ABSTRACTS

of Oral Presentations and Posters
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PREFACE

The following section contains abstracts of papers/posters presented at the 38th Biennial Meeting of the American Society of Sugar Beet Technologists.

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Section A – Agronomy
Oral Presentations

ALDER, CLARKE G. Crop Consultant, The Amalgamated Sugar Company, 138 West Karcher Road, Nampa, ID 83687. **The economics of skipping a glyphosate application on Roundup ready sugarbeets.**

In years past, growers have applied a myriad of herbicides in order to bring a healthy crop of sugarbeets to harvest. Now, with the advent of the Roundup ready sugarbeet, it is much more uncommon to find an unhealthy sugarbeet crop due to weed competition. Roundup ready technology is one of the most significant changes in the history of the crop. Since its introduction however, many growers have become complacent believing that fewer applications of roundup are necessary each season—some to the point that they are reducing yield significantly by skipping or putting off necessary timely applications of the herbicide. This trial began as a local educational tool for growers in the Treasure Valley of Idaho, but provides useful information for all sugarbeet growers who are attempting to weigh the costs of particular applications of roundup against any yield loss they may incur by skipping the application. The trial was conducted in two different growers' fields under fairly similar environmental conditions. Agronomic practices were similar although not identical. Several treatment packages were administered with application timings ranging from pre-emergence to row closure. The yields tended to be higher with higher weed control, but sugar percentages did not appear to change significantly with weed control for most treatments.

BEAUDRY, RANDOLPH[1]*, MONA SHAABAN1, BRADLEY MARKS[1] AND KHALED YOUSEF[2]. [1]Michigan State University, East Lansing, MI and [2]Menoufia University, Menoufia, Egypt **Modeling Temperature and Heat Flux in Field Piles of Sugarbeets in Michigan**

Harvested sugar beet (*Beta vulgaris* L.) roots are stored in Michigan in large piles and exposed to ambient weather conditions during winter storage period, which generally lasts three to four months. During this

time, the air temperature may range from as low as -23 °C to as high as 16 °C. Winter air temperatures are rising in association with long-term trends of increasing global temperatures. Higher air temperatures contribute to increasing respiration and storage decay due to increasing metabolic activities, and give decay organisms optimal conditions to increase their growth and aggressiveness. Decay losses can result in losses of 206 g sugar/ ton beets/ day, which can amount to as much as $1 million dollars per week for the Michigan industry. Thus, it is important to understand the composition of the pile temperatures by developing a model to predict pile temperature based on the history of air temperature, pile age, and pile architecture. We designed a 2D model of the temperature profile of a non-ventilated pile as a function of air speed, direction, relative humidity, and temperature.

BEAUDRY, RANDOLPH[1]*, GREG CLARK[2], DAN ZEMAITIS[1], MATT ALT1. [1]Michigan State University, East Lansing, MI and [2]Michigan Sugar, 2600 S. Euclid Ave., Bay City, MI 48706. **Assessment of impact severity in handling systems using instrumented sphere technology.**

The harvesting process for sugar beets involves a number of steps, each of which has the potential to impart some level of damage to the fruit. The severity of impacts during handling by several pieces of harvest equipment was determined using a 4.75-inch diameter Impact Recording Device (instrumented sphere, IS) manufactured by Techmark, Inc. The sphere was run through a Ropa beet harvester, a Kringstadt Ironworks beet cart and a MAUS. Each handling operation was analyzed at least three times. The Ropa harvester was evaluated dropping on to a field pile and dropping into a beet cart. The beet cart was evaluated dropping into a semi trailer. The Maus was evaluated dropping into a semi trailer. The semi trailer was evaluated (once) as it deposited its load. Of the three pieces of equipment evaluated, the harvester imparted far more and more severe impacts then either the beet cart or the MAUS. On average, the harvester delivered 292 impacts between 40 and 100 gravities, 67 between 100 and 200, and 6 between 100 and 200 gravities. The beet cart yielded 60, 15, and 4 impacts between 40-100, 100-200, and 100-200 gravities, respectively. The MAUS was the least damaging, yielding 40, 12, and <1 impacts between 40-100, 100-200, and 100-200 gravities, respectively. We translated energies perceived by the instrumented sphere to those perceived by the beet root. Generally speaking, those impacts resulting in greater than 70 g's resulted in tissue deformation and presumed bruising. A drop height of 24 inches was sufficient to impart a force of this magnitude. Beet root temperature did not significantly affect acceleration imparted by beet-to-beet impact. The data suggest that there is room to minimize the number of impacts delivering excessive energies to the root via impacts. Even minor impacts should be evaluated further, however, since there is potential for loss of the protective root epidermal layers and potential for enhanced decay as impact frequency increases.

BELLES, DAVID[1]* and PALLE PEDERSEN[2], [1]Syngenta, 4037 E. Karsten Dr., Chandler, AZ 85249 and [2]Syngenta, 317 330th Street, Stanton, MN 55018. **Vibrance, a new SDHI fungicide for Rhizoctonia control in sugar beet.**

Rhizoctonia root rot, caused by *Rhizoctonia solani*, is one of the most common soil-borne diseases of sugar beet (*Beta vulgaris* L.). *Rhizoctonia solani* causes pre- and post-emergence damping-off and seedling blight, resulting in stand and yield reduction. The use of seed applied fungicides like azoxystrobin and fludioxonil are a common way to manage the seedling disease to get optimum plant stand establishment and increase yield. Sedaxane is a new experimental fungicide active ingredient being developed by Syngenta Crop Protection for seed treatment use on sugar beet. Sedaxane belongs to the succinate dehydrogenase class of fungicides (SDHI) FRAC group 7. The mode of action of sedaxane is the inhibition of fungal respiration. The benefits of sedaxane on sugar beet from the control of *R. solani* from trials conducted in several locations in 2014 are presented.

BELMONT, KELLI M.*, W. HOWARD NEIBLING, DON W. MORISHITA, and ERIK J. WENNINGER, University of Idaho, Kimberly Research and Extension Center, 3806 N. 3600 E., Kimberly, Idaho, 83341. **Effects of irrigation, tillage system and fertilizer rate, on sugar beet root and sugar yields.**

Much is not yet clearly understood about the interactive effects of fertilizer application rates, irrigation amounts, and crop residue level on the yield and sugar content of sugar beet. A field study was conducted in 2013 and 2014 at the UI Kimberly Research and Extension Center to study the effects of fertilizer, irrigation, and tillage on root and sugar yields, nitrates, and conductivity. Three tillage treatments were established: conventional tillage (CT), strip tillage (ST), and direct seeding (DS). The irrigation treatments were based on sugar beet evapotranspiration (ET) and were: 50, 100, and 150% of ET. Four nitrogen fertility rates were applied: 50, 75, 100, and 125% of recommended rates for CT sugar beet. Experimental design was a split plot randomized complete block design with tillage as the main plot, irrigation as the sub-plot, and fertilizer rate as the sub-sub-plot. There was a significant tillage by irrigation rate interaction for root yield. Root yield was statistically equal among all three tillage treatments and averaged 93 Mg/ha at the 100% ET rate. However, at 150% ET, the DS yield (76 Mg/ha) was significantly lower than CT (96 Mg/ha) or ST (94 Mg/ha) and statistically equal to CT at the 50% ET rate. Periodic stand counts during the growing season suggest that sugar beet stand was likely the biggest factor affecting DS root and sugar yields. If we can improve crop stand in the DS, root and sugar yields could potentially equal CT and ST yield. Data from 2014 on root and sugar yield, stand count, differ-

ences in crop establishment costs and energy usage for the three tillage systems, and above/ below ground biomass data will also be presented.

