of the F1024 hybrid at a site with root maggot present. Root maggot resistance has been incorporated into elite breeding populations with acceptable sucrose concentration and other desired traits by applying established breeding techniques. A comparison of hybrids developed from lines selected for root maggot tolerance indicate significantly greater gross sugar yield (Mg ha^{-1}) and significantly less root maggot damage when tested under root maggot infested conditions compared to comparable hybrids derived from the non-root maggot resistant elite lines. In sites without root maggots, differences in gross sugar yield between the same root maggot tolerant hybrids and elite hybrids were not significant. Within the same trial, non-tolerant hybrids with standard rates of the insecticide seed treatment of Poncho® Beta (a.i. by weight, Clothianidan 34.3%, Beta-Cyfluthrin 4.6% and 1,2-Propanediol 1.8%) also had significantly greater gross sugar yield in the presence of maggots than untreated checks and substantially less damage. The reduction in damage utilizing host-plant resistance was similar to the control obtained with this seed treatment. An additional increase in sugar yield and decrease in damage was achieved by using tolerant hybrids in combination with this seed treatment. Root maggot resistant hybrids show promise as a viable option for growers in areas where sugarbeet root maggot damage reduces yields.

CHANDA, ASHOK K.* and JASON R. BRANTNER, University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716 **Soil DNA-based detection of Rhizoctonia solani AG 2-2 for determining Rhizoctonia risk.**

Rhizoctonia damping-off and root rot caused by *Rhizoctonia solani* have been the most common root diseases of sugarbeet in Minnesota and North Dakota in recent years. *Rhizoctonia solani* has a wide host range and growing susceptible crops such as soybeans and corn in rotation with sugarbeet can gradually build up inoculum levels of *R. solani*, leading to significant yield losses when sugarbeets are grown. Sclerotia, survival structures produced by *R. solani*, can overwinter in soil and act as primary inoculum for initiating infections on sugarbeet seedlings and adult roots. The distribution of *R. solani* inoculum in a given field can be highly variable. Traditional growth chamber seedling assays can take up to 4 weeks to determine the inoculum potential of a soil. However, the impact on mature roots cannot be assessed using this assay and presence of non-Rhizoctonia damping-off pathogens can overestimate the root rot index. The objective of this study is to develop a robust soil DNA isolation method to detect and quantify the inoculum of *R. solani* AG 2-2 to eventually assess the potential Rhizoctonia diseases risk based on DNA levels. We sampled soil from 16 growers' fields in each of 2016 and 2017, from both diseased and healthy spots in those fields. The soil was divided into 0-2, 2-4, and 4-6 inches depth sub-samples. Soil was also collected from the same spots to perform a 4-week growth chamber assay to determine the seedling Rhizoctonia root rot index (RRI). In addition, ten roots adjacent to each sampling point were rated for Rhizoctonia root rot using a 0-7 scale. In 2016, the mean root rot ratings ranged from 1.12 to 3.72 and root rot incidence values ranged from 18 to 68 %. We found significant correlation across all sampling points and all fields between RRI and root rot ratings ($r = 0.59$ and $r^2 = 0.34$), and RRI and root rot incidence values ($r = 0.56$ and $r^2 = 0.32$). There was significant correlation ($r= 0.24$; $r^2= 0.06$) between RRI and DNA of *R. solani*, and root rot rating and DNA of *R. solani* ($r = 0.31$; $r^2 = 0.11$). In 2017, the mean root rot ratings ranged from 2.76 to 4.94 and root rot incidence values ranged from 44 to 78 %. Currently we are determining the correlation at the field level between (i) RRI and root rot ratings, (ii) RRI and root rot incidence, (iii) RRI and DNA of *R. solani*, and (iv) root rot rating and DNA of *R. solani*, for 2017 samples. In the future, soil Rhizoctonia-DNA data may help us assess the risk of an individual field for *R.solani*, to develop a tailored Rhizoctonia management plan by the growers.

FUGATE, KAREN K.*[1], JOHN D. EIDE[1], DANIEL N. MARTINS[2], MICHAEL A. GRUSAK[1] and FERNANDO L. FINGER[3], [1]USDA, Agricultural Research Service, [2]Dept. de Biologia Vegetal, [3]Dept. de Fitotecnia, [1]ETSARC, 1605 Albrecht Blvd. N., Fargo, ND 58102, [2]Fed. Univ. de Viçosa, 365712-000, Viçosa, MG, Brazil, [2]Fed. Univ. de Viçosa, 365712-000, Viçosa, MG, Brazil
Intercellular localization of sucrose-degrading enzymes in sugar beet taproots provides clues to the role of sucrose catabolism in sucrose accumulation.

Despite the importance of sucrose accumulation to the sugar beet industry, the physiological processes involved in sucrose accumulation in the sugar beet taproot are poorly characterized and factors regulating these processes are unknown. Sucrose catabolism has long been implicated in the promotion of biomass and sucrose accumulation during the production season, and correlations between sucrose-degrading enzyme activities and sugar beet root sink strength and sucrose content are common. Yet, how sucrose accumulation is promoted by enzymes that cleave sucrose is a paradox. Since localization of enzymes and metabolites often provides clues to enzyme function, research was conducted to determine the intercellular location of the major sucrolytic activities in the sugar beet taproot with respect to the intercellular location of sucrose storage. Intercellular sites of sucrose storage, sucrose synthase expression, and alkaline invertase activity were determined by histological analysis of taproot sections after sucrose precipitation with barium hydroxide, in situ hybridizations with probes for the two sucrose synthase genes expressed in roots, or cytological staining for the products of alkaline invertase activity. Sucrose storage was evident in the parenchyma cells of intervascular rings and rays but was notably absent from cells within and surrounding vascular bundles. Surprisingly, the intercellular localization of sucrose synthase expression mirrored the intercellular sites of sucrose accumulation. The similarity in sucrose synthase expression and sucrose storage suggest an involvement of sucrose synthase activity in sucrose accumulation in the sugar beet taproot, possibly through its involvement in generating metabolic energy to support active transport of sucrose into the vacuole.

GROEN, CORY, J. * David C. Mettler, and Mark W. Bloomquist, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. **Cercospora leaf spot management under high disease pressure in Beta vulgaris in southern Minnesota.**

Cercospora Leaf Spot is a serious economic disease in sugar beet that has had a major impact on sugar beet production in the Midwest over the last several years. One hurdle to manage this disease is the development of resistance due to the polycyclic nature of Cercospora and the limited number of effective fungicide modes of action. The objective of this study was to determine the efficacy of different fungicides and spray programs in controlling Cercospora. This trial was planted to a sugar beet variety that was slightly susceptible to Cercospora and was inoculated to achieve an even disease pressure across the site. In both years that this trial was conducted treatments were applied five times at ten to twelve-day intervals. Foliar ratings and pictures were taken throughout the summer once applications of the fungicides began. This trial was also harvested to gather yield and quality data. During both years combining two different modes of action gave significantly better control than treatments with only one mode of action. This is true when looking at the foliar ratings and the harvest data. In 2017 the spray program with two modes of action in every application gave a return of 2,012lbs of extractable sugar per acre more than a similar program with only one mode of action in every application.

HANSON, LINDA E.*[1], DOUGLAS H. MINIER[2] and FRANK N. MARTIN[3], [1]USDA- ARS, [2]Michigan State University, [1]612 Wilson Road, 37 Plant Biology, East Lansing, MI 48824, [2]612 Wilson Road, 37 Plant Biology, East Lansing, MI 48824[3]1636 E. Alisal St., Salinas, CA 93905 **Phylogenetic groups in Rhizoctonia solani AG 2-2 from sugar beet and related host range.**

Rhizoctonia solani AG 2-2 is the casual agent of seedling damping-off and root and crown rot of sugar beet. Rhizoctonia root and crown rot is the most important soil- borne disease of sugar beet in the USA. Historically the isolates of this anastomosis group (AG) on sugar beet have been separated into two intraspecific groups (ISG), IIIB and IV. These vary in host range and virulence. However, attempts to develop rapid screening methods for the ISG were problematic. A four gene phylogeny revealed these ISG are artificial, and instead identified 3 major phylogenetic groups that do not correspond to ISG IIIB and IV. These genetic types in Rhizoctonia solani AG 2-2 may help to explain some of the varying reports for host range for the ISG. To check for phenotypic differences in the 3 phylogenetic groups, isolates representing the groups were tested for virulence on dry bean and sugar beet at both seedling and adult plant growth stages. While there was variability in virulence within all three phylogenetic groups, significant differences between groups were identified. The phylogenetic group with the highest average virulence on dry bean was different than the one that had the highest average virulence on sugar beet. The identification of genetically supported groups provides the potential to develop rapid screening methods to allow for improved identification of the genetic types important in different geographic regions and on varying crops.

HOLMQUIST, LOUISE* and THOMAS KRAFT, Maribo Hilleshög Research, Säbyholmsvägen 24, S-261 91 Landskrona, Sweden **Molecular studies of the interaction between Rhizoctonia solani and sugar beet.**

The genome of a *Rhizoctonia solani* AG2-2IIIB isolate was sequenced and compared to four other sequenced *R. solani* genomes. The AG2-2IIIB genome was the largest with a genome size of 56 Mb. The first barrier a fungus needs to overcome for a successful infection of its host is the cell wall. We predicted cell wall degrading enzymes (CWDE) in the AG2-2IIIB genome and found many of the CWDE groups expanded compared to other fungi, especially the polysaccharide lyase group represented by the pectate lyase family 1 (PL-1). Effector proteins are known to be important for fungal infection and we predicted 61 effector proteins in AG2-2IIIB and 11 of them were unique compared to the other AGs. Gene expression analysis during infection showed an increased expression for three of these effectors; LysM, RlpA and CRP1. We used *Cercospora beticola* as a heterologous expression system and transformed it with the three identified effector genes. When the overexpressed strains were inoculated on sugar beet leaves we could see an increase of lesion size for the

LysM and CRP overexpressing strains. Fungal biomass in infected leaves were measured and leaves inoculated with LysM and RlpA overexpressing strains had higher fungal DNA content. This indicates a role of these genes in the infection process. For studying resistance mechanisms in sugarbeet, we sequenced the transcriptome of sugar beet breeding lines with different levels of resistance against *R. solani*. After extensive data analysis we identified three Major latex protein (*MLP*) gene homologs that were differentially expressed in partially resistant varieties five days after inoculation. We overexpressed them in *Arabidopsis thaliana* and saw an indication of a lower infection compared to wild-type when inoculated with *R. solani*. The *MLP* genes in sugar beet might be involved in the resistance mechanisms against *R. solani*. We also did interaction studies on the effector proteins where we used pull-down experiments followed by amino acid sequencing and found that the CRP1 effector potentially interacts with a plasma membrane protein in sugar beet, BvPIP1;1. This protein was differentially expressed at five days post inoculation and further studies on this protein and the interaction is on-going.

HUYGHE, CHRISTIAN[1], F. MAUPAS[2], K. HENRY[3], V. LAUDINAT[2] and B. DESPREZ* [3], [1]INRA, [2]ITB, [3]Florimond Desprez Veuve & Fils SAS, [1]Institut National de la Recherche Agronomique, 147, Rue de l'Université, F-75338 Paris, France , [2]ITB, 45, rue de Naples , F-75008 Paris, France, [3]Florimond Desprez Veuve & Fils SAS, BP41, 3, Rue Florimond Desprez, F-59242 Cappelle-en-Pévèle, France **AKER a French Research Initiative for a competitive Innovation for Sugar Beet.**

AKER is an 8-year programme (2012 to 2020) with 11 partners and a budget of around 20 Mio Euros with 5 Mio granted by the French Ministry of Research. As starting this initiative, all partners were convinced that breeding should play an important role in the capacity of sugarbeet to be competitive in front of cane. The challenge was to increase the rate of sugar yield gain (around 2% actually), and, as a more global challenge, creating varieties to meet high quality, safety and sustainable agriculture.Global diversity available and its management to answer these questions is critical. Considering the funnel effect of breeding, AKER's project aims to widen this funnel maximizing the availability by exploring the genetic resources variability, and to shorten the time duration to the final elite production.By taking into account all germplasm available including 50 world genebanks, and after genotyping, we estimated that a core collection of only 15 plants was sufficient to carry all allelic variability which is not encountered already in the elite germplasm. After eight years of backcrossings with elite lines, by choosing the right complementary ones, we got 3,000 plants representing all variability coming from these 15 exotic plants into an elite background. The two years left within the program is to phenotype all this final core collection. We so expect to get a value of each of these small source of genomic variations. Bringing useful traits or dirty ones. Another idea was to transferred this revolutionary methodology which we call genomic selection coming from cattle breeding to crop breeding, and particularly to sugar beet breeding. The goal is the increase the speed of genetic progress. We can summarize by acting that GS is really a promising tool, also for sugar beet breeding.Concerning phenotyping, AKER is devoting 60% of its total budget. Remembering that we have to phenotype as much traits as possible the 3,000 hybrids from the Core Collection. We need high-throughput, non destructive, accurate and dynamic phenotyping. Phenotyping from seed, early growth stages to seedling and of course growing stage to harvest including diseases or any abiotic stress. Example such as seed phenotyping thanks to a three dimensional X-ray machine is shown. IR thermography to evaluate sugar content in young plantlets, MRI to get access to fat content of the embryo within dry seed, Hyper spectral image test (visible + IRP) to get access to biochemical content of organs. For the 2018 campaign, the field experiment consist of more than 70,000 plots specifically dedicated to AKER : to examine the 3,000 hybrids and some of the other AKER breeding experiment. This Research program is funding by the French Government, under the management of the Research National Agency (ANR). AKER is included in the «Investissements d'avenir » as referred as ANR-11-BTBR-0007