BLOOMQUIST, MARK W.*, GARY J. LINDAHL. Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **Date of harvest influence on yield, sugar content, and recoverable sugar per acre at Southern Minnesota Beet Sugar Cooperative.**

Southern Minnesota Beet Sugar Cooperative has an early harvest period prior to stockpiling of the sugar beets for long-term storage in October. During this controlled early harvest period, sugar beets are only stored for a few days prior to processing. This early harvest period allows SMBSC to operate the factory for up to an additional five weeks versus waiting until the temperatures are favorable for long-term sugar beet storage. This early harvest period comes at the expense of shortening the growing season for the portion of the crop that is harvested early. To incentivize growers to harvest a portion of their crop during the early harvest period, a premium is paid on the tons delivered during this period. The premium is designed to make the grower whole when harvesting a portion of his crop early versus the increased yield that would be realized if the entire crop was allowed to grow until long-term storage conditions were acceptable. In 2011, SMBSC began trials to measure the yield, sugar content, and recoverable sugar per acre on a weekly basis throughout the potential early harvest period. These trials were a combination of small plot trials and a larger strip sized trial. These trials were harvested on a weekly basis during the early harvest period. The large strip trial was harvested each week with the grower cooperator's harvest equipment. The small plot trials were harvested with the use of a tractor mounted one row defoliator and harvester. The rate of gain for the small plot trials averaged over the 2011-2013 early harvest period was an increase of 1.6 tons per week and a .56% increase in sugar content per week.

BRANTNER, JASON R.[1]*, ELIZABETH A. CRANE[2], AND ASHOK K. CHANDA[1], [1]University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716 and [2]Department of Plant Pathology, North Dakota State University, Fargo, ND 58108. **Lime amendment reduces infection of sugar beet by *Aphanomyces cochlioides* in soils over a wide range of pH.**

Damping-off and root rot of sugarbeet, caused by the soilborne pathogen *Aphanomyces cochlioides*, are widespread problems in the sugar beet growing areas of Minnesota (MN) and North Dakota (ND), especially under warm and wet soil conditions. Application of factory spent lime to fields is used to control *Aphanomyces*, but data is lacking for the effect of lime on *Aphanomyces* in fields with higher pH soils. Effect of lime amendment on Aphanomyces damping-off was evaluated in 12 field soils collected from six counties in MN and ND, spanning a

pH range of 5.3 to 8.0. The treatments included lime amended [10 tons wet weight/A (162 g/5 L soil)] and non-amended soils. Sugar beet cultivar 'Crystal 985RR' (25 seed/pot) was used in this study. The experiment was conducted in a controlled environment growth chamber and pots were watered daily to provide high soil moisture for 4 weeks to favor damping-off. Aphanomyces soil index values (SIV = 0-100 scale where 0 = no disease and 100 = all plants died during the 4-week assay) were determined. In addition, soil samples were taken to Agvise Laboratories for pH and nutrient analyses. Aphanomyces damping-off was significantly (P = 0.05) reduced in 9 of 12 soils with lime amendment. Reduction in Aphanomyces SIV was not correlated with original soil pH or with change in soil pH following lime amendment. Reduction in Aphanomyces SIV was correlated with increase in soil Ca^{2+} (P = 0.05). Lime amendment has the potential to reduce infection of sugar beet by *A. cochlioides* over a range of original soil pH.

CLARK, GREGORY M.*[1], JAMES F. STEWART[2], LEE A. HUBBELL[2], and BRIAN J. GROULX[2], [1]Michigan Sugar Company, 2600 S. Euclid Ave., Bay City, MI 48706, [2]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706. **Influence of various spent lime rates on sugarbeet production, rotational crops and soil characteristics.**

Spent lime is a valuable resource for the growers. On a typical year, Michigan Sugar Company produces 154,000 tons of lime with 220,000 tons being used by the growers, thus aiding in the reduction of Michigan Sugar Company's spent lime surplus that has accumulated the past 100 years. In 2012, Michigan Sugar Company initiated a project to study the effects of spent lime on sugarbeets, rotational crops and soils. Three trials were established each year during 2012, 2013 and 2014 for a total of nine trials. Spent lime was applied at rates of 0, 2, 4, 8 and 12 tons per acre in the fall and incorporated and sugarbeets were planted the following spring. Individual plots were six (22 inch) rows wide and 50 feet long. The treatments were replicated six times and were arranged in a randomized complete block design. Rotational crops were planted into the plot area in years two and three and each trial will be completed after the fourth year when sugarbeets will be planted again. Tissue samples were taken each year to track nutritional levels in sugarbeets and rotational crops. Soils were also evaluated each year for pH levels and other parameters. Sugarbeet emergence, final stand, vigor, yield and quality were obtained. Sugarbeets were also evaluated for Rhizoctonia and Aphanomyces root rots. Yields of rotational crops were not obtained the first two years because harvesting equipment was not available, however, beginning in 2014 rotational crop yields will be taken. After two years of testing (6 trials) spent lime applications increased sugarbeet yields at each location. The 12 ton treatments had the highest yields followed by 8 tons, 4 tons, 6 tons, 2 tons and the untreated check. Manganese was the only nutri-

ent negatively affected by lime applications. Sugarbeet petioles from the untreated plots had an average of 14 ppm Mn compared to 12 ppm Mn in the 12 tons treatments. Soil pH increased from 7.5 in the untreated plots to 7.85 in the 12 tons per acre treatments. Sugarbeet stand followed the same trend as yield, with higher spent lime rates having more sugarbeets per plot. Dead beet counts showed a slight numerical advantage to the spent lime treatments but differences were not significant and disease levels were low.

COBURN, CARL W. and ANDREW R. KNISS. University of Wyoming, Dept. 3354, 1000 E. University Ave., Laramie, WY 82071. **Eco-efficiency comparison of conventional and glyphosate-resistant sugarbeet herbicide treatments.**

The rapid adoption of glyphosate-resistant sugarbeet has largely displaced conventional herbicides. Eco-efficiency analysis allows the comparison of production systems by quantifying the output produced per unit of environmental impact of the inputs used. A meta-analysis was performed to compare the eco-efficiency of herbicide treatments in conventional and glyphosate-resistant sugarbeet production. Using herbicide and yield data from 9 studies located in multiple growing regions in the U.S., a partial eco-efficiency analysis was performed. Risk quotients were calculated based on herbicide exposure and toxicity to various environmental indicators to provide an estimate of environmental impact. Yield was divided by treatment risk to determine eco-efficiency. Greater values of eco-efficiency indicate lower environmental impact per unit of sugar production. Yield resulting from glyphosate treatments was higher than yield from standard split rate herbicide treatments (P=0.02) and micro rate treatments (P=0.01). Eco-efficiency of 2 to 3 applications of glyphosate was equal to or greater than standard split rate treatments for all environmental indicators. Micro-rate herbicide treatments had higher eco-efficiency than glyphosate treatments for terrestrial indicators, but not for aquatic indicators. The results indicate eco-efficiency analysis could be a valuable tool for comparing sustainability of different production methods.

DILLMAN, JOHN L.[1]* and JOHN A. SMITH[2], [1]Betaseed, Inc., 1714 E. 17th Street, Scottsbluff, NE 69361 and [2]Professor Emeritus, University of Nebraska, P.O. Box 602, Encampment, WY 82325. **BetaPlanter — Temporary solution to false seed skips with Deere sugarbeet planter monitors.**

Growers who use pneumatic Deere planters for planting sugarbeets often experience 'false skips' with their planter monitor, sometimes as high as 35% false skips. The result is inaccurate seed population values from the planter monitor which is the primary function of the monitor. The problem is that the seed sensor in the planter seed tube misses some seeds, especially smaller sized seeds, when the seed is not posi-

tioned directly in the center of the sensor viewing window. The objective of this project was to find a short term solution to eliminate false skips with the planter monitor when planting smaller sized sugarbeet seeds with the Deere planters and Deere seed tubes. Extensive testing of the Deere planter seed tube on a planter test stand verified the false skips with smaller sized sugarbeet seed (such as 2M pellets). The optional Deere seed tube insert eliminated the false skips, but contributed to unacceptable seed spacing accuracy, as found by many sugarbeet growers years ago. The authors found that carefully removing the lower eight inches of the original Deere seed tube insert, eliminated the false skips but maintained good seed spacing accuracy. This shortened seed tube insert was named the "BetaPlanter". Field testing in eight different growers' planters in actual sugarbeet fields during the 2014 planting season verified that the BetaPlanter eliminated false skips while maintaining good seed spacing accuracy. Although the BetaPlanter is only a short term solution until Deere can make more permanent changes in the design of the sensor/monitor system, the BetaPlanter will allow Deere planter monitors to provide accurate seed population while giving accurate seed spacing.

ELISON, DAVID M.[1]* AND GREG DEAN[2], [1]The Amalgamated Sugar Co., P O Box 700, Paul, ID 83347, and [2]The Amalgamated Sugar Co., 138 W. Karcher Avenue, Nampa, ID 83687. **The effects of date of planting and plant population on yield and sugar percentage in sugar beet culture.**

A known response to early sugar beet plant establishment is that vegetative growth and the establishment of the top growth responsible for sugars formation is also established earlier and therefore more time for root growth and sugar depositing before the normal harvest date is accomplished. It is also a known factor that plant population contributes largely to the overall production of sugar on a per acre basis. To a sugar beet producing grower, the questions regarding, "How much plant population do I need to optimally produce pounds sugar per acre" and "When do I plant to accomplish that" are intrinsic to the production process. When weather difficulties forestall planting and early crop establishment or in many cases reduce the intended planted seed population from emerging or reduces it after emerging, then questions arise regarding the need to re-seed and start over. The purpose of this study was to determine at what point in time and with what plant population do you optimize sugar production. As a side purpose, it was intended to determine at what point in time and at what plant population a grower should consider replanting when population is reduced by emergence difficulties or stand loss. Six planting dates approximately ten days apart and six plant populations for each of those dates were used in replicated plots to determine the effects of time and population on growth. The effects of time were linear with the earlier the planting date resulting in more production. The effect that plant population had

on optimizing production showed that a fairly wide range starting at a minimum of 100 plants per 100 feet of row and increasing to around 180 plants per 100 feet of row on a 22 inch row spacing achieved desired results.

GOFFNETT*, AMANDA M. AND CHRISTY L. SPRAGUE and Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Glyphosate-resistant weed issues in Michigan and potential management options in sugarbeet.**

The evolution of glyphosate-resistant and multiple-resistant weeds continue to threaten U.S. growers, especially as they move into the sugarbeet production regions of the U.S. Currently, there are three different weed species, horseweed (marestail), waterhemp, and Palmer amaranth that have been identified as resistant to glyphosate in Michigan. In fact, some of these populations are also resistant to the ALS-inhibiting herbicides, making them even more difficult to manage. Field trials were conducted on two different growers' fields with confirmed cases of glyphosate-resistant horseweed and Palmer amaranth. Several different herbicide tank-mixtures and application timings were evaluated for control of these weeds. The same trials were duplicated at the Saginaw Valley Research and Extension Center near Richville, Michigan to examine what effects the different weed control programs had on sugarbeet yield and quality under weed-free conditions. Control of glyphosate-resistant horseweed was dependent on clopyralid rate and the number of applications. Clopyralid applied three times at 56 g ai ha^{-1} followed by 105 g ai ha^{-1} followed by 105 g ai ha^{-1} provided the greatest season-long control glyphosate-resistant horseweed. To manage glyphosate-resistant Palmer amaranth, phenmedipham plus desmedipham applications were needed at least two times at a minimum rate of 0.56 kg ai ha^{-1} with the inclusion of an acetanilide herbicide like acetochlor. The various treatments examined for control of glyphosate-resistant horseweed or Palmer amaranth did not reduce yield in any of the yield studies compared with the glyphosate alone treatments.

HOFFMANN, CHRISTA M.*, AND KATHARINA SCHNEPEL, Institute of Sugar Beet Research, Holtenser Landstr. 77, D – 37079 Göttingen. **Causes for differences in the storability of sugar beet genotypes.**

Storage losses can be lowered by the choice of a sugar beet variety with high storability (low sugar losses and accumulation of invert sugar). The aim of our study was 1) to identify parameters that may indicate the storability of sugar beet genotypes and 2) to find criteria to select varieties with low storage losses without expensive and time-consuming storage trials. In two years 18 sugar beet genotypes were

cultivated in field trials at four locations in Germany. After harvest the beets were stored for different storage periods (8 and 12 weeks) at 8°C and 20°C in climate containers. Weight, dry matter content, sugar content, invert sugar and marc content were determined, and furthermore, pathogene indestation scored. Sugar losses and invert sugar content after storage were closely correlated ($r^2 = 0.98$). Genotypes with a high marc content (insoluble cell-wall components) in fresh matter before storage showed a lower infestation with pathogens during storage. Although other resistance factors could also affect infestation, there is some evidence that the marc content before storage can be used as criterion to select for storability of sugar beet genotypes.

HONARVAR, MASOUD[2]* AND AHMAD BAHADORBEYGI[1], [1]Phd Student of Food Science and Engineering, Faculty of Food Science and Engineering, Islamic Azad University of Sanandaj Branch, Sanandaj-Iran; [2]Assistant Professor of Food Science and Engineering Department, Islamic Azad University, Science and Research Branch, Tehran-Iran Assistant Professor of Food Science and Engineering Department, Islamic Azad University, Science and Research Branch, Hesarak, Tehran, I.R.Iran; 1477893855 **A close look at the relationship between sugar beet technological value and its relative level by using Image processing.**

The present research is done during sugar beet extraction when sugar beet was on its way to Hamadan-Iran sugar factory. Here sugar beet sampling was based on random sampling. Having captured the images of sugar beet diagonal cutting, by using a table scanner a chemical analysis was done in order to measure the particularities in relation to the product quality (percentage of sugar, harmful nitrogen, sodium and Potassium present in sugar beet root). By considering meaningfulness of the size effect on the reduction of sugar percentage and increase of impurities (sodium and Potassium, harmful nitrogen) and by looking at the particularities correlation table, it can be said that reduction in sugar beet percentage and increase in level of sugar beet impurities are is in harmonize with sugar relative level, so with enlargement of sugar beet and enlargement of its level the amount of sugar percentage decreases and its impurities increases and vice versa. However it should be noted researches show that in small sugar beet vast Physicochemical changes happen in contrast to large ones so small sugar beet should not be kept or be storage. The observations show that executable Sugar with impurity percentage of (0.969) has the maximum positive correlation, so it has positive correlation with Sugar extraction coefficient of 0.740. Moreover Sodium in sugar beet root has negative correlation with sugar execution coefficient -0.765 but it has positive correlation with sugar Molasses(0.826). And based on research finding sugar beet level has negative correlation with pure sugar percentage -0.724, sugar execution coefficient -0.679 and with impure sugar-0.697.