KOEPS, THOMAS*[1], TIFFANY MCKAY-WILLIAMS[1] and HANS-HENNING VOSS[2], [1]Betaseed, Inc., [2]KWS SAAT SE, [1]898 Center St W, Kimberly, ID 83341, [2]Grimsehlstrasse 31, 37555 Einbeck, Germany **Breeding gain for Curly Top hybrids and lines in Idaho, Montana and Wyoming over the last ten years.**

Curly top of sugarbeet is widespread throughout the western United States and is a significant disease problem for sugarbeet production in Idaho, Montana and Wyoming. Typical symptoms are dwarfed, crinkled and rolled upward and inward leaves with roughened veins on the lower side that often produce swellings and spine-like outgrowths. Further symptoms are leaf yellowing and stunted growth of the plant. Beet Curly Top Virus (BCTV), Beet Severe Curly Top Virus (BSCTV) and Beet Mild Curly Top Virus (BMCTV) are the causal agents of Curly Top of sugarbeet. These three closely related viruses belong to the family Geminiviridae, genus Curtovirus. In North America, BCTV is only transmitted by the beet leafhopper (Circulifer tenellus) in a persistent manner. Seed treatment with insecticides, e.g. Poncho Beta, and Curly Top resistant varieties are the best ways to control the Curly Top disease. In 2017, experimental varieties in Idaho showed up to 15 % higher sugar yield and up to 9 % higher relative sugar content compared to the four commercial checks. These new experimental varieties were competitive to the two available out-of-area varieties and provided Curly Top resistance in addition. The newest varieties in

Montana and Wyoming in 2017 showed up to 10 % higher sugar yield and up to 7 % higher relative sugar content compared to the three commercial checks. Proprietary data with the newest testcross hybrids showed similar results. In order to achieve this huge breeding gain on the hybrid level, significant improvements for the CT lines are required. Adjusted proprietary data between 2014 and 2017 showed that the newest Curly Top lines were 5-8 % higher in sugar yield and 3-5 % higher in relative sugar content compared to an older CT line that was frequently used in previous CT hybrids. Furthermore, these data showed that the newest CT lines performed on the same level as an elite line that is frequently used in the eastern markets. While the sugar yield and sugar content of the CT lines have increased over the last years, the CT resistance stayed on a similar level. This is shown by a trial that compared the newest CT parental lines with older standard CT components that were frequently used in previous CT hybrid development. Preliminary 2018 data further supports these findings.

LIEBE, SEBASTIAN*[1], EDGAR MAISS[2] and MARK VARRELMANN[1], [1]Institute of sugar beet research, [2]Institute of Horticultural Production Systems, [1]Holtenser Landtr. 77, 37077 Göttingen, Germany, [2]Herrenhäuser Str.2, 30419 Hannover, Germany **Application of a reverse genetic system for Beet necrotic yellow vein virus and Beet soil-borne mosaic virus in sugar beet.**

Beet necrotic yellow vein virus (BNYVV) and Beet soil-borne mosaic virus (BSBMV) are both members of the genus Benyvirus in the family Benyviridae. Although representing closely related species, the symptoms they induce in their natural host sugar beet (Beta vulgaris subsp. vulgaris), differ considerably. BSBMV-infected sugar beet roots appear asymptomatic, whereas the leaves display light yellow vein banding, mottling or mosaic patterns. In contrast, BNYVV-infected roots display extensive secondary root proliferation and the canopy shows symptoms such as vein yellowing and necrotic spots on the leaf surface. In contrast to BNYVV wild-type A-type isolates which are controlled by natural Rz1-based resistance, BSBMV can systemically infect plants of this genotype. BNYVV has evolved pathotypes with specific mutations in the major pathogenicity protein P25, which allows them to overcome Rz1. A similar ability has been observed for BNYVV isolates carrying an additional fifth RNA species (i.e. P type). The second major resistance gene Rz2, however, mediates resistance against both species and all known pathotypes. To demonstrate that only P25 mutations are responsible for this Rz1 breaking effect, mutations were introduced into BNYVV RNA3. Furthermore, a BNYVV RNA5 cDNA clone was produced. Since it had been shown that BNYVV and BSBMV can form viable pseudorecombinants in B. macrocarpa, the effect of pseudorecombinants on virus replication, symptom development was also investigated in B. vulgaris. Moreover, it was aimed to identify the BSBMV genome component responsible for Rz1 breaking effect. Young sugar beet seedlings were mechanically inoculated with leaf sap obtained from B. macrocarpa plants systemically infected with the different RNA3 mutants and/or BNYVV A-type/BSBMV pseudorecombinants. Compared to BNYVV wild-type, all P25 mutants that were previously described to overcome Rz1 increased virus titer in an Rz1 genotype and number of infected plants. Addition of RNA5 from P-type to BNYVV RNA1-3 A-type mediated Rz1 resistance breaking. In contrast to the expectations, BSBMV RNA 3 addition to BNYVV RNA1+2 did not lead to a Rz1 resistance breaking whereas BSBMV 1+2 plus BNYVV RNA3 was clearly able to propagate in the Rz1 genotype. In further studies, additional mutants including recombinant RNA2 cDNA clones and RNA mutants with exchanges in the 5´- as well as 3´non-translated regions have to be made to analyse the molecular basis of resistance breaking.

MCGRATH, MITCH, USDA-ARS, 1066 Bogue St, 360 PSSB, Michigan State University, East Lansing, MI 48824 **Tales from the sugar beet genome.**

Breeders would like to better manipulate the sugar beet genome to meet growers' demands. Unlike managing the physical environment for optimal crop growth and protection, where the environment is visible and accessible, the beet's internal 'genetic' environment is somewhat opaque and not yet manageable, at least in a logical manner. Breeding does effect genetic change, often in desirable directions, through well-known genetic processes of selection, migration, genetic drift (e.g. quasi-randomness), and mutation. The history of these changes is written in the beet's internal environment, since the instruction sets have been passed down through generations. Thus, the record of selection is accessible given a proper language of inquiry. Also, well known is that much of this record is encoded in DNA (e.g. the genome), and technology has accelerated for obtaining and deciphering DNA sequences. A few reasonable genome assemblies of sugar beet have been constructed, loosening an analytical bottleneck. Novel insights are beginning to percolate through the sugar beet scientific community, especially useful for bringing context and clarity to breeding and selection. Finally, decoding the instruction set is also well known, as the genome is transcribed and translated for plant growth. Thus, changes in the genome sequence affect expression of genes, and useful variants are selected during breeding for hybrid seed production. The nature of these useful variants, while mostly unknown, are key, and a facile system of interrogation is being deployed. The approach uses fairly standard population genetics methods and relies on DNA from any chosen beet populations, where each population has some value (such as for sucrose content or specific disease reaction). Changes due to, in part, selection are evident from the detectable change(s) in gene frequency, and these changes can be traced to the genomic coordinates of the beets' internal landscape. A few examples will be presented to illustrate these ideas.

MILLER, JAY*, PATRICK O'BOYLE and MARGARET REKOSKE, Betaseed, Inc., 1325 Valley View Road, Shakopee, MN 55379 **Sugar Beet Breeding Progress Of Cercospora Resistant Varieties In North America.**

Cercospora (Cercospora beticola Sacc.) is an important disease affecting over 60% of the North American markets. The principal means of controlling losses is through the use of resistant varieties and fungicide protectants. Due to the loss in the effectiveness of Cercospora fungicides, including strobilurins, recent leaf spot infections have resulted in significant production losses and increased production costs in many sugar beet producing areas. Consequently, several markets need varieties with a higher level of Cercospora resistance thus in these markets the approval requirement for Cercospora have been changed to reflect this need. While the current resistant varieties significantly outperform non-resistant genotypes under Cercospora infections, they can be up to 10% lower yielding in the absence of disease. Although the rate of performance and breeding gains of highly tolerant Cercospora varieties is comparable to the gains achieved by other breeding programs, an increased rate in breeding gains of this program would close the performance gap.

SMIGOCKI, ANN*[1], HAIYAN, LI[1], REZIA BRAZA[1], JULIE MONGEON-SNIDER[1] and ROBERT BRUCCOLERI[2], [1]USDA, ARS, Molecular Plant Pathology Lab, [2]Audacious Energy, LLC, [1]10300 Baltimore Ave., Bldg. 004, Beltsville, MD 20705, [2]60 Gates Farm Rd., Glastonbuy, CT 06033 **Beta vulgaris lipid biosynthesis genes increase oil levels and tolerance to fall armyworm and Rhizoctonia solani in genetically modified sugar beet roots and Nicotiana plants.**

Fuel production from sugar beet can be achieved by genetically modifying the taproot to produce lipid oils (fatty acids) that can be transformed into biodiesel via simple chemical refinement. Producing oil from sugar beets as compared to producing ethanol from corn is very favorable. We cloned sugar beet fatty acid biosynthesis genes BvLec1, BvLec2/Fusca3, BvWri1 and BvTAG1, orthologs of the Arabidopsis genes AtLec1, AtLec2, AtWri1, AtFUSCA3 and AtTAG1, respectively, and over-expressed them in sugar beet roots and Nicotiana benthamiana plants. In Nicotiana leaves, fatty acid content increased by 40 – 70% when any one of the sugar beet genes was overexpressed, and 25 – 50% with the Arabidopsis genes. In sugar beet hairy roots, fatty acid levels increased by 70 – 80% with the sugar beet genes and 60 – 200% with the Arabidopsis genes. High oil producing Nicotiana plants were screened for insect and fungal resistance. When Nicotiana leaves with a high oil content were fed to fall armyworm larvae, a significant reduction in larval weights and an increase in larval mortality were observed. Inoculation of BvLec2/Fusca3 or BvWri1 plants with Rhizoctonia solani AG2-2 and AG4 reduced plant death by up to

50%. Our data demonstrates that sugar beet fatty acid biosynthesis genes have a function in plant defense and that they should provide an approach for producing sufficient levels of plant fatty acids to be economically useful for utilization by the biodiesel industry.

STEWART, JAMES F*, BRIAN J. GROULX, COREY J. GUZA and DENNIS BISCHER, Michigan Sugar Company, 1459 South Valley Center Drive, Bay City, MI 48706 **Control of Cercospora beticola and Alternaria alternataleaf spot diseases in sugarbeets with tank mix fungicide treatments.**

Michigan sugarbeet (Beta vulgaris) growers have suffered significant damage from Cercospora and Alternaria leafspot infections in recent years. Leafspot resistance to fungicides, an increase in Alternaria infestations and a lack of high yielding varieties with adequate tolerance to leafspot diseases have contributed to the problem. In addition, fall weather has been warmer and wetter in recent years, which has encouraged late season leafspot infections. When the Cooperative converted to the Roundup Ready system the available Roundup Ready varieties were not well adapted to Michigan and did not meet the variety approval standards. As a result, Cercospora tolerance levels were relaxed so that growers could plant Roundup Ready varieties. The more susceptible Roundup Ready varieties have contributed to our issues with leafspot control. To improve the situation, our Cooperative implemented five year seed approval plans for 2015 and 2020 with the goal of restoring adequate varietal tolerance to Cercospora leaf spot. Effective control of Cercospora and Alternaria leafspot in sugarbeets requires an integrated and intensive approach. Variety selection, crop rotations, resistance issues, timely fungicide applications and other factors need to be considered. An increase in the scope of research has been implemented to find solutions to the leafspot problems. Twenty seven separate leafspot trials were conducted in 2018. Tank mixing EBDCs or Coppers with triazole fungicides is critical for leafspot control and is an important resistance management strategy. From 2013 to 2015 tank mix treatments improved leafspot control by approximately 25 percent. Trial work from 2016 to 2018 has shown that tank mix treatments are even more important than a few years ago. Presently, Cercospora and Alternaria leafspot cannot be controlled in Michigan without tank mix treatments. This paper will examine the efforts to establish effective guidelines for controlling leafspot diseases in Michigan, with an emphasis on fungicide tank mix treatments.