HONARVAR, MASOUD[2]* AND AHMAD BAHADORBEYGI,[1] [1]Phd Student of Food Science and Engineering, Faculty of Food Science and Engineering , Islamic Azad University of Sanandaj Branch, Sanandaj-Iran, [2]Assistant Professor of Food Science and Engineering Department, Islamic Azad University, Science and Research Branch, Tehran-Iran Assistant Professor of Food Science and Engineering Department, Islamic Azad University, Science and Research Branch, Hesarak, Tehran, I.R.Iran; 1477893855. **Comparison of technological particularities among different varieties of sugar beet.**

Sugar beet quality is determined by different factors such as: percentage of impure sugar, percentage of executable sugar, purity of the syrup, amount of the elements like nitrogen, sodium and potassium, Molasses sugar and alkalinity. The present research is conducted during an execution on the different varieties of sugar beet which were sent to Hamedan sugar factory. Here sampling was based on random sampling. Different varieties of sugar beet is as follows: SBSI 004 (research institute of improving and obtaining sugar beet seed, Karaj, Iran), variety of Puma and Dorothy (Syngenta company, Sweden), Rosier and Morel(Florimond desprez company, Paris), Stain and Letitia(KWS company, Germany)and Flores(Maribo company, Denmark). The amount of impurities in sugar beet shows that when sugar percentage increases the amount of impurities such as potassium, sodium and nitrogen decrease. Results obtain from data variance show that there is no meaningful difference between varieties in case of impure sugar percentage, nitrogen and Alkalinity. Analysis of data variance shows a meaningful difference between the examined varieties at 1% in comparison to sodium, potassium, Sugar extraction efficiency, sugar Molasses and percentage of executable sugar. Based on the final comparison it can be said that Rosier has maximum average of impure sugar, 17.62 and Morel has the minimum average of that, 14.53. And comparison done on the obtained average shows that Stain has the higher amount of sodium, potassium, nitrogen, sugar molasses, and lower amount of ECS and Rosier has lower amount of impurities and higher percentage of executable sugar and higher coefficient of executable sugar.

KEE, DAVID[1]*, JOHN A. LAMB[2], MARK W. BREDEHOEFT[3], JAMES RADAMACHER[1], CHRIS DUNSMORE[1], and NICOLE VANOS[3]. [1]Agricultural Research Department, Southern Minnesota Beet Sugar Cooperative, Renville, MN 56284, [2]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108, and [3]Monsanto Company, Willmar, MN. **Split nitrogen fertilizer applications for sugar beet production in Southern Minnesota.**

Sugar beet growers are concerned about sugar beet root yield and quality. To remain competitive, the growers must fine-tune their nitrogen fertilizer management to increase sugar beet quality and thus making a better economic situation for sugar production. This project

investigated the effect of 'feeding' N to the sugar beet during the growing season by using split applications. An experiment was established at five locations in the Southern Minnesota Beet Sugar Cooperative growing area. The split applications of nitrogen were at pre-plant and early July of urea at 66 and 132 kg N ha^{-1} and split treatment of 66 and 132 kg N ha^{-1} with the pre-plant split applied as poly coated urea and the July application as urea. Another method used was to split apply N as a liquid. Two liquid N products, NaChurs SRN and Kugler KQ-XRN were used as treatments. The pre-plant application was with 33 or 66 kg N ha^{-1} as urea or poly coated urea and the liquid applications were applied at the 10 and 20 leaf stage. The liquids were applied at a rate of 18.7 l ha^{-1} delivering a total of 13 kg N ha^{-1}. The sugar beet roots were harvested in October for root yield and quality determination. Root quality was determined at the Southern Minnesota Beet Sugar Cooperative quality laboratory in Renville, Minnesota. At four of the five sites, there was also no advantage to the use of a split application of urea or the use of foliar slow release products to sugar beet production.

KNISS, ANDREW R.*[1] and ROBERT G. WILSON[2]. [1]University of Wyoming, Dept. 3354, 1000 E. University Ave., Laramie, WY 82071. [2]University of Nebraska, Panhandle Research & Extension Center, 4502 Ave. I, Scottsbluff, NE 69361. **Managing glyphosate-resistant kochia in sugarbeet rotations.**

Glyphosate-resistant (GR) kochia has become widespread in western Kansas, and has recently been confirmed in several sugarbeet growing states. Multiple tactics will need to be used to manage GR kochia once it shows up in sugarbeet rotations. A diverse crop rotation will, in itself, help manage GR kochia. It is critical that we focus on kochia management in all crops in the rotation, and not just in sugarbeet. Ironically, though, use of a crop rotation will also limit the available herbicide options. For example, many corn herbicides provide excellent control of kochia, but will not allow rotation to sugarbeet the following year. A series of field studies were conducted in Wyoming and Nebraska in 2012 and 2013 to aid in developing GR kochia management recommendations in sugarbeet rotations.

Based on the results of these field studies, several conclusions and recommendations can be made. The primary finding, unsurprisingly, is that options to manage glyphosate-resistant kochia in the sugarbeet crop are limited, and may be heavily influenced by environmental conditions. In 2013, kochia control was much greater than in 2012, at least in part due to better weather during herbicide applications. Severe drought and dry conditions reduced herbicide efficacy in 2012. Good conditions in 2013 allowed us to get much better kochia control, but without glyphosate, kochia control was still marginal in most treatments. The best combination observed was ethofumesate PRE at 0.75 to 1.25 lbs/A followed by triflusulfuron plus phenmedipham plus

desmedipham applied at the 2 true-leaf stage of sugarbeet. This combination provided between 70 to 95% control of kochia. In combination with glyphosate, this treatment will be expensive and is an indication of how the cost of weed control may increase once glyphosate-resistant kochia invades sugarbeet fields.

Because glyphosate-resistant kochia control will be difficult in sugarbeet, it is imperative that kochia be managed aggressively elsewhere in the crop rotation. Our research suggests that if corn precedes sugarbeet in the crop rotation, the density of kochia can be reduced significantly by using a corn herbicide program of saflufenacil PRE followed by glyphosate plus dicamba POST. It will be very important to control any kochia plants that escape herbicide treatment in crops preceding sugarbeet, because kochia is a prolific seed producer.

The following recommendations are suggested for kochia control in sugarbeet rotations: (1) Target kochia as the primary weed in all crops grown in rotation with sugarbeet. Always manage kochia aggressively in the rotation. (2) Use non-glyphosate herbicides that are effective on kochia in each of the crops rotated with sugarbeet. (3) Have a near-zero tolerance for kochia escapes in the crop preceding sugarbeet in the rotation. Each dollar spent on kochia control in corn may result in many dollars saved on weed control in the sugarbeet crop. (4) If kochia is expected to be a problem sugarbeet, apply ethofumesate PRE at a minimum of 0.75 lbs/A on sandy soils, and increase the rate accordingly for heavier soils.