TSCHOEP, HENDRIK*, JUAN VEGAS, DAVID BOEHM and GERHARD STEINRUECKEN, SESVanderHave, Soldatenplein Z2, 15. 3300 Tienen, Belgium **How Big Data Will Change Breeding Strategies in Sugar Beet – A Perspective from SESVanderHave.**

Constant genetic gain and ever faster variety improvement is the ultimate goal of every breeding company. Decreasing genotyping cost allowed marker selection for monogenic traits and QTL in a very cost-effective manner and significantly contributed to genetic progress in the last decades. In recent years, genomic selection methodologies enabled the selection for even more complex traits such as yield, plant architecture and polygenic disease resistances. In the near future, phenotypic and environmental data acquired in a high-throughput manner in glasshouse experiments and field trials will provide another layer of data a breeder has to analyze and interpret. It is therefore essential to turn the massive amount of data we currently generate, and will acquire in the future, over the course of a breeding program into meaningful information that can be used to draw conclusions and take decisions. This will require fundamental changes in the way breeders work, such as changes in breeding strategy as well as acquisition of new skills and expertise to support those changes. Within this talk SESVanderHave would like to outline its strategy on how to handle big data in order to provide competitive varieties adapted to local needs for the coming decades.

TURANO, FRANK*[1], THOGURU, JOHN[1], CHEEPINEETI, SULOCHANA[1], SHIPP, JEFFREY[1], LIBSACK, STEVE[2] and TURANO, KATHLEEN[1], [1]Plant Sensory Systems, LLC, [2]All Beets,LLC, [1]1450 South Rolling Road, Baltimore, MD 21227, [1]1450 South Rolling Road, Baltimore, MD 21227 **NUEST™ beets: More sugar with lower inputs.**

Signaling molecules delivered to specific plant parts at a specific time can improve and maximize crop production. The Nitrogen Use Efficient Stress Tolerant (NUEST™) technology targets the biosynthesis of naturally occurring signaling molecules to promote distinct agricultural traits. Sugar beets with the NUEST™ technology were developed initially using genetic engineering techniques. Greenhouse-grown engineered beets had larger roots and higher sugar content, resulting in a significant increase in sugar per beet. The engineered beet lines that had the highest sugar were bulked for seed production, and the resulting offspring were tested in two different field trials. The NUEST™ beet line with the highest sugar content had a 2.3° increase in Brix and 30% higher sugar per acre compared with the null siblings. More recently a gene edited version of the NUEST™ beets (the alpha-NUEST™ beet) has been developed. Initial results from greenhouse-grown alpha-NUEST™ beets reveal increases in sugar content (2.6° higher Brix) similar to that observed in the genetic engineered NUEST™ beets. The alpha- NUEST™ beet trait has been stacked with a gene edited herbicide resistance (alpha-HR) trait. Parental lines of the alpha-NUEST™ and the stacked (alpha-NUEST™-alpha-HR) beets will be available for hybrid crosses in 2019.

VANDERSTUKKEN, MAARTEN*, OLIVIER AMAND, HENDRIK TSCHOEP, DAVID BOEHM and GERHARD STEINRUECKEN, SESVanderHave, Soldatenplein Z2, 15. 3300 Tienen, Belgium **An Integrated Breeding Approach Towards Cercospora beticola Resistant Varieties – A Perspective from SESVanderHave.**

Cercospora Leaf Spot (CLS), caused by Cercospora beticola, is an aggressive fungal disease, causing significant financial losses. In recent years, the disease has substantially expanded its area of occurrence and aggressiveness. Moreover, effectiveness of fungicides is decreasing due to increasing fungicide resistance. CLS tolerance is a main trait focus for SESVanderHave breeding. In our breeding efforts we make best use of existing genetic variability (existing sources, wild allele mining, polygenic resistance) by applying modern genotyping and phenotyping technologies, and complement this with novel breeding technologies (GM, site directed mutagenesis, etc.). These efforts have already brought varieties to market that combine performance with strong CLS tolerance. Within this talk, SESVanderHave will outline our breeding strategy for the development of competitive CLS-tolerant varieties as part of an integrated pest management program.

WEBB, KIMBERLY M.*[1], SHRESTHA, SUBIDHYA[2], TRIPPE III, RICHARD[1], RIVERA-VARAS, VIVIANA[3], DE JONGE, RONNIE&sup[4], SECOR, GARY A.[2] and BOLTON, MELVIN D.&sup[5]; [1]USDA-ARS, SMSBRU,[2] North Dakota State University,[3] North Dakota State University[4]; Utrecht University[5]; USDA-ARS[1] ,1701 Centre Ave., Fort Collins, CO 80526[2], Department of Plant Pathology, Fargo, ND 58108, [2]Department of Plant Pathology, Fargo, ND 58108[4], Plant-Microbe Interactions, Department of Biology, Science4Life, 3584 CH, Utrecht, The Netherlands[5]; Red River Valley Agricultural Research Center, Fargo, ND 58108 **Comparative genomics and phylogenetic relationships of the Fusarium population from sugar beet suggests a new look at species designations.**

Fusarium spp. are responsible for significant yield losses in sugar beet (Beta vulgaris) with Fusarium oxysporum f. sp. betae most often reported as the primary causal agent. Recently a new species, F. secorum, was reported to cause disease in selected locations in the U.S. Little is known about the range of virulence within F. secorum nor how this relates to the overall Fusarium population previously described. We obtained Tef1-α sequence from seven isolates of F. secorum and added this data to a phylogenetic tree that includes F. oxysporum f. sp. betae. Unexpectedly, the F. secorum strains nested into a distinct clade (Clade B) that included several isolates previously designated as F. oxysporum f. sp. betae, suggesting those species designations are outdated. These results prompted an expanded phylogenetic analysis of the Tef1-α sequence from genome sequences of publicly-available Fusarium spp. This

analysis further designated isolates previously reported as F. oxysporum f. sp. betae from Clade A as F. commune, a species that is not known to be a sugar beet pathogen. Sugar beet isolates within Clade C nested within the Fusarium oxysporum species complex, confirming those isolates as
F. oxysporum. Whole genome analysis was performed on representative isolates from Clade B (670-10 and Fob257c) and Clade C (F19 and non-pathogenic isolate F29). Comparative genomics supports the identification of isolate Fob257c as F. secorum and the identification of Clade C isolates (F19/F29) with F. commune. Inoculation on sugar beet with differing genetic backgrounds demonstrate that F. secorum strains range in virulence from low to highly virulent depending on cultivar. Taken together, our data suggests a greater range of Fusaria cause disease on sugar beet than previously thought. Consequently, screening sugar beet for disease resistance should rely on isolates representing the diversity of the population.

WEBB, KIMBERLY M.*[1], WINTERMANTEL, WILLIAM M.[2] and BROECKLING, COREY D.[3], [1]USDA-ARS, SMSBRU, [2]USDA-ARS, CIPRU, [3]Colorado State University, [1]1701 Centre Ave., Fort Collins, CO, [2]1636 E. Alisal St., Salinas, CA, [3]Proteomics and Metabolomics Facility, C130 Microbiology, 2021 Campus Delivery, Fort Collins, CO **Metabolomic profiling reveals insights into the sugar beet defense response to Beet necrotic yellow vein virus.**

Rhizomania, caused by Beet necrotic yellow vein virus (BNYVV) is an economically damaging viral disease of sugar beet (Beta vulgaris). Single dominant resistance (Rz) genes which reduce virus titer and disease severity in plants, have been deployed in commercial varieties to manage rhizomania in the field. However, resistance breaking isolates have been reported that overcome one of the commonly used resistance genes, Rz1, in several production regions. Because the specific genes and mechanisms that lead to resistance are unknown, having a better understanding of the sugar beet defense response to BNYVV should lead to the development of more durable sources of rhizomania resistance. Therefore, to elucidate the mechanisms associated with resistance to BNYVV, we have performed a non-targeted metabolomic comparison of near isogenic sugar beet lines differing for rhizomania resistance, carrying either of two resistance genes (Rz1 or Rz2), or the susceptible alleles (rz1 or rz2). Primary and secondary metabolites were detected by gas chromatography – mass spectrometry (GC-MS) and ultra-pressure liquid chromatography – mass spectrometry (UPLC-MS). Additionally, the roles of select phytohormones were characterized by targeted UPLC-MS. Clear differences in metabolites were identified in response to infection with BNYVV (regardless of strain) with fewer differences revealed by sugar beet genotype. Several compounds associated with the plant defense response were induced due to infection with BNYVV such as

salicylic acid, extrachloroplastic phospholipids, diterpenoids, and cinnamoyltryramine. Several associated plant biological pathways were identified and can lead to future studies to determine functional relationships with sugar beet resistance to BNYVV.

WINTERMANTEL, WILLIAM M.*[1], JOHN WEILAND[2], OLIVER NEHER[3] and MELVIN BOLTON[2], [1]USDA-ARS, Crop Improvement and Research Unit, [2]USDA-ARS, Red River Valley Agricultural Reserch Center, [3]The Amalgamated Sugar Company LLC, [1]1636 East Alisal Street, Salinas, CA 93905, [2]1605 Albrecht Blvd. North, Fargo, ND 58102, [3]1951 S Saturn Way, Ste 100, Boise, ID 83709 **Identification of beet necrotic yellow vein virus (BNYVV) in the USA that compromises Rz2-based resistance to Rhizomania disease.**

Crop genetics has combined with advances in seed treatment and agronomic practices to afford US sugar beet producers record yields in recent years. The integration of resistance genes into sugarbeet for management of rhizomania disease, caused by beet necrotic yellow vein virus (BNYVV), has ensured economic viability of the crop during the global spread of BNYVV. Following the widespread detection of resistance breaking (RB) BNYVV strains, which have the ability to overcome the resistance engendered by the widely planted Rz1 gene, concern over the sustainability of production in fields with RB BNYVV strains prompted an expansion in planting of varieties carrying both Rz1 and Rz2 resistance genes. In the fall of 2017, a limited number of sugar beet fields planted to double- resistant hybrids in Idaho exhibited classic or near-classic symptoms of rhizomania in small patches. Sugarbeet plants collected from these locations and exhibiting rhizomania tested positive for BNYVV by ELISA and showed genotypes within the P25 protein of RNA3 that corresponded to known Rz1 RB strains. In experiments performed in two different USDA laboratories, soil from within the patches of interest was used to bait BNYVV onto test seedlings possessing the Rz1 gene, the Rz2 gene, as well as double-resistance with Rz1+Rz2. Serological testing of the seedlings by ELISA for the presence of BNYVV at 5- 6 weeks post-planting confirmed BNYVV levels in sugarbeet plants containing Rz1+Rz2 at least 3x the levels in healthy plants. RNA sequencing was subsequently performed on extracts of isolates showing high accumulation in Rz2 sugarbeet varieties in order to identify viral genes and gene sequences that may be involved in the apparent ability of BNYVV to overcome Rz2 resistance. To our knowledge, this is the first report of BNYVV compromising resistance engendered by the Rz2 resistance gene in US production fields.

Physiology, Genetics and Plant Pests Poster Presentations

EUJAYL, IMAD*[1], FALER, JOYCE[2] and STRAUSBAUGH, CARL[1], [1]USDA-ARS- NWISRL, [2]The Amalgamated Sugar Co., [1]3793 N. 3600 E. Kimberly, ID 83341, [2]1951 S. Saturn Way, Suite 100, Boise, ID 83709 **Winter Sugarbeet: Identification of a mutant parental line resistant to post-winter bolting.**

The biennial nature of the sugarbeet plant leverages extended vegetative growth that is associated with increased sugar yield under favorable climate. Planting sugar beet in the fall/autumn can provide a new winter crop or extend the growing season in temperate climates. The genetics of sugar beet resistance to post-winter bolting is highly heritable (h2=0.85) and under control of a quantitative trait locus (QTL) in chromosome IX. Specifically, BR1 is the major monogenic inheritance indicator of the locus, but with incomplete genetic-penetrance. In this study we identified a mutant line; namely KEMS12- 17FP (selected from KEMS-12; PI672570) that carries four DNA markers within this QTL. KEMS12-17FP was planted in the fall of 2015 at the USDA-ARS research station in Kimberly, Idaho (42.5o N 114.4o W). In the spring of 2016, individuals homozygous for the four DNA-markers didn't bolt. The selected individuals were artificially re-vernalized for 120 days that resulted in normal seed setting. When planted in the fall of 2017, the KEMS12-17FP plants had 82% post-winter bolting resistance since the line was not homozygous for this trait. Roots from non-bolting individuals were manually harvested and sampled for sucrose content. The average sucrose content of 15.5% of this pre-breeding line is normal. This line was used as female-parent to produce F1, while the male parents (KPS19, KPS24 and KPS25) were heterozygous and their post-winter bolting resistance was unknown. The F1 individuals were planted in the fall of 2017 had both post-winter bolting resistant individuals and individuals that bolted after winter. KEMS12-FP17 is a parental line that is suitable for introducing the non-bolting resistance trait into commercial parental genetic backgrounds to produce non-bolting frost tolerant cultivars.

FUGATE, KAREN K.*[1], ABBAS M. LAFTA[2], JOHN D. EIDE[1], MOHAMED F.R. KHAN[2] and FERNANDO L. FINGER[3], [1]USDA, Agricultural Research Service, [2]Department of Plant Pathology, [3]Dept. de Fitotecnia, [1]ETSARC, 1605 Albrecht Blvd. N., Fargo, ND 58102, [2]North Dakota State University, Fargo, ND 58108, [3]Fed. Univ. de Viçosa, 365712-000, Viçosa, MG, Brazil **Bidirectional sucrose transporters are upregulated during sugar beet root storage.**

During production, large concentrations of sucrose accumulate in the parenchyma cells of the sugar beet taproot. Accumulation is possible because sucrose is sequestered in the vacuole of these cells, thereby separating sucrose from the sucrose-degrading enzymes which are predominantly present in the cytoplasm. During storage, sequestered sucrose is remobilized to provide the substrates and energy needed to heal wounds, maintain metabolism, and to fuel plant defenses against storage pathogens. How sucrose is remobilized to fuel this metabolism, however, is unknown, although this information would provide valuable insight into the mechanisms by which sucrose is lost during storage. To identify metabolic and genetic factors that may be involved in sucrose remobilization and degradation in storage, transcriptional and metabolic changes were determined in roots stored at 5 and 12°C for 0, 12, 40 or 120 days. While the sucrose concentration in the sugar beet taproot declined, only small changes in expression were noted for the sucrose synthase and invertase genes which are directly responsible for sucrose cleavage during storage. However, three bidirectional sucrose transporter genes, that were expressed at very low levels at time of harvest, were highly upregulated during storage, with expression increases of 26, 103, and 52,000-fold, respectively, observed for the three genes. The expression of bidirectional sucrose transporters has not been previously reported in the sugar beet taproot, and no information regarding their function is currently available. However, bidirectional sugar transporters facilitate sugar transport across vacuolar and plasma-membranes in other plant species. This information, in conjunction with the large increase in their expression that occurred during storage, suggest that bidirectional sugar transporters may function in sucrose remobilization in postharvest sugar beet taproots.

GOODWILL, THOMAS R.*[1], HOLLY J. CORDER[2] and LINDA E. HANSON[1], [1]USDA- ARS-SBRU, [2]Michigan State University, [1]612 Wilson Rd, Plant Biology, Rm 37, East Lansing, MI 48824, [2]3775 South Reese Rd, Frankenmuth, MI 48734 **Optimizing Techniques for Evaluating Cercospora Leaf Spot in a Michigan Field Nursery.**

Cercospora leaf spot disease nurseries were run in Colorado (CO) since the 1950's. Colorado was a good place to evaluate Cercospora, since that region had few other leaf spots. The region experienced housing development and limits on irrigation water, making it hard to keep the nursery in Colorado. In 2006, the Cercospora nursery was moved to Michigan (MI) where the climate is humid and water is abundant, which creates conditions for ideal development of Cercospora. However, Michigan's climate also is conducive to the development of other leaf diseases, which has necessitated modification and optimization of techniques used to create a successful Cercospora leaf spot nursery. The Ruppel and Gaskill methods were initially used in Michigan, but now have some key changes. In MI, the Cercsopora nursery is inoculated using spore counts instead of leaf:water ratios, irrigation is applied minimally, buffer/spreader rows are placed perpendicular in the fields, and leaves collected for inoculum are selected to avoid other common leaf spots. In 2009 and 2010, the Ruppel and Gaskill methods and the MI methods were compared. In both years, the peak of the epidemic was at least 10 days earlier using the MI methods as compared to the Ruppel and Gaskill methods. A closer look at how changes to the Ruppel and Gaskill methods have improved the performance of the Cercospora leaf spot nursery, in MI, will be discussed.

GROULX, BRIAN J*, JAMES STEWART, COREY GUZA and DENNIS BISCHER, Michigan Sugar Company, 1459 S. Valley Center Drive, Bay City, MI 48706 **Managing Rhizoctonia solani root rot in sugarbeets in Michigan with registered and experimental fungicide applications.**

Michigan sugarbeet growers lose an estimated 1 to 4 tons per acre to Rhizoctonia root rot infestations depending upon the region they farm in. Yield losses can be much higher when weather conditions prevent timely fungicide applications, when sprayer malfunctions occur or when the wrong variety is planted. Michigan Sugar Company has three distinct Rhizoctonia risk zones. The western region has a high risk of Rhizoctonia root rot and tolerant varieties in addition to Quadris applications are required to grow a successful crop. The central region has a moderate risk and the eastern growing region has a low to moderate risk of Rhizoctonia. Rhizoctonia root and crown rot is caused by the fungus Rhizoctonia solani. This fungus is divided into several anastomosis groups (AGs). R. solani AG 2-2 IV and IIIB are the AGs that cause root and crown rot in sugarbeets. Surveys conducted by Dr. Linda Hanson, USDA-ARS, East Lansing Michigan, show that the IIIB strain is more virulent and prevalent than the IV strain. Almost all of the Michigan sugarbeet growers utilize Quadris (azoxystrobin) in some manner. Approximately 50 percent of the growers apply Quadris in-furrow at planting followed by an 8 leaf foliar application directed at the sugarbeet crown. About 40 percent of the growers apply only a foliar Quadris application and about 10 percent apply only an in-furrow application. Quadris applied in-furrow (7 to 10 fl oz/A) at planting in a 3 to 4 inch T-band followed by a Quadris application at the 8 leaf stage (14 fl oz/A) in a 7 inch band has provided the best Rhizoctonia root rot control in Michigan. Quadrisapplied in-furrow at 7 to 10 fl oz/A provides better Rhizoctonia control than Quadris (14 fl oz/A) applied in a 7 inch band at the 4 to 8 leaf. The 7 fl oz in-furrow rate is recommended for most of the Michigan growing region and the 10 fl oz rate is recommended for our western "high risk" region. With foliar applications, the 6 to 8 leaf stage has generally provided the best results. Quadris applied at the 2 leaf stage and the 10 to 12 leaf stages have not given good Rhizoctonia control. Trials have also been conducted applying Quadris near row closure timing with little success. Because of the possibility of the fungus developing resistance to azoxystrobin, several fungicides with different modes of action are being evaluated by Michigan Sugar Company. Moncut (flutolanil) Group 7, Proline (prothioconazole) Group 3, Headline (pyraclostrobin) Group 11 and Xanthion

(pyraclostrobin plus a bacillus species) Group 11 and 44 have demonstrated effective Rhizoctonia control in research trials. This paper will discuss results from Michigan research trials utilizing the aforementioned fungicides for control of Rhizoctonia root rot in sugarbeets.

HANSON, LINDA E.*[1], JAIME F. WILLBUR[2] and JAN BYRNE[2], [1]USDA-ARS, [2]Michigan State University, [1]612 Wilson Road, 37 Plant Biology, East Lansing, MI 48824, [2]612 Wilson Road, 35 Plant Biology, East Lansing, MI 48824

Beet anthracnose from sugar beet in Michigan.

Starting in 2016, sugar beet samples with unusual symptoms were received at the Michigan State University Diagnostic Services and the sugar beet pathology labs. Seedlings with atypical stunting and foliar discoloration were received in the spring of 2016; a Colletotrichum species was isolated from these seedlings. Stunting and foliar discoloration symptoms were reproduced on sugar beet when greenhouse grown USDA germplasm was inoculated. Later in the season, and again in 2017 and 2018, leaf samples were received with lesions that had acervuli. Particularly distinctive were oblong lesions on the petiole. An identical Colletotrichum species was isolated from these samples. The fungus from both seedlings and adult plant leaves was identified as Colletotrichum dematium based on morphology. Colletotrichum dematium has been reported to cause beet anthracnose on sugar beet in Japan and on table beet in Canada. The pathogen causes anthracnose on other crops, including spinach in various parts of the world. To our knowledge C. dematium has not been previously reported on beets (sugar or table) in the United States. Genetic classification of the isolates is ongoing.

KAFFKA, STEPHEN[1], WILLIAM WINTERNMANTEL[2] AND ROBERT LEWELLEN[2]; [1]Department of Plant Science, University of California, Davis, CA 95616[2]; USDA-ARS, Salinas, CA, and USDA-ARS, Salinas, CA, (retired)

A pictorial scale for rating damage and loss to Beet vascular necrosis occurring in California.

Beet vascular necrosis caused by the bacterium *Pectobacerium carotovorum* subsp. *betavasculorum, (Gardan et al., 2003)* (formerly: *Erwinia carotovora* subsp. *Betavasculorum),* is a bacterial disease of sugarbeets that can cause significant economic losses. It occurs most commonly in late spring on young, vigorously growing crops, especially those fertilized with or taking up large amounts of nitrogen, and was common in the Delta region in northern California when sugarbeets were grown there. Evaluation of cultivars offered for sale or proposed for sale in California occurs yearly as part of a statewide cultivar evaluation program run by the California Beet Growers Association. Trials to evaluate commercial, near-commercial and experimental beet varieties have been carried out at Davis yearly for more than 10 years. Beets typically are planted in early May, and inoculated with a mixture of five strains of *Pectobacterium* collected from fields in California during previous years when beets were grown widely throughout the state. The culture is maintained at UC Davis. Inoculation occurs at the 8 to 12 leaf stage, immediately following damage to the crown. Beets are grown under standard conditions and evaluated near the end of August at approximately 110 to 120 days after emergence. A simplified scale rating the percent of root damaged has been developed to compare plant resistance to infection following inoculation, based on earlier work by Lewellen et al., (1978). Two indices, called a *Healthy index*, which weights variety performance based on the number of roots with zero or limited infection, {Healthy Index = [100*[(#=0)+ (#=VN) + (#=7%)]/# of plants in plot} and a *Disease Index* which weights performance based on the more infected roots {Disease Index= (#=7%)*7 + (#=25%)*25 + (#=50%)*50 + (#=75%)*75 + (#=93%)*93 + (3=100%)*100]/# of plants in plot}. These trials have had consistent results over time and are open to entries from all breeders. The scale is illustrated visually in this poster and sample results from previous years are provided.

LAFTA, ABBAS M.*[1], KAREN K. FUGATE[2], JOHN D. EIDE[2] and MOHAMED F.R. KHAN[1], [1]Department of Plant Pathology, [2]USDA, Agricultural Research Service, [1]North Dakota State University, Fargo, ND 58108, [2]ETSARC, 1605 Albrecht Blvd. N., Fargo, ND 58102 **Drought stress increases sugarbeet root respiration rate and susceptibility to storage rots.**

In Minnesota and North Dakota, sugarbeets are predominantly produced without irrigation. Drought stress, is therefore inevitable when seasonal rainfall is insufficient to meet the water requirements of the crop. Drought stress prior to harvest negatively affects plant growth, root and sucrose yield, and increases the concentrations of impurities that cause sucrose to be lost to molasses during processing. The effects of varying level of water stress on storage properties of sugarbeet, however, are not well characterized. To better understand and quantify the effects of preharvest water conditions on plant growth and sugarbeet storage, greenhouse experiments were conducted to determine the impact of varying levels of water stress on leaf photosynthesis and root storage properties including respiration rate and susceptibility to storage rots. Plants were grown in 15-liter pots for 18 weeks with supplemental light under a 16 h light/8 h dark regime and then subjected to water stress for 1, 2, or 3 weeks prior to harvest. Control treatments were watered daily. Photosynthesis was measured at the end of each water stress treatment and the harvested roots were stored at 10oC and 85% relative humidity for 12 weeks. Plant growth, photosynthesis and root yield were reduced by water stress. Roots harvested from visibly water stressed plants had higher rates of respiration and increased susceptibility to storage rot due to Botrytis cinerea and Penicillium claviforme. These results indicate that root dehydration caused by water stress during the growing season negatively impacts root storage.