LAMB, JOHN A.[1]*, MARK W. BREDEHOEFT[2], DAVID KEE[3], JAMES RADAMACHER[3], CHRIS DUNSMORE[3], and NICOLE VANOS[3]. [1]Deparment of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108, [2]Monsanto Company, Willmar, MN, and [3]Agricultural Research Department, Southern Minnesota Beet Sugar Cooperative, Renville, MN 56284. **Comparison of urea and poly-coated urea for sugar beet production in Southern Minnesota.**

Sugar beet growers are concerned about sugar beet root yield and quality. To remain competitive, the growers must fine-tune their nitrogen fertilizer management to increase sugar beet quality and thus making a better economic situation for sugar production. Since 2002, the Southern Minnesota Beet Sugar Cooperative has had a goal of better quality. The purity of the root has increased from 87 % to 92 % during this time. This has occurred from a combination of refined varieties, harvest management, and nitrogen fertilizer application. The increase in percent sucrose in the root has not occurred. This project investigated the effect of 'feeding' nitrogen to the sugar beet during the growing season by using poly-coated urea, a slow release nitrogen source. An experiment was established at five locations in the Southern Minnesota Beet Sugar Cooperative growing area. The study included the factorial combination of six nitrogen application rates (0, 33, 66, 99, 132, and 165 kg N ha^{-1}) and two nitrogen sources (urea and poly-coated

urea). The study had five replications. The sugar beet roots were harvested in October for root yield and quality determination. Root quality was determined at the Southern Minnesota Beet Sugar Cooperative quality laboratory in Renville, Minnesota. The information from five sites has indicated that the use of poly coated urea as a N source did not increase root yield or extractable sucrose per acre when compared to urea. Its use decreased sugar beet quality as measured by extractable sucrose per ton similarly to urea.

LIST, RICHARD R.[1] * and BRIAN J. GROULX[2]. [1]Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI 48706 and [2]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Drive, Bay City, MI 48706. **Covering field piles in Michigan.**

As Michigan growers continue to ask about increasing the number of cleaner/loader (maus) operations, Michigan Sugar Company is looking at possible ways to allow more sugarbeets to be maused. One possible way would be to leave sugarbeets in piles in grower fields and maus them to factory locations between Thanksgiving and Christmas. In Germany, most all sugarbeets being delivered are maused from grower field piles to factory locations. All piles delivered after the first of December are covered in November with a special fabric. This special fabric allows moisture to escape from the pile while keeping rain and snow from entering the pile and freezing the pile solid. The fabric is placed on the field piles by a unique machine that is attached to the back of a tractor. This machine will unroll the fabric over the top of the pile and tuck in the fabric on the bottom. In Michigan, leaving 300,000 to 400,000 tons in grower fields (15 to 20 days of slice) would allow for the possibility of 4 to 5 more maus operations. Over the next couple years, Michigan Sugar Company plans on covering 25,000 tons of sugarbeets each year and leaving them in grower fields until December. The sugarbeets will be tested for shrink and sugar loss/gain to determine if a premium needs to be paid to growers leaving sugarbeets in their fields.

MORISHITA, DON W.*, KELLI M. BELMONT, ERIK J. WENNINGER, and W. HOWARD NEIBLING, University of Idaho, Kimberly Research and Extension Center, 3806 N. 3600 E., Kimberly, ID 83341. **Irrigation, tillage system, and fertilizer rate on weeds, insects and diseases in sugar beet.**

The amount of tillage, irrigation and nitrogen fertilizer applied in a cropping system has been shown to influence pest populations and diversity. A field study was conducted in 2013 and 2014 to determine the effect of irrigation amount, nitrogen fertilizer rate, and level of tillage on weeds, insects and diseases in sugar beet. Three tillage treatments were established: conventional tillage (CT), strip tillage (ST), and direct seeding (DS). Irrigation treatments were based on sugar beet evapo-

transpiration (ET) and were: 50, 100, and 150% of ET. Four nitrogen (N) fertility rates were applied: 50, 75, 100, and 125% of recommended rates for CT sugar beet. Experimental design was a split plot randomized complete block design with tillage as the main plot, irrigation as the sub-plot, and fertilizer rate as the sub-sub-plot. Weed seedling emergence counts were made within fixed 0.25 m2 areas in each sub-sub plot four times. Glyphosate was applied at the 2-leaf crop stage at 84 g/ha and again 15 days later in combination with dimethenamid-P at 0.95 kg/ha. No differences were observed in weed populations between the tillage, irrigation or N rate in 2013. This indicates that weed emergence was not affected by tillage, irrigation rate or N rate in sugar beet. Leafminers and sugar beet root aphids were sampled twice. Nitrogen rate had no effect on leafminers; however, leafminers responded to tillage treatments. On May 31, more eggs per plant were found in the CT relative to the ST and DS, which did not differ from each other. No differences in leafminer eggs were observed among tillage treatments on June 12. On both dates, more leafminer larvae were observed in CT than in ST and DS, which did not differ from each other. Random *Aphanomyces* and *Rhizoctonia* diseased plants were found throughout the study site, but there was no correlation with tillage, irrigation or nitrogen fertilizer rates.

MORISHITA, D.W.*, KYLE G. FRANDSEN, and KELLI M. BELMONT. University of Idaho, Kimberly Research and Extension Center, 3806 N. 3600 E., Kimberly, ID 83341. **Effect of sprinkler incorporation timing on the activity of soil-active herbicides applied with glyphosate.**

Soil-active herbicides applied in combination with glyphosate can effectively control a broad-spectrum of weeds, reducing the added selection pressure for glyphosate resistant weeds when using glyphosate alone. A field experiment was conducted at the UI Kimberly Research and Extension Center in 2012, 2013, and 2014 to determine how soon sprinkler incorporation is needed following glyphosate plus soil-active herbicide applications for weed control before the soil-applied herbicides become ineffective. Experimental design was a 4 by 5 factorial RCB with four replications. Incorporation timing treatments were established by waiting 0, 3, 6, or 9 days before incorporation (DBI). All treatments except the untreated control were sprayed with 0.86 kg ha^{-1} glyphosate at the 2-leaf sugar beet growth stage. At the 4- to 6-leaf stage, glyphosate at 0.86 kg ha^{-1} was applied in combination with five soil-active herbicides: s-metolachlor, EPTC, ethofumesate, dimethenamid-P, and acetochlor. To incorporate the herbicides, 1.25 cm of water was applied over the entire study site. Common lambsquarters and green foxtail density at 14 and 27 days after the last application (DALA), wild oat and other weeds (combination of other weeds species that were small in number) at 14 DALA were affected by incorporation timing. There were consistently fewer total weeds in the 0 and

3 DBI treatments than 6 and 9 DBI at 14 and 27 DALA. In response to herbicides, green foxtail density was lowest with dimethenamid-P. Wild oat density was lowest with s-metolachlor. There were no differences in beet yield or quality in response to incorporation timing or herbicide treatment.