MICKELSON, HAL*[1], JEFF NIELSEN[1] and ASHOK CHANDA[2], [1]University of Minnesota, Northwest Research and Outreach Center, [2]University of Minnesota, Department of Plant Pathology & Northwest Research and Outreach Center, [1]Crookston, MN 56716, [2]CROOKSTON, MN 56716 **Synergies of Triazole Fungicides with Five Tank-mix Partners for Controlling Cercospora Leaf Spot on Sugarbeet.**

The rise in insensitivity of *Cercospora beticola* isolates to various fungicides necessitates their use in mixtures. Fungicides mixtures can be synergistic, antagonistic or additive in effect depending on the chemistry and type of formulation. Unforeseen effects on disease control and harvest yield and quality can result when applying mixtures without knowledge of existing fungicidal interactions. The objective of this trial was to identify triazole by tank-mix partner interactions that impact Cercospora Leaf Spot (CLS) disease control or sugarbeet root yield and quality. A CLS inoculated trial was conducted at the University of Minnesota, Northwest Research and Outreach Center, in 2017 and 2018; designed as a replicated four by six factorial experiment, randomized using a split–plot restriction. Fungicide treatments were applied four times during the growing season. Individual triazoles Caramba, Inspire XT, Minerva and Proline 480 SC were assigned as whole plots; BALLAD Plus, Badge SC, Bravo Weather Stik, Lifegard WG, Manzate Max and 'no-partner' as split plots. CLS severity data were collected using a 1 to 10 scale approximately every seven days after inoculation. Yield and quality data were collected at harvest. Statistically significant triazole by tank-mix partner interactions were observed for disease severity and harvest yield. That is the four triazoles differ for their pattern of synergy with the partners. All triazoles have the same mode of action (MOA), inhibition of C14 demethylation in sterol biosynthesis, but differ significantly in their spectrum of activity. Inspire XT with no partner demonstrated CLS control that was as good or better than with a tank-mix partner and demonstrated the highest numeric root-yield level. The other three triazoles demonstrated their best CLS control both when tank-mixed with Manzate Max and when mixed with Bravo Weather Stik. Their lowest level of CLS control and yield were with no partner. The biological disease control agents BALLAD Plus (involving *Bacillus pumilus* strain QST 280) and Lifegard WG (involving *Bacillus mycoides* isolate J) achieved CLS disease control and yield levels similar to the copper fungicide Badge SC. Mancozeb fungicides including Manzate Max, copper fungicides including Badge SC, and biological agents are in current commercial use for CLS control in sugarbeet. Approval for use on sugarbeet of chlorothalonil fungicides including Bravo Weather Stik is under consideration.

NIELSEN, JEFF*[1], HAL MICKELSON[1] and ASHOK CHANDA[2], [1]University of Minnesota, Northwest Research and Outreach Center, [2]University of Minnesota, Department of Plant Pathology & Northwest Research and Outreach Center, [1]Crookston, MN 56716, [1]Crookston, MN 56716 **Impact of Late-season Fungicide Application on Cercospora leaf spot development in Subsequent Growing Seasons.**

Cercospora leaf spot (CLS) caused by *Cercospora beticola* remains a major production challenge across sugarbeet growing areas of Minnesota and North Dakota, other USA growing areas and worldwide. A CLS epidemic is most dependent on inoculum potential and weather. Specific factors leading to CLS epidemics include favorable weather conditions, lack of highly resistant varieties, and development of resistance or tolerance to current fungicides and lack of new fungicide chemistries. Short infection cycle coupled with production of large number of conidia can lead to severe CLS epidemics. *Cercospora beticola* survives between seasons as pseudostromata, the overwintering structures. Survival duration is associated with the rate of crop-residue decomposition; often a four-year crop rotation is encouraged. Early in-field CLS disease observations are often adjacent to areas previously in sugarbeet production, in areas close to shelterbelts and near areas where CLS management was subpar because of challenges associated with spray equipment and adequate fungicide coverage. Anecdotal observations suggest that early CLS development can follow tillage patterns, including tillage that moves crop residue between adjacent fields. Even though CLS disease development is slow or appears to have stalled in the fall environment before harvest, CLS pseudostromata that developed during a growing season can leave ample inoculum to revive infections the next growing season. The objective of this experiment was to evaluate the effect of various fungicides applied at the end of the growing season (1 to 21 days prior to harvest) on development of CLS disease in the next growing season. Sugarbeet was planted in 2018 on sugarbeet plots that had been sprayed with Priaxor, Inspire XT, Super Tin or Badge SC at labeled rates in 2017. Badge SC was applied in tank solutions adjusted to pH 5.0 and 8.3. Untreated control plots were included and an end-of-the 2017 season CLS severity score recorded. Plots were arranged in a randomized complete block design. Development of CLS was recorded in 2018 beginning June 27 and continued until August 6. On June 27, no CLS lesions were observed for plots receiving Badge SC pH 5.0 or Inspire XT, whereas CLS symptoms were visible for all other treatments. By July 11, there were significant differences among treatments with the untreated control having highest CLS, intermediate for Priaxor and Badge SC pH 8.3, and lowest for Super Tin, Badge SC pH 5.0 and Inspire XT. The importance of late season CLS disease control is an apparent conclusion from the observed CLS differences. Differences in the timing of first visible CLS symptoms and progress of CLS suggest Super Tin, Badge SC pH 5.0 and

Inspire XT as suitable for late season CLS management. These appeared to help reduce the levels of overwintering inoculum and delay CLS disease onset the next growing season.

PEGOT-ESPAGNET, PRUNE [1], DESPREZ B.*[2], DEVAUX B.[2], DEVAUX P.[2], HENRY K.[2], HENRY N.[2], WILLEMS G.[3], GOUDEMAND E.[2] and MANGIN B.[1], [1]INRA, [2]Florimond Desprez Veuve & Fils SAS, [3]SESVanderHave, [1]INRA, LIPM, équipe GGT, 24 Chemin de Borde Rouge - Auzeville, CS 52627 31326 Castanet-Tolosan, France. Phone: +33 5 61 28 57 27, [2]3, Rue Florimond Desprez, BP 41, F-59242 Cappelle-en- Pévèle, France, [3]SESVanderHave, Industriepark Soldatenplein Zone 2 / Nr 15, 3300 Tienen, Belgium **Original Genetic Diversity Discovery Comparing A Sugar Beet Elite Panel With A Progeny From (Sugar Beet Elite X Exotic) Cross.**

Selection of stable varieties producing the highest amount of extractable sugar per hectare (ha), resistant to diseases and respecting environmental criteria is undoubtedly the main target for sugar beet breeding. Introgressing exotic germplasm into breeding programmes can be a way to bring new interesting allelic diversity in breeding material. Two sugar beet populations, an elite panel (2101 genotypes, phenotyped in 21 environments, genotyped with 629 SNPs) and (elite x exotic) progeny (187 genotypes, nine environments, genotyped with 303 SNPs), were compared for three traits: potassium quantity (K meq/100g), sodium quantity (Na meq/100g) and N-alpha-amino quantity (N meq/100g). Genome-wide association studies (GWAS) were performed for each trait in each population with the multi-locus mixed model approach (MLMM) proposed by Segura et al. (2012). The eBIC parsimony criterion (Chen and Chen, 2008) was used to choose the MLMM model that explains best trait variability with the least SNPs. Then SNPs were merged into QTLs if they were located on the same chromosome and have linkage desequilibrium greater than a significance threshold, calculated for each population from corrected r2 (Mangin et al, 2012). The number of selected SNPs was higher in the elite panel due to higher power of detection and larger diversity. Very close SNPs in both populations were found, e.g. a probably pleiotropic QTL for Na and N traits located at the middle of the chromosome 5. Differences in genetic architectures were also observed, as the SNP detected for Na in the second half of the 5th chromosome in the (elite x exotic) progeny for which there is not colocalized detected SNP in the elite panel for this trait. Moreover, some SNPs detected in the (elite x exotic) progeny showed a favorable effect of the exotic (i.e., the impurity quantity decreases with the presence of the exotic allele). These results illustrate that the introgression of exotic alleles into elite germplasm is an interesting method to bring new useful variability in breeding material. This Research program is funding by the French Government, under the management of the Research National Agency (ANR). AKER is included in the «Investissements d'avenir » as refered as ANR-11-

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Segura, V., Vilhjálmsson, B. J., Platt, A., Korte, A., Seren, Ü., Long, Q., and Nordborg, M. An efficient multi-locus mixed-model approach for genome-wide association studies in structured populations. Nature genetics, 44(7):825–830, 2012.

STRAUSBAUGH, CARL*[1] and ERIK WENNINGER[2], [1]USDA-ARS NWISRL, [2]Univ. of Idaho, [1]3793 North 3600 East, Kimberly, ID 83341, [2]Kimberly R&E Center, 3806 North 3600 East, Kimberly, ID 83341
Management of Curly Top in Sugar Beet with Foliar Insecticides.

Curly top (CT) caused by Beet curly top virus is a widespread disease problem vectored by the beet leafhopper in semiarid sugar beet production areas. Host resistance is the primary defense against CT, but resistance in commercial cultivars is only low to intermediate. The neonicotinoid seed treatments supplement this resistance to provide early season CT control, but are currently under review. In order to identify other CT management options, 7 foliar insecticides AzaDirect, Beleaf, BotaniGard, Endevor, Rycar, Sultan, and Truvia) were compared versus a non-treated check and 2 commercial insecticides (Poncho Beta and Asana) in 2018 on commercial sugar beet cultivar B57. The plots were arranged in a randomized complete block design with 8 replications. A CT epiphytotic was created by releasing six viruliferous beet leafhoppers per plant at the 8- leaf growth stage on 19 Jun, which was 1 week after the foliar treatments were applied. A natural infestation of black bean aphids (BBA) also allowed for aphid control to be evaluated. Foliar CT symptoms were evaluated on 24 Jul and 5 Sep and the percentage of plants with an aphid colony in the crown was determined on 24 Jul. In the non-treated check, CT symptom development was severe and 42% of the plants had BBA. Based on visual CT ratings, Poncho Beta and Asana were significantly better than the 7 foliar insecticides which provided little or no influence on the control of CT. Poncho Beta ranked first for aphid control (4% of plants had aphids), but Truvia (18%) also performed better than most other products. These data show that sugar beet production in areas with curly top and black bean aphids would potentially suffer without the availability neonicotinoid seed treatments.

WEILAND, JOHN J.*[1], ROSHAN SHARMAPOUDEL[2], GARY A. SECOR[2] and MELVIN D. BOLTON[1], [1]USDA - ARS, [2]NDSU, [1]1616 Albrecht Blvd N. Fargo, ND 58102, [2]NDSU Dept. 7660, PO Box 6050, Fargo, ND 58108 **A novel satellite virus discovered during a bait assay for soilborne viruses of sugar beet.**

Next generation sequencing has emerged as a powerful diagnostic tool to assist the plant pathologist in the detection and diagnosis of new and known disease agents. In an effort to better characterize the milieu of soilborne viruses present in conjunction with BNYVV in association with rhizomania disease, sugar beet seed of a rhizomania- susceptible variety was sown into soil typed for inducing severe rhizomania disease. At 5 weeks post planting, seedlings were harvested, and the roots carefully washed prior to an extractive treatment which enriched for the presence of viruses within the sample. Electrophoresis of the RNA extracted from the enriched sample revealed an unusually abundant RNA species (~1.2 kilobases in size) in addition to standard ribosomal RNA contaminants of the preparation. Cloning and subsequent sequencing of the RNA species indicated it to be a previously-unknown satellite virus weakly related to satellite maize white line mosaic virus and other satellite viruses associated with 'helper' Necroviruses. Future objectives will be to identify the helper virus associated with the novel satellite virus among the many viruses detected within the analysis and to produce infectious cDNA clones of both helper and satellite for pathogenicity studies. Infectivity studies of this nature ultimately will lead to an understanding of any contribution of this virus/satellite combination to rhizomania or other sugar beet diseases.

WEILAND, JOHN*, JONATHAN NEUBAUER and MELVIN D. BOLTON, USDA - ARS, 1616 Albrecht Blvd N. Fargo, ND 58102 **Commercial sugar beet in Minnesota possessing the Rz2 gene and testing positive for BNYVV.**

Sugar beet production in Minnesota was under threat from the emergence of Rhizomania disease in the 1990s and the inclusion of Rz1 gene for resistance to the disease in subsequent approved varieties proved efficacious in producer fields. Defeat of Rz1 in many regions by resistance-breaking (RB) isolates of BNYVV, causal agent of rhizomania disease, prompted addition of a second resistance gene, Rz2, to the defense arsenal in an effort to retain economic viability to sugar beet production where needed. As a proactive measure, the majority of producers in Minnesota currently grow commercial hybrids possessing both genes; additional genes may be present as part of the resistance selection process implemented by the seed industry. In an effort to establish a baseline for the detection of BNYVV in field-grown sugar beet possessing the combined Rz1 +Rz2 resistance package, beet roots of such varieties as well as several possessing Rz1 alone were obtained from production fields in the American Crystal, Min-Dak Farmers, and the Southern Minnesota Beet Sugar

Cooperative regions of Minnesota. Beet root morphology ranged from those exhibiting classic Rhizomania disease to healthy looking roots with several of the latter nevertheless exhibiting occasional hairy root proliferation in the root furrow. Testing of the lateral rootlets and root hairs by ELISA yielded positive confirmation of the presence of BNYVV in the tissue for most roots tested while several healthy roots tested negative for the virus. The molecular typing of the BNYVV obtained from test-positive roots with respect to genomic regions implicated in RB ability will be presented. Factors combining with the discovery in the impact on future yields will be discussed.

WINTERMANTEL, WILLIAM M.*[1], LAURA L. JENKINS HLADKY[1] and DIMITRE MOLLOV[2], [1]USDA-ARS Crop Improvement and Protection Research Unit, [2]USDA-ARS National Germplasm Resources Laboratory, [1]1636 East Alisal Street, Salinas, CA 93905, [2]Bldg 004 BARC-West, Beltsville, MD 20705 **Genomic characterization of Beet oak leaf virus: a putative member of the family Rhabdoviridae.**

Beet oak-leaf virus (BOLV) is a soil-borne virus that induces oak-leaf shaped patterns on sugarbeet leaves, but roots of BOLV-infected sugarbeet plants appear healthy in contrast to those of plants infected by Beet necrotic yellow vein virus (BNYVV), which causes rhizomania disease. BOLV was previously identified in soils from California, Colorado, Idaho, Michigan, Minnesota, Nebraska, Oregon and Washington, often co- infecting plants infected with BNYVV. An isolate of BOLV producing oak leaf symptoms on sugarbeet was collected from the USDA research station in Salinas, CA in 2016 and confirmed to be infected with BOLV by ELISA testing using antiserum previously developed against the original isolate of BOLV. To determine the sequence of BOLV, total RNA was extracted from symptomatic leaves of this plant and examined by next generation sequencing (NGS). Sequencing results suggesting the presence of a varicosa-like virus, as well as sequences of Beet cryptic virus 1 (BCV1) which does not cause disease but is common in sugarbeet. Primers were designed to the varicosa-like virus sequences and used to confirm the presence of this virus in the original extract used for sequencing, as well as in archived, purified RNA samples of BOLV collected between 2008 and 2012. All amplicons shared 99-100% sequence identity, further confirming the sequenced virus as BOLV. In order to obtain additional sequence of the virus, extract was sent for cDNA library construction and high throughput sequencing (HTS). HTS data assembly demonstrated the presence of BCV1 and two varicosa-like virus RNAs. The L protein encoded by RNA1 shares 39% amino acid identity with that of Lettuce big vein associated virus (LBVaV; genus Varicosavirus, family Rhabdoviridae), its closest known relative, whereas the coat protein of RNA2 shows only 30% identity with the LBVaV coat protein, suggesting this RNA may be significantly diverged from other known members of the genus Varicosavirus.

These results demonstrate that BOLV is a new member of the family Rhabdoviridae, and a putative divergent member of the genus Varicosavirus.

Processing
Oral Presentations

BJARNE CHRISTIAN NIELSEN* and TIM DIRINGER, Neltec Denmark A/S, Vestergade 35, 6500 Vojens, Denmark **A new approach to control spray water addition and spinning time in batch centrifuges.**

The sugar quality delivered by batch centrifuges depends a lot on the massecuite quality and the operation of the centrifuges. The massecuite quality is mainly influenced by the crystallisation. The amount of sugar crystals, the crystal size and crystal size distribution contribute to the purgeability of the massecuite. The operation of the discontinuous centrifugal has to be adapted to the massecuite quality in order to receive sugar of good and stable quality. One key issue in the process of centrifugation is the addition of spray water. It is not only important how much water is added but also the number of sprays and the proper timing of the sprays have a major influence on the sugar quality. Usually each spraying interval is defined by timers that will give the start point and the end point of the spraying interval. Neltec has developed a method that allows monitoring of the syrup purging. The signal of the syrup purging from the centrifugal can be used to control each spraying interval at the technical correct time instead of using fixed timers. Another important set point on batch centrifuges is the correct time to stop the spinning. If the spinning is stopped too early the final moisture of the sugar crystals will be to high. If the spinning is stopped too late the sugar will be too dry and it may be difficult to fully discharge. The new Neltec ColourQ 1700 BC will allow the factory to stop spinning at the right time to obtain a more uniform sugar moisture. The presentation of the results collected in different sugar factories shows how the Neltec control system for batch centrifuges can help the factories to optimize the centrifugation process by avoiding pre set timers for water addition and spinning control.

BRUHNS, PHILIPP*, TIMO KOCH, AND LOTHAR KROH, Technische Universität Berlin, Gustav-Meyer-Allee 25 **Studies on the storage stability of white beet sugar depending on its quality.**

Storage stability is an important element of sugar quality. Due to color formation during storage the sugar color can exceed the quality criteria for white sugar. It is not possible to predict the color formation tendency of a white sugar charge. Also the source and the mechanism of color formation are unknown.

Color formation in sugar is caused by several factors, which can be divided into the external influences such as humidity and temperature during storage and the internal causes such as contents of ash, polyphenols, nonsucrose-saccharides and amino compounds. Experiments under accelerated storage conditions at 30 °C and 50 °C have shown an accelerating influence of the temperature and the humidity on the color development. But the nonsucrosecompounds have a more important influence. This can be seen in the uneven color distribution in the crystals and the strong color formation tendency of the syrup layer in the surface film of white sugar crystals. A higher quality sugar will develop less color. In the study investigations on the distribution of colorants and non-sucrose compounds in sugar crystals were carried out and the changes of the nonsugar compounds in the surface film during storage were analyzed. The purpose of this study was to show correlations between the changes in contents of nonsugar compounds and color formation. The saccharides were analyzed with a HPAEC-PAD, the amino acids were enriched with a solid-phase extraction and quantified with a GC-MS. 14 amino acids could be quantified in white sugar. The found decrease in the amino acid and monosaccharide content during storage indicates that the Maillard reaction is responsible for color formation. In further studies the Maillard reaction was studied in model experiments and the formation of by-products and colorants depending on the water content examined. Conclusions were drawn about the color formation in sugar and the optimal storage conditions. The formed oligomers were analyzed with mass spectrometry and structures similar to the postulated structures from Kroh and Cämmerer were found [1]. [1] Cämmerer, B.; Jalyschko, W.; Kroh, L. W.: Intact Carbohydrate Structures as Part of the Melanoidin Skeleton. Journal of Agricultural and Food Chemistry 2002, 50, 2083–2087.

CARLSON, JEFFREY L.*[1] and DONALD C. HARTMAN[2], [1]Southern Minnesota Beet Sugar Cooperative, [2]Garratt-Callahan, [1]83550 County Road 21, Renville, MN 56284, [2]50 Ingold Rd, Burlingame, CA 94010 **Utilization of a Process/Pond Sulfur Mass Balance to Identify Controllable Sulfur Sources in Wastewater and Process Ponds at Southern Minnesota Beet Sugar Cooperative.**

At the Renville, Minnesota facility Southern Minnesota Beet Sugar Cooperative is required to measure and report all ambient air concentrations averaging above 30 ppm lasting 30 minutes to the State of Minnesota from April 1 through October 31. In the spring and fall of 2018, process streams and ponds were analyzed for sulfur, organic loading and other inorganic compounds to identify the sources of sulfur. The paper discusses the results of a sulfur mass balance and possible solutions for specific high-sulfur containing streams include rerouting the steams for different uses and the merit of using of alternative chemicals.

CARLSON, JEFFREY L., Southern Minnesota Beets Sugar Cooperative, County Road 21, Renville, MN 56284 **Experiences with Wash Water Clarifier Performance at Southern Minnesota Beet Sugar Cooperative.**

Many factors can potentially affect the performance of a wash water clarifier including pH, the presence of calcium, entrained air, flows, rake speed, temperature, flows, total suspended solids, dissolved solids, density. Over the past several years a SMBSC has studied and modified the operation of the wash water clarifier to improve its performance. Some of the most important results were that the addition of lime, amount of entrained air and internal clarifier flows had the biggest influence on the performance.

CHUDASAMA, ARVIND Int Sugar Journal, Informa Business Intellingence, Christchurch Court, 10-15 Newgate Street, London, EC1A 7AZ, UK
Exploiting lignocellulosic feedstocks for lignin and chemicals.

Over the past decade, there has been considerable research on cellulosic biofuels. This involves, breaking down biomass residues be it crop or wood waste into component parts cellulose, hemicellulose and lignin, and breaking down the former two further into C5 and C6 sugars to make them available for the production of fuel ethanol via the conventional fermentation routes. There has been considerable research, by both biotech start-ups and government research establishments to develop process conversion technologies to produce purified lignin, a valuable commodity and platform chemical from which to produce a variety of other useful chemicals and end products (e.g. muconic acid and pyrogallol which currently have a combined market value of US$255.7 billion, carbon fibre composites). This paper provides an overview of current developments in the sector and the opportunities these proffer the sugar industry in exploiting the emerging technologies to diversify and prosper from the waste product it generates.

DIRINGER, TIM* and BJARNE CHRISTIAN NIELSEN, Neltec Denmark A/S, Vestergade 35, 6500 Vojens, Denmark **Pay back of process control (A supplier's point of view).**

Pay back of new investments are often just valued by the amount of savings in regards of energy, sugar losses, labour costs etc. But these calculations often only give a small part of the real pay back of the process control. In the structure of a sugar factory you can find many areas where a simple addition in process control can lead to a more stabilized process that will increase the efficiency of the operators, the process and the overall performance of a sugar factory. This efficiency contributes significantly to the pay back of an investment although it cannot be calculated in numbers. During the last 30 years Neltec has supported sugar factories world wide not only by selling and commissioning of

inline colour measurement for sugar crystals, but also by helping the sugar factories to use the equipment in the correct way to achieve a more efficient process. Based on this experience this paper will try to show that pay back of investment is much more than only comparing money that has been spent with money that has been saved.

HOTCHKISS, ARLAND, U.S. Department of Agriculture, 600 E. Mermaid Lane **Sugar Beet Pulp Fiber.**

New co-products of sugar beet processing would increase value to growers and processors. Sugar beet pulp from a Minnesota processor was extracted with acid and alkali to produce pectin, alkaline soluble pectin and cellulose fractions. The sugar beet pectin does not gel like citrus pectin used for jelly and jam, but it is an excellent oil in water beverage emulsifier. Carboxy-methyl-cellulose can be produced from sugar beet cellulose and the cellulose has nano-fiber composite adhesive applications. The sugar beet pectin contains abundant arabino-galacto-oligosaccharide side chains that confer prebiotic properties that promote the growth and activity of health-promoting gut bacteria and also increase apoptosis of colon cancer cells. Health claims that commercial sugar beet fiber increases fecal bulk and sugar beet pectin maintains normal blood-cholesterol levels were approved by the EU. Therefore, several sugar beet pulp co-products could be utilized to add value to U.S. sugar processing.

HUENERLAGE, MICHAEL* and ARNDT, OLIVER, Eberhardt Schwab GmbH, Am Bauhof 21, 32657 Lemgo, Germany **Lime Kiln – possibilities for capacity increase.** A continuously increasing sugar demand challenges existing beet sugar factories.

In several factory audits it became obvious that most of the existing lime kilns are maxed out, especially if very old installations or Belgian type lime kilns – like in the US located beet factories – are involved. In some parts of a sugar factory a capacity increase can be achieved while a new additional equipment will be integrated in parallel to the existing one (i.e. a centrifugal). But this approach can be hardly applied at major factory equipment such as the lime kiln and milk of lime plant. This paper presents technical limits, ideas and options, to be considered when the lime and CO_2 quantity must be increased. In detail the paper touches the topics (1) technical limits of existing mixed feed kilns especially Belgian type kilns (2) induced draft vs. pressurized kilns, (3) effects of changes in the mechanical equipment or refractory lining, (4) additional benefits that would justify a conversion from coke to natural gas operation on existing lime kilns, (5) advantages of a new lime kiln installation, (6) the details of available technologies, (7) technology update for natural gas fired kilns and (8) economical aspect coke vs. natural gas and

(9) forecast view to develop systems usable for alternative gaseous fuels (i.e. biogas).

KAHRE, SCOTT M., Sugars International LLC, 305 Inverness Way South Unit 204, Denver, CO 80112 **Development of Factory Performance Curves Using SugarsTM for Windows.**

Sugar beet processing involves a series of complex, interconnected processes. Beet supply conditions and process parameters in one part of the factory have cascading effects throughout the rest of the facility. It is necessary to gain a full understanding of these relationships between process inputs and process outputs in order to optimize the process as a whole and maximize profitability. This can be a very difficult and time- consuming task, especially considering the non-linearity of many process relationships. A novel approach to this task has been developed using the SugarsTM for Windows mass and energy balance simulation software. "Performance Curves" can be generated by running a series of balances on an established factory model, varying one input parameter over a range of possible values. Two examples are presented: varying cossette sugar content, and varying diffuser draft. Comparisons are made between responses of parameters such as overall extraction, steam demand, molasses purity, net revenue etc. The applications of this technique to production planning, financial forecasting, and capital improvement planning are also discussed.