PETERS, THOMAS J.[1]*, AARON L. CARLSON[1] and RICHARD K. ZOLLINGER[1], [1]North Dakota State University, NDSU Dept. 7670, PO Box 6050, Fargo, ND 58108-6050. **A Systems Approach to Weeds Management in Fields Planted to Sugarbeet.**

There are several weeds in sugarbeet that are not adequately controlled by or are demonstrating low-level resistant to glyphosate. Herbicides applied in combination with glyphosate also are less efficacious against weeds due to resistant biotypes (acetolactase synthase inhibitors) or are being discontinued by their manufacturers (ethofumesate and desmedipham plus phenmedipham). Our objectives were field research and are development of training curricula for field agriculturalists to reintroduce a systems approach to weeds management in fields planted to sugarbeet. That is, weeds management in the field that might be planted to as many as four crops in the sequence. Components of a systems approach are scouting and proper weed identification and documentation and mapping of weeds, a holistic approach to selection of pesticides including consideration of the crops in the sequence, use of tank-mixes and a combination of soil applied and postemergence herbicides representing herbicide families with different sites of action. Finally, develop and implement training curricula for agriculturalists who historically may have scouted sugarbeet fields rather than fields planted to sugarbeet.

POINDEXTER, STEVEN S.* , THOMAS J. WENZEL, Michigan State University Extension, One Tuscola St., #100, Saginaw, MI 48607. **Field Evaluations of Standard Sugarbeet Seed Treatments Compared to Metlock Suite and Kabina™ in Combination With/Without Quadris® Applied In-furrow at Planting.**

Research trials were conducted in 2013/14 in grower fields under natural soil disease conditions (not artificially inoculated). Data collection included: effect on emergence/final stand, seedling disease/ long term Rhizoctonia control and effect on sugarbeet yield and quality. Most current research with seed treatments has been done using artificial inoculation techniques. Seed treatments were commercially applied on same seed lot(s) and Quadris applications were applied in a T-band in-furrow.

Current results indicate that both Metlock Suite and Quadris alone, or in combination can have slight effect slowing emergence. Kabina seed treatment showed no slow down effect on emergence. Quadris in furrow has been shown to sometimes reduce emergence by 3 to 5%.

However Quadris applied T-band is superior to seed treatments for long term control and yield when later season Rhizoctonia root rot is present. Under heavier seedling disease pressure Quadris applied in-furrow alone had less seedling disease than Metlock Suite. The Metlock Suite treatments had less seedling disease than the Check. Quadris can be applied in-furrow and in combination with Kabina and/or Metlock Suite with only a slight negative effect on emergence. Kabina seedling disease control was inconclusive due to low seedling disease pressure in the trials that included Kabina in 2014. Yield data and additional results from 2014 trials are forthcoming.

REGITNIG, PETER J.*and BRYAN R. AVISON, Lantic Inc., 5405 – 64th Street, Taber, Alberta, T1G 2C4. **Nitrogen rate x placement in sugar beets.**

In conventionally tilled sugar beets in Alberta the majority of nitrogen fertilizer applied is broadcast and incorporated with smaller percentages applied in narrow bands. With the advent of RTK-GPS guidance systems, banding of fall fertilizer under the future sugar beet row is now possible in a conventionally tilled field. Some sugar beet growers have reduced fertilizer rates when applying fertilizer under the row in a ridge tillage system; however, the efficiency of banding under the row versus broadcasting has never been directly compared in Alberta. Four factorial trials were conducted between 2009 and 2012 to evaluate fall banded and broadcast nitrogen using 6 rates from 0 to 150 lbs N per acre. Sugar beet stand was not significantly affected by fall nitrogen placement, but in 3 of 4 individual trials average early season plant vigor for banded nitrogen was significantly higher than the value for broadcast nitrogen. When 4 trials were averaged over both nitrogen placements, sugar beet root yield was increased by 4.11 tons per acre with 150 lb N per acre compared to no nitrogen application. When root yield was averaged over all nitrogen rates, treatments banded under the row were 0.95 ton per acre higher than broadcast treatments. Extractable sugar per acre (ESA) values followed the trend observed for root yield with banded treatments having 324 lbs per acre more ESA than broadcast treatments. Small but significant increases in sugar beet amino nitrogen levels for banded nitrogen compared to broadcast nitrogen were observed in 3 of 4 tests suggesting banded nitrogen was slightly more available. Sugar beet vigor, root yield, ESA and amino nitrogen levels all suggested that banding nitrogen under the sugar beet row resulted in better utilization of the fertilizer than broadcasting and incorporating it.

SCHAMBOW, THOMAS J*. and ANDREW R. KNISS. University of Wyoming, Dept. 3354, 1000 E. University Ave., Laramie, WY 82071. **Effect of reflected light quality on *Beta vulgaris* growth.**

Light reflected from nearby vegetation (such as weeds) can cause shade avoidance responses in many plant species. These shade avoidance responses alter the growth pattern of plants, potentially increasing petiole length, altering leaf angles, and decreasing crop yield. Experiments were conducted on three subspecies of *Beta vulgaris*—sugarbeet, table beet and Swiss chard—to determine if light reflected by colored plastic or nearby weeds would influence growth. Plants were grown in five-gallon pales and surrounded with the specific light treatment. All beet plants were grown so that no direct competition for resources occurred. Measurements included weekly leaf angle, petiole and leaf length measurements, and leaf counts. At harvest, petiole and leaf length, root diameter, root length and root weight were measured. Differences in growth between light treatments were observed in all subspecies by 60 days after planting. Beets grown near weeds had fewer leaves compared to all other treatments. These results suggest a shade avoidance effect was initiated by *Beta vulgaris* plants and may have implications for early season weed control in sugarbeet.

STEINKE, KURT*, CHRIS BAUER, and ANDREW CHOMAS, Department of Plant, Soil, and Microbial Sciences, Michigan State University, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824. **Evaluation of nitrogen products to optimize sugarbeet production.**

Increasingly unpredictable spring weather conditions and continued concern for Great Lakes water quality have placed greater emphasis on improving management of nitrogen (N) fertilizer applications and strategies to promote efficient fertilizer usage in sugarbeet production. Earlier research has indicated that 40 lbs. N/A applied as a 2x2 application at planting resulted in positive root yields, but an increasing numbers of growers wish to pursue stale seed bed approaches to N management for the remainder of the N application. The objective of this study is to determine the impact of enhanced efficiency and alternative fertilizers applied prior to or during planting in lieu of traditional soluble N sources applied sidedress. Field trials were initiated in 2013 and 2014 to determine sugarbeet response to N stabilizers, dried chicken manure, and slow-release N. The study was arranged as a randomized complete block with four replications. All treatments received 45 kg N/ha as a 2x2 starter application and a total N rate of 180 kg/ha. Dried chicken manure and 74 kg N increased root yield and sucrose per acre with no negative effects on sugar quality. Greater rates of dried chicken manure with no supplemental N decreased root yield and sucrose per acre. Slow release N and N stabilizers offered few positive effects on root yield. Growing season observations and final quality parameters will be presented.