KOCHERGIN, V.*, E. JOHNSON and S. PEACOCK, Amalgamated Research LLC, 2531 Orchard Dr. E., Twin Falls, ID 83301 **Molasses Desugarization in the US Beet Sugar Industry: Recent Update.**

Molasses desugarization (MDS) is an example of a large-scale chromatographic separation that has been in use in the United States beet sugar industry for almost 40 years. The process has proven commercially viable under current market conditions, energy and environmental cost. As a result, most US sugar beet companies have been operating one or more MDS installations. Because of the variation in efficiencies and configuration of existing installations, it is sometimes difficult to evaluate the desired separation targets and identify the areas of operational improvement. Over the last few years, achievable separation targets have improved significantly, and new equipment configurations have been developed. Initially, a calculated sugar recovery ("sugar in the bag vs sugar in molasses") of 75-78 % was considered acceptable. In modern systems, up to 88 % efficiency is commercially achievable. However, almost no guidance is available in the recent literature about how to achieve these results for various process configurations. The current presentation will attempt to provide these answers as well as assist in a general understanding of large scale chromatographic technologies, existing types of equipment and factors that

influence separation efficiencies. For many years, MDS systems were installed as stand-alone operations that could easily be "plugged" into conventional sugar factories. As chromatographic extract has notably different characteristics compared to thick juice, special consideration will be given to the way the extract processing is integrated in factories.

LARSEN, KASPER GEHL* and JENSEN, ARNE SLOTH, EnerDry A/S, Kongevejen 157, 2830 VIrum, Denmark **Towards CO2 neutral beet sugar production.**

In the years to come there will be a political demand to the industry to emit less CO2, and the goal is CO2 neutral production. In order to meet this, the cheapest is to replace drum dryers by steam driers, which in general stands for 1/3 of the CO2 emission. Secondly the needed steam must be produced from CO2 neutral fuel; wood chips, wood pellets, straw, beet pulp. Electrical energy from the grid is already partly CO2 neutral and will in the future be produced 100% CO2 neutral. Therefore, the development goes towards electrical cars, where energy from fossil fuels is replaced by much less energy, supplied as electricity. Houses are to be heated by heat pump technology, where typically 3 kWh fuel is replaced by 1 kWh electricity. By steam drying of the beet pulp the power production in the sugar factory is reduced, but the ratio between saved fuel a lost power production is much higher than most other projects. Investment in steam drying saves much more CO2 emission per million € than other investments, like wind turbines, or biogas plants. Boilers for CO2 neutral biomass are expensive. A less expensive solution is a gasifier, producing gas to be burned in existing boilers. So far, the beet pulp is relative expensive as fuel, due to the value it has as fodder pellets. The dried beet pulp contains more energy than the factory needs, in opposition to the energy in the produced biogas, if all pulp is used in the biogas production. Alternatively, the whole factory can be operated on power from outside by Mechanical Vapor Recompression. But the ratio between used power and the saved fuel is not attractive.

LIMA, ISABEL M. *[1], CHARLES CLAYTON[1], ANNIE TIR[1], CRAIG PARKER[2] and EMMANUEL SARIR[3], [1]USDA-ARS-SRRC, [2]British Sugar, [3]Carbo Solutions International, [1]1100 Robert E Lee Blvd, New Orleans, LA 70124, [2]Peterborough, UK, [3]Los Angeles, CA **Powdered Activated Carbon to Adsorb Colorants from Sugar Beet Syrup: A Pilot Plant Study.**

During sugar beet processing, molasses is subjected to slow moving bed chromatography to extract high value betaine and recover more sucrose. The result is commonly a high color sugar beet extract. Sucrose recovery can be increased by recycling this extract from the chromatography system back into the crystallization unit. However, this is only economically viable after it

undergoes color reduction. Feasibility pilot plant studies were undertaken on the use of a high surface area powdered activated carbon (PAC) and diatomaceous earth (DE) to adsorb color compounds from sugar beet extract. Color compounds associated with beet extract either are generated during processing or are natural colorants. Experiments were performed using a batch decolorization process to maximize color removal and determine an optimal distribution of PAC either as a body feed or a pre-coat in a filter. A target of 50% color removal was achieved using 4,000 ppm of PAC with a recommended distribution of 75% as pre-coat in the filter and 25% as body feed in the process feed tank. A 50/50 distribution of PAC also produced consistent rate of color removal. PAC performance was slightly better for native colorants to sugar beet than factory colorants. Addition of PAC did not lead to sucrose loss neither had any negative effect on the pH of beet extract.

MAYER, MIKE* and SCHOENFELDER, CARL, Hydrite Chemical Company, 300 N. Patrick Blvd., Brookfield, WI 53045 **Utilization of Peracetic Acid as an Antimicrobial Agent in Sugar Beet Processing.**

In sugar beet processing, favorable conditions (i.e. temperature, pH, water activity, sugar and other nutrients) exist in which promote microbial growth, resulting in sugar loss. At various points within the process system, antimicrobial agents are used to reduce sugar loss by slowing the microbial growth (bacteriostatic) or killing the microorganisms (bactericidal). Within the U.S., sugar beet factories are regulated under the Food and Drug Administration (FDA) which allow the use of a number of chemicals to control microorganisms in sugar beet mills. Due to regulations and availability, the most commonly used antimicrobial agents are ammonium bisulfite, glutaraldehyde and hop acids. However, there is a continual need for alternative disinfectant technologies to meet the changing regulations and to prevent adaption by microorganisms. The purpose of this paper is to introduce a potential alternative antimicrobial agent, peracetic acid. Peracetic acid (PAA) is a strong oxidizing agent that has an oxidation potential greater than chlorine or chlorine dioxide. It has found wide utility in controlling microorganisms in food processing, agricultural, oil & gas, water treatment, and wastewater industries. Several trials have been carried out in sugar beet mills in the United Kingdom, Belgium, Italy and Finland with PAA demonstrating the technical ability of replacing formaldehyde, glutaraldehyde and dithiocarbamate programs to control microorganisms. This product like all other antimicrobial agents have limitations, but the application of peracetic acid chemistry in the sugar beet process exhibits many benefits.

NELSON, MICHAEL*[1], KAREN CUMMINGS[2] and RYAN VARGAS[1], [1]USP Technologies, [2]The Amalgamated Sugar Company, [1]1375 Peachtree Street NE, Suite 300N, Atlanta, GA 30309, [2]50 South 500 West, Paul, ID 83347**Lessons learned from hydrogen peroxide dosing into high-strength holding ponds at Amalgamated Sugar's Mini-Cassia plant.**

Hydrogen peroxide was dosed into four holding ponds to evaluate treatment benefits from March 2017 through August 2018. The hydrogen peroxide was applied using floating dosing lines (Peroxidons) spanning the entire length of each pond. This strategy was applied with and without surface aeration. Pond water quality parameters were rigorously monitored throughout the course of the evaluation. With dosing of hydrogen peroxide the general trends observed included decreases in chemical oxygen demand (COD), ammonia concentrations, and the intensity of several purgeable reduced sulfur, nitrogenous, and organic vapor phase compounds using USP's Shake Test methodology. Increases in nitrate concentration, oxygen reduction potential (ORP), and dissolved oxygen (DO) levels also were observed with dosing of hydrogen peroxide. With this strategy surface ORP could be maintained in the range of -100 to 0 mV versus the baseline range of -600 to -200 mV.

NELSON, MICHAEL*[1], KYLE BAIR[2] and RYAN VARGAS[1], [1]USP Technologies, [2]The Amalgamated Sugar Company, [1]1375 Peachtree Street NE, Suite 300 N, Atlanta, GA 30309 , [2]138 W Karcher Road, Nampa, ID 83687
Seasonal supplementation of aeration within high-strength water holding ponds using hydrogen peroxide at Amalgamated Sugar 's Nampa plant.

Excess flume and process water is stored within holding ponds with and without aeration and treated biologically until loadings are reduced sufficiently to allow discharge to the municipal treatment plant. This water is often retained into the summer when elevated temperatures could foster the development of septicity. The quantity and composition of this water varies significantly from each campaign. Hydrogen peroxide dosing was evaluated in the summer months of 2017 and 2018. Aeration capacity was expanded in 2018 and nutrient supplementation was conducted in 2017 and 2018. Chemical oxygen demand (COD) removal rates, oxygen reduction potentials (ORP), and dissolved oxygen (DO) concentrations were tracked throughout the evaluation. With hydrogen peroxide dosing concentrations of purgeable common reduced sulfur odorants like hydrogen sulfide and mercaptans/thiols were lowered. Purgeable vapor phase nitrogenous compounds, measured as ammonia and total amines, were not reduced with hydrogen peroxide dosing.

RAMANAN, ABILASHA*, CEO and Joakim Nyman; ImpactVision, Impact Hub San Francisco, 1885 Mission Street, San Francisco, California, United States 94103 **Detection of non-magnetic foreign objects in sugar at production-grade speed using hyperspectral imaging and machine learning technology.**

For the sugar industry, namely processors and distributors, contamination of sugar with foreign matter is a huge issue. Performing quality control through visual inspection is highly laborious, costly and inaccurate. A metal detector used can only detect metallic materials, and X-ray systems are designed to detect objects more dense than the food substance itself, meaning that lighter, non-magnetic materials such as plastic, paper, cardboard, insects, textiles etc., go undetected and can cause line stoppage, missed batches and in the worst instances, product recalls costing millions of dollars. Computer vision enables autonomous detection of contamination, and a hyperspectral camera in the near infrared spectrum allows for even materials difficult for the human eye to see such as translucent plastic to be detected, alongside other non-magnetic contaminants. With the machine learning algorithm Support Vector Machine a model can learn the spectral signature of different materials. It can be used to classify every single pixel as sugar or a contaminant and even discern the type of the material. The Specim FX10 is a line scanning hyperspectral camera operating in a wavelength range of 400-1000 nm and with a spatial resolution of 1024 pixels. With the Specim FX10 an autonomous system has been developed to detect and remove foreign matter of up to a size 0.5 mm on a 50cm wide conveyor belt moving at a speed of 75cm per second. Results shows that the accuracy of detection is significantly increased by using a hyperspectral camera instead of an RGB camera, especially for white and translucent plastic materials, where using an RGB camera gave a precision and recall score of 0.0 while using a hyperspectral camera gave 0.95 and
0.99 respectively. This tool has great potential for accurate, high resolution detection of non-magnetic contaminants at production-grade speeds.

RHOTEN, CHRISTOPHER D.*[1] and DR. BERND-CHRISTOPH SCHULZE[2], [1]ESCON America, [2]ESCON GmbH, [1]PO Box 1308, Black Mountain, NC 28711, [2]Schlossstrasse 48A,12165 Berlin, Germany **Alkalization pretreatment of thin juice supplied to weak acid cation thin juice softening.**

Operation of Weak Acid Cation (WAC) thin juice softening requires that concentration of limesalts in thin juice supplied to the WAC ion exchange cells be no higher than 0.100g CaO/100DS. In the normal course of beet storage, organic acid concentration in beets increases resulting in higher limesalts concentration in thin juice. When limesalts concentration in filtered hard thin juice increases above the operational limit of 0.100g CaO/100DS, the juice must be re-alkalized with an alkalizing agent to correct the alkalinity deficiency thus reducing the limesalts concentration in thin juice supplied to the WAC units.
Soda ash is generally used for the purpose of juice re-alkalization. Operation of 2nd carbonation at optimum alkalinity and correct soda ash addition results in limesalts concentration corrected to under 0.100gCAO/100DS approximating that in thin juice produced from fresh beet. Proper control of the re-alkalization

process results in thin juice routinely having sufficiently low limesalts concentration for supply to the WAC softening process while also giving relatively stable pH and color behavior in juice concentration. When so supplied, the WAC softening system routinely produces soft thin juice within targeted softened juice limesalts concentration limits. Relatively precise control of both 2nd carbonation alkalinity and addition of alkalizing agent, especially during periods of fluctuating beet quality, is essential to avoid both under and over alkalization of the juice. Under-alkalization results in limesalts concentration exceeding the operational limesalts limit to the WAC units. High limesalts concentration in juice supplied to the WAC units leads to resin overloading and, in turn, to temporary reduction in effective resin capacity along with difficulty in restoring resin capacity during normal resin regeneration cycles. Alternatively, over-alkalization, in spite of yielding sufficiently low limesalts concentration to the WAC units, leads to pH and color increase during juice concentration.

RICHARD, CHARLEY*[1], DARRELL GERDES[2], CARLOS CHAPA[3] and KEVIN RAMSEY[4]; [1]Sugar Processing Research Institute, [2]Imperial Sugar, Louis Dreyfus Company , [3]The Coca-Cola Company, &sup4;ASR Group, [1]1100 Robert E. Lee Blvd, New Orleans, LA 70124, [2]Sugar Land, TX, [3]Atlanta, GA, [4];Yonkers, NY **An Update: The US National Committee on Sugar Analysis and International Commission on Uniform Methods of Sugar Analysis.**

The United States National Committee on Sugar Analysis (USNC) was formed in 1937 and is the official member organization from the US to the International Commission for Uniform Methods of Sugar Analysis, better known by its acronym ICUMSA. This is the international organization that works to provide standardized methods for the analysis of sugar, molasses and various other associated products as well as sugar processes in both beet and cane operations. The members of ICUMSA are the national committees from each of the sugar industries that wish to participate. Summarizes of the USNC meeting held June 29, 2018 in Bonita Springs, FL and the ICUMSA meeting held August 26-29, 2018 in South Africa will be presented. The paper also seeks input from individuals within the sugar beet industry on specific method improvement or development as well as for membership to the USNC organization.

SUNKAVALLI, SAGAR*[1], GANTZER, CHARLES[2], HADNOTT, BAILEY[2], MENKEN, KEVIN[2], ANDREWS, LISA[2], FINNESGAARD, DALE[2] and LING, ALISON[2], [1]Southern Minnesota Beet Sugar Cooperative, [2]Barr Engineering Company, [1]83550 County Road 21, Renville, MN 56284, [2]4300 MarketPointe Dr, Suite 200, Minneapolis, MN 55435 **Feasibility of Biomass Storage and Implications for Operation of Anaerobic Digesters.**

Anaerobic reactors used in treating high-strength sugar beet wastewater require an extended startup period at the start of each beet-processing campaign. This study evaluated the feasibility of storing anaerobic biomass, specifically biomass from upflow anaerobic sludge blanket (UASB) reactors, during inter-campaign for use in reactor startup. UASB biomass from a sugar beet processing facility's wastewater treatment plant and from nearby UASB biomass sources was evaluated. Two parameters that reflect how useful a biomass is for UASB reactor startup are activity and ability to be retained in the reactor. Specific biomass activity and hydraulic retention characteristics were evaluated in bench-scale tests. Specific activity is the rate at which a unit mass of biomass can utilize a substrate, and was measured is batch anaerobic culture tests using stored UASB feed water. Washout characteristics were evaluated using a column upflow test operated over a range of upflow velocities. Column test results reflect the granularity of the biomass and, when compared with functioning reactor upflow rates, inform whether biomass would stay in the reactor during operation. Based on literature review and equipment considerations, room temperature storage was tested. Biomass was stored with or without an initial carbon feeding of corn starch and with supplementary ammonia nitrogen. Under the conditions tested, long-term storage had adverse effects on both specific activity and biomass granularity. Biomass was stored for up to eight months at room temperature with and without an initial carbon feeding. Storage durations of 2-5 months would likely be needed for full-scale inter-campaign biomass storage. A representative half-life for specific activity was about 3 months for the stored external biomass sources and the stored UASB reactor biomass. Thus, after about 3 months of storage, about 50 percent of the biomass granule's specific activity would be lost, and after about 6 months of storage, about 75 percent of the specific activity would be lost. Additionally, stored biomass typically remained granular for the first four months, but lost granularity between 4 and 8 months of storage. The use of an initial carbon feeding did not significantly affect the rate of activity loss or change in granularity. These results suggest that inter-campaign storage could be employed to supplement UASB reactor startup in areas where fresh, external UASB biomass sources are not readily available. However, biomass activity decreased substantially with storage, and biomass granularity also decreased to a lesser extent.

SUNKAVALLI, VIDYASAGAR*[1] and TONY WIDBOOM[2], [1]Southern Minnesota Beet Sugar Cooperative, [2]Barr Engineering Co., [1]83550 County Road 21. Renville, MN 56284, [2]4300 MarketPointe Drive Suite 200, Minneapolis, MN 55435 **Impacts of Recent Federal Air Quality Regulatory Changes on Sugar Beet Factories.**

In a series of recent and pending guidance documents, the U.S. Environmental Protection Agency (EPA) is fundamentally changing how sugar beet factories are regulated. EPA has changed its project emissions accounting procedures used to determine what constitutes a project, and whether projects are subject to lengthy federal air-permitting processes. Additionally, EPA has also issued a new guidance memorandum that repealed the "once in, always in" (OIAI) policy, allowing reclassification of a major source of hazardous air pollutants (HAPs) to an area source. Finally, EPA is in the process of changing how sources are defined and grouped. These changes were reviewed in relation to operations at two sugar beet factories to determine how the changes will impact factory operations and environmental compliance moving forward. Impacts to the industry as a whole werealso considered given that factories are subject to different air quality regulations throughout the country. The new guidance from EPA affords the sugar beet industry many opportunities to reduce their air quality regulatory burden and reduces the risk that capital projects will trigger the costly and time-consuming federal New Source Review (NSR) regulations. Emission decreases may be considered without a full "netting" process when determining NSR applicability, offering the opportunity to streamline permitting of efficiency improvements, plant reconfiguration, or replacement of aging equipment. Enforcement risk for factory expansions is also reduced because EPA will now consider only post-project actual emissions against major NSR thresholds, and will allow management of actual emissions below those thresholds. Although repealing the OIAI policy does not impact the case studies, this change could have significant impacts to the industry because a number of factories are classified as major sources of HAPs and may be able to show their emissions are not major through testing. Removal of Boiler MACT requirements (where applicable) could save significant costs related to performance testing and tune-ups. Finally, there may be situations where equipment under separate control or sites not geographically adjacent are improperly grouped with the factory stationary source. Expected upcoming changes (as of October 2018) could provide even more benefits to the industry. EPA is anticipated to clarify its routine maintenance exclusion, streamlining the review process for plant maintenance activities. Similarly, expected clarification of how projects are defined and aggregated will reduce the risk of triggering NSR review.

THUMMEL, MICHEAL T.*, SCHOENFELDER, CARL J., Hydrite Chemical Company, 300 N. Patrick Blvd, Brookfield, WI 53045 **Benefits and Methodology of Utilizing Strong Oxidizers for Clean In Place.**

The variability within unit process parameters, in addition to the nature and complexity of processing equipment, presents a real challenge to removing soils effectively, within an acceptable time frame. Plant expansions or modifications which have not included consideration toward upgrading clean in place (CIP) pumps, piping, and ancillary systems to maintain an optimal circulation rate, compound the issue. With these contributors impacting adequate circulation of the CIP solution, it can be difficult to ensure that there is sufficient soils removal activity occurring throughout the equipment's entire surface area when utilizing a conventional alkaline cleaning solution only. In these instances, the chemical action of an alkaline cleaner, alone, may be inadequate. The inclusion of a strong oxidizer, such as hydrogen peroxide, along with foam control agents, to the alkaline cleaning process, has proven to be very effective in overcoming this limitation. Mechanical action created by hydrogen peroxide decomposition, contributes to deposit removal and scouring in these low flow, low circulate rate conditions, by way of its' micro-bubbling effect. Surface contact of the cleaning solution is thereby increased. Accompanying chemistries provide the dual action of foam control and wetting agent. In process trials, and subject to conditions associated with typical fouling within beet plant equipment, the chemistry has been verified to have improved effectiveness. This chemical adaptation, in conjunction with developed application methodologies and guidelines, can provide the producer an alternative or augmentation to an established clean in place program.

WAMBOLT, CAROL L.*, DORIS C. FLEMING and LARSON H. CALDWELL III, Amalgamated Research, LLC., 2531 Orchard Drive East, Twin Falls, ID 83301 **Application of near-infrared spectroscopy (NIRS) for the detection of sucrose and betaine in streams surrounding the molasses desugaring by chromatographic process (MDC).**

Molasses is a by-product of sugar beet processing yet still has tremendous value, containing 50% sugar and 5% betaine by dry weight. Molasses desugaring by chromatography (MDC) has proven to be an advantageous extension of beet sugar factories to increase sugar yield as well as aid in the recovery of other valuable components such as betaine. One problem with industrial molasses desugarization is the lack of fast analytical methodology needed for effective process control. NIR spectroscopic measurement techniques offer several advantages compared to traditional analytical methods. NIR analysis provides rapid measurement data (30-60 seconds) for better decision making in production processes, requires little to no sample preparation and uses no chemicals or consumables. NIRS calibration models were developed which accurately predict sucrose and betaine levels across a wide range of concentrations, allowing for effective monitoring of the MDC process. The predictive performance of these models will be discussed.

Processing
Poster Presentations

BOUCHÉ, CATHERINE, ITECA SOCADEI, 445 Rue Denis Papin, 13592 Aix-en-Provence, FRANCE **The use of on-line HD cameras to optimize the crystallization process.**

Image processing techniques are now widely used in many sugar factories willing to optimize their massecuite production and improve sugar quality while increasing efficiency. The poster describes the installation of a high resolution camera on a batch pan and high resolution color cameras above a conveyor transporting wet sugar discharged from 2 sets of 4 centrifugals. It shows that a good characterization of the variables involved in the massecuite production leads to an improve operation of any type of batch pan. Analyzing the videos and statistical data, the operators can establish the best possible sequences to stabilize the massecuite production with highest yield. It also demonstrates how the sugar color at the centrifuges outputs can be rapidly stabilized: how it can also be used to optimize the individual washing times and automatically detect non conformities to avoid contaminating the dryer. The data from those experiments present the significant results achieved using on-line HD cameras.

EICKHORN, MANUEL. RHEWUM GmbH, Rosentalstrasse 24, Remscheid, 42899 Remscheid - Germany **Assessment of dust explosions in the sugar industry with regard to screening technology.**

The prevention of dust explosions is a necessary treatment to ensure the safe operation of sugar plants worldwide. Especially in the field of screening technology only few mistakes can lead to hazardous process conditions. This paper discusses the principles of sugar dust explosions with special focus on their formation. An example is given to show possible threats which can occur during production. Advices for choosing suitable process parameters and equipment are given. A professional dust control is key to decrease the risk of dust explosions.

LIMA, ISABEL M. USDA-ARS-SRRC, 1100 Robert E. Lee Blvd, New Orleans, LA 70124 **Sugar beet pulp as feedstock for biochar production.**

Processing of sugar beet roots for extraction of white refined sugar also yields sugar beet pulp as a byproduct. Traditionally, sugar beet pulp has been used as animal feed for its nutritional worth but other value-added transformations could further improve the economics of sugar beet production.

Thermo-chemical conversion of sugar beet pulp is one such avenue. This process converts the organic carbon rich pulp into a value-added biochar as the main product, but also produces synthesis gas and bio-oil, two products that could fit into alternative energy frameworks. This study looks at the physico-chemical and adsorptive properties of pelleted sugar beet pulp biochars produced at four different pyrolysis temperatures: 350, 500, 650 and 800°C for 1 hour residence time and investigated various uses from adsorption/remediation materials to source of fuel and use as soil amendment. Biochars were able to adsorb various heavy metals from solution, particularly lead, chromium and copper. While lower pyrolysis temperature biochars performed better in adsorption experiments, higher temperature biochars were better candidates for fuel applications. Due to their N-P-K composition, biochars from sugar beets also showed potential to be used as soil amendments to enhance soil health and improve crop yields.

SCHÖPF, STEFAN LenzingTechnik GmbH, Werkstrasse 2 4860 Lenzing Austria **Versatile filtration systems for many applications in the sugar mill**

In order to produce white crystalline sugar out of beet or cane, various process steps are required. Besides extraction, purification, evaporation and crystallization, filtration represents one of the key processes in sugar manufacturing. Filtration is required for sugar streams like thin juice, thick juice and molasses to produce high quality sugar in an economic way. Furthermore, filtration is also required for utility preparation, e.g. for purification of condensate, wash water or cooling water. The Lenzing Technik GmbH has been successful in the field of filtration for more than 40 years now and delivers remarkable benefits to the sugar industry with its unique filtration technologies.This paper describes how one versatile filtration system could be used for filtration of the main sugar streams, but also for highly efficient preparation of the utilities within the sugar production process.

WRIGHT, MAUREEN*[1], THOMAS KLASSON[1] and KEITAROU KIMURA[2], [1]USDA- ARS-SRRC, [2]NFRI-NARO, [1]1100 Robert E Lee Blvd, New Orleans, LA 70124 USA, [2]2- 1-12 Kannondai, Tsukuba, Ibaraki 305-8642, Japan **Application of beet juice as a fermentation substrate for acetoin production.**

Acetoin is a four-carbon ketone-alcohol used in the food, cosmetic, and industrial chemical industries. It is primarily produced by chemical synthesis. Due to the rising cost of petroleum, efforts are being made to more cost-effectively produce acetoin. A potentially efficient, non-chemical source of production utilizes microbial conversion of sugars to acetoin. In this study, the bacterium Bacillus subtilis was used to convert sugars in beet juice as a replacement for pure glucose in the fermentation process. Using unpurified natural sugars would allow an increase in profitability because the greatest

expense associated with biomass conversion are due to the substrate and costs associated with purifying it. Bacillus subtilis cells were grown in the presence of mixtures of glucose and the unpurified agriculturally-sourced sugars in beet juice at varying concentrations. Acetoin and sugar levels were analyzed by HPLC. Data revealed that a mixture of 75% beet juice with 25% glucose yielded an amount of acetoin that was almost equivalent to that of 100% glucose.