TARKALSON DAVID D* AND BRADLEY A. KING, USDA Agricultural Research Service, Northwest Irrigation and Soils Research Laboratory, 3793 N 3600 E, Kimberly, ID 83341. **Sugarbeet Response to Water Availability**

Increasing climate variability and competition for finite water resources have resulted in a need to determine the effect of in-season water availability on sugarbeet production. Data from 8 cultivars over 7 site-years at the NWISRL in Kimberly, ID was used to assess the impacts of various water inputs (from approximately 125% to 10% sugarbeet evapotranspiration [ET]) on sugarbeet production. Water input amounts for the treatments were applied weekly based on estimated sugarbeet ET. Irrigation supplemented precipitation to match the input treatments. In general, sugarbeet yields are reduced with decreasing water supply below estimated crop water demand (100% crop ET). A quadratic regression model significantly related the normalized sugarbeet yield reduction for all cultivars and site-years over the range of sugarbeet ET inputs, resulting in an increasing rate of yield reduction as crop water availability is reduced. Sucrose yield reductions ranged from 7% to 42% for sugarbeet ET rates of 90% to 40% of full irrigation, respectively. Soil water holding capacity, crop rooting depth, irrigation system characteristics, and irrigation management storage and supply are important in buffering yield loss during water deficit conditions, and will influence the yield reduction at a given deficit ET input.

TARKALSON, DAVID D* AND DAVE L. BJORNEBERG, USDA Agricultural Research Service, Northwest Irrigation and Soils Research Laboratory, 3793 N 3600 E, Kimberly, ID 83341. **Nitrogen Management in U.S. Sugarbeet Production**

Nitrogen (N) management is an important factor in sugarbeet production because decreased profits are associated with both under and over supply of N relative to crop need. Under supplying N greatly affects root yield, and over supplying N results in increased root impurities (decreases sucrose extraction efficiency) and decreased sucrose content. Much research has been conducted over time to determine optimum N supplies for sugarbeet in various climates, soils, and management practices. This paper will review and summarize the history of N management in U.S. sugarbeet systems, with the goal to help facilitate future research in order to further improve N management.

Sections A – Agronomy
Poster Presentations

ALDER, CLARKE G. Crop Consultant, The Amalgamated Sugar Company, 138 West Karcher Road, Nampa, ID 83687. **The economics of skipping a glyphosate application on Roundup Ready sugarbeets.**

In years past, growers have applied a myriad of herbicides in order to bring a healthy crop of sugarbeets to harvest. Now, with the advent of the Roundup Ready sugarbeet, it is much more uncommon to find an unhealthy sugarbeet crop due to weed competition. Roundup ready technology is one of the most significant changes in the history of the crop. Since its introduction however, many growers have become complacent believing that fewer applications of roundup are necessary each season—some to the point that they are reducing yield significantly by skipping or putting off necessary timely applications of the herbicide. This trial began as a local educational tool for growers in the Treasure Valley of Idaho, but provides useful information for all sugarbeet growers who are attempting to weigh the costs of particular applications of roundup against any yield loss they may incur by skipping the application. The trial was conducted in two different growers' fields under fairly similar environmental conditions. Agronomic practices were similar although not identical. Several treatment packages were administered with application timings ranging from pre-emergence to row closure. The yields tended to be higher with higher weed control, but sugar percentages did not appear to change significantly with weed control for most treatments.

CANE, TERRANCE L., The Amalgamated Sugar Company LLC, 138 West Karcher Road, Nampa, Id 83687. **Strip tilling and planting sugar beets into established alfalfa.**

Many growers along the Snake River plain of south western Idaho in Amalgamated Sugar Company's Elwyhee District depend on alfalfa as part of their crop rotation. They struggle with the effort it takes to prepare a field for planting to sugar beets. These growers were introduced to strip tillage in sugar beets in late 2007. In 2009, two fields, a 75 acre and an 80 field was strip tilled and planted into established stands of alfalfa by two different growers. Removal of alfalfa was achieved by the use of Roundup herbicide. One field was applied post plant and while the other field was treated prior to the last cutting in the previous fall. Result was significant increase in root yield with no decrease in sugar content. In 2014 60% of all growers in the Elwyhee District are using strip tillage on 3411 acres (31% of all beet acres grown) with 36% of those acres strip tilled into established alfalfa. Growers are still experiencing good yields and sugar quality along with a reduction in tillage cost and wind damage.

CHOMAS, ANDREW* and KURT STEINKE, Department of Plant, Soil, and Microbial Sciences, Michigan State University, Plant and Soil Sciences Building, 1066 Bogue Street, East Lansing, MI 48824. **Agronomic potential of slow release nitrogen on sugarbeet yield and quality.**

Volatile fertilizer prices, increasingly unpredictable spring weather conditions, and degradation of Great Lakes water quality have placed greater emphasis on improving management of nitrogen (N) fertilizer through strategies that more closely synchronize N availability with peak sugarbeet N demand. Polymer-coated urea (PCU) limits the amount of N available for microbial transformation after field application potentially increasing fertilizer efficiency and reducing environmental N losses. The objective of this study is to determine how to utilize PCU in sugarbeet production by examining blending ratios of PCU with urea. Field trials were initiated in 2013 and 2014 to examine 5 blending ratios of PCU:Urea consisting of 100:0, 75:25, 50:50, 25:75, and 0:100. The study was arranged as a randomized complete block with four replications. All treatments were applied pre-plant incorporated and included 45 kg N/ha as a 2x2 starter application for a total N application of 180 kg/ha. Both 100% PCU and 100% urea produced similar root yields, percent sugar, sucrose per acre, and gross grower payment. The 100% PCU treatment did produce lower amino-N concentrations as compared to treatments including urea. Plant characteristics and observations over multiple growing seasons will be discussed.

DEAN, GREG A.[1]*, ELISON, DAVID M.[2] and FOOTE, PAUL[2], [1]The Amalgamated Sugar Company LLC, 138 W. Karcher Rd., Nampa, ID 83687 and [2]The Amalgamated Sugar Company LLC, 50 S 500 W, Paul, ID 83347. **Understanding Southwestern Idaho sugarbeet planting dates and populations.**

In order for sugarbeet growers to optimize sugar production, they need to know how timing of planting and plant stand affects yield. From 2012 through 2014, a two factorial study (planting date x plant population) was conducted in Southwestern Idaho to evaluate these factors. Six planting dates combined with 6 plant populations were studied. Results of this research help to identify the point at which a delay in planting negatively affects yield as well as the range of plant stand needed to maximize sugar production.

GROULX, BRIAN J.[1] *, JAMES F. STEWART[1], LEE A. HUBBELL[1], and GREGORY M. CLARK[2]. [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, [2]Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706. **Bringing Research Harvest into the 21st Century.**

Currently, harvest of Michigan Sugar Company's research consists

of roughly 100 acres of test plots with two, two-row Farmhand harvesters. These machines have gone through many updates including grab-roll cleaning beds, hydraulic components, and digital scales over their 15 years of use. They have been maintained and work very well, but their slow pace forces harvest to begin early to be done by November, usually 45 days of harvest. It became apparent that more trials could be planted and maintained than could be harvested, so it was time for a new harvesting process. Our research team met with fabricators in the area to work through some of the details. The construction of this new six-row harvester resulted in a collaboration between Richmond Brothers Fabrication, Ike's Welding and Manufacturing, and Cech Corporation; each supplying parts they specialize in. The harvester will lift beets much like any harvester, but that is where the similarities end. Once clear of the lifting wheels, the beets will travel up an incline scrubber chain where they fall onto six separate sets of grab-rolls for additional cleaning. These grab-rolls then dump into the six separate baskets, each with a hydraulic trap door on the bottom. These baskets are suspended on load cells which communicate through a wireless Bluetooth connection with an Android tablet which will record and document the weights. Once the weight and tare sample are collected, the trapdoors in the baskets will be opened and the beets will fall onto a cross conveyor chain to be windrowed. The tare samples will be stored on a platform behind the work area that has a hydraulic scissor lift to facilitate unloading. Other improvements include the use of tracks to support it and its push button hydraulic adjustment. The new scale program also speeds up data collection in the field as well as statistical analysis in the office.

JHA, PRASHANT [3]*, DON MORISHITA[1], JOEL FELIX[2]. [1]University of Idaho, Kimberly R&E Center, 3806 N. 3600 E., Kimberly, ID 83341; [2]Oregon State University/Malheur Experiment Station, Ontario, OR 97914; [3]Montana State University, Southern Agricultural Research Center, 748 Railroad Highway, Huntley, MT 59037. **Confirmation of Glyphosate-Resistant Kochia (Kochia scoparia) in Idaho and Oregon Sugar Beet Fields.**

Occurrence of herbicide-resistant kochia (*Kochia scoparia* L. Schrad) is an increasing concern for crop growers in the northwestern United States. Based on grower complaints for lack of kochia control with repeated applications of glyphosate (at the recommended field-use rate) in glyphosate-resistant (GR) sugar beet in eastern Oregon and western Idaho in 2014, we collected and investigated putative GR kochia accessions from those fields; three accessions from eastern Oregon (designated ALA, VAL, and DB) and one accession from western Idaho (designated WIL). The objective of this research was to confirm the level of resistance and investigate the molecular mechanism of resistance to glyphosate in the selected kochia accessions. On the basis of whole-plant dose-response assays, ALA, VAL and DB accessions from

Oregon had I_{50} (dose needed for 50% control) R/S ratio (resistance index) of 2.1, 7.0, and 9.7, and the R/S ratio of WIL accession from Idaho was 4.7. For glyphosate resistance, 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene was analyzed for target-site mutations (PCR and sequencing) and relative increase in gene copy numbers through qPCR. No target-site mutations were detected at Pro_{106} of the *EPSPS* gene. All GR kochia accessions had ~ 3 to 8 copies of the *EPSPS* gene compared with a single *EPSPS* gene copy of a susceptible accession. This is the first confirmation of the evolution of glyphosate-resistant kochia in Idaho and Oregon. Because of lack of alternative, effective and economical herbicide options for kochia control in sugar beet, growers need to proactively manage the GR kochia seed bank with alternative effective modes of action herbicides in crops such as corn or wheat/barley grown in rotation with GR sugar beet, with the integration of tillage practices.

LAMB, JOHN A.[1]*, MARK W. BREDEHOEFT[2], ALBERT L. SIMS[3], MICHAEL A. SCHMITT[1], DAVID KEE[4], JAMES RADAMACHER[4], CHRIS DUNSMORE[4], and NICOLE VANOS[4]. [1]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN 55108, [2]Monsanto Company, Willmar, MN, [3]Northwest Research and Outreach Center and Department of Soil, Water, and Climate, Crookston, MN 56716, and [4]Agricultural Research Department, Southern Minnesota Beet Sugar Cooperative, Renville, MN 56284. **Nitrogen management for sugar beet grown in Southern Minnesota.**

Nutrient management research and education for sugar beet production in Southern Minnesota has been a cooperative activity between University of Minnesota faculty and the research department of Southern Minnesota Beet Sugar Cooperative (SMBSC) since 1996. Southern Minnesota Beet Sugar Cooperative initiated the cooperative work by a request for improved nitrogen management research and education. This request was in response to several poor quality sugar beet crops in the 1990's. A series of studies were undertaken from 1996 to 2014 to improve nitrogen management. Along with the research, an education program was put into place. Besides the annually grower production seminars, a series of demonstration plots were established in 2000 and 2002. The topics covered were precision soil sampling, optimum nitrogen rates, side-dress N application, previous crop, and manure application. The outcomes from this research and education program include increased frequency of soil testing, reduction of residual soil nitrate-N, reduction of N fertilizer applied, increased root yield, and increased root purity. Economic impact for SMBSC is $60 per acre per year or $7,200,000 per year.

POWELL, GARY E.*, AMANDA C. HARDEN, AND CHRISTY L. SPRAGUE, Department of Plant, Soil, and Microbial Sciences, Michigan State University, 1066 Bogue Street, East Lansing, MI 48824. **Competitiveness and management of volunteer corn in sugarbeet.**

Glyphosate-resistant volunteer corn is a consistent problem in glyphosate-resistant sugarbeet grown in Michigan. Two field experiments were conducted in 2012 and 2013 at the Michigan State University Agronomy Farm in East Lansing and at the Saginaw Valley Research and Extension Center near Richville, Michigan. The objectives were to: 1) quantify the effects of volunteer glyphosate-resistant corn on glyphosate-resistant sugarbeet yield and sucrose quality, 2) determine the effects of row-width on volunteer corn interference in sugarbeet, and 3) develop effective management strategies. In one trial glyphosate-resistant 'HM 9173 RR' was planted at 124,000 plants ha^{-1} in 38- and 76-cm rows. At the time of planting, 'F_2' glyphosate-resistant corn seed was planted approximately 13-cm off the sugarbeet row at populations of 0; 2,150; 4,310; 8,610; 17,220; and 34,430 plants ha^{-1}. In another study a targeted population of 17,220 volunteer corn plants ha^{-1} (1.7 plants m^{-2}) was controlled at five different stages between the V2 and V11 corn. Results were often reflected by variations in precipitation between years and locations. However, in general sugarbeet planted in narrow rows competed more effectively with volunteer corn than sugarbeet in wide rows. Narrow rows also inhibited corn growth which resulted in lower corn biomass quantities than in wide rows. Sugar quality was also lower in wide rows in three of four site-years and sugarbeet yield was similar between 0 and 8,610 volunteer corn plants ha^{-1}. Overall planting sugarbeet in narrow rows helped reduce competition from glyphosate-resistant volunteer corn. Volunteer corn needs to be controlled if populations are greater than 8,610 plants ha^{-1} in order to maximize sugarbeet yield and quality. Although there was variability within the years, volunteer glyphosate-resistant corn should be controlled with clethodim or quizalofop prior to the V8 corn stage to maximize sugarbeet yield and quality.

SEARLE, DENNIS[1]*, GREG DEAN[2], JAMES D. BARBOUR[3], AND OLIVER T. NEHER[4], [1,2]The Amalgamated Sugar Company LLC 138 W. Karcher Rd., Nampa, ID 83687, [3]University of Idaho 29603 U of I Lane, Parma, ID 83660-6699, [4]The Amalgamated Sugar Company LLC 1951 S. Saturn Rd., Boise, ID 83709. **Two-spotted spider mites, an emerging problem in sugar beets in Idaho.**

Two-spotted spider mites (TSSM) are ubiquitous in Idaho crops and rarely caused significant damage to sugar beets. In recent years, the infestation with TSSM reached levels causing economic losses. Changes in cropping practices, crop rotation and a change in climate conditions (prolonged periods of elevated temperatures and reduced relative humidity) forced TSSM from surrounding crops into sugar

beets. In 2014, a study was initiated to look at potential insecticides/miticides for their control. Two applications of Movento, Onager, Lorsban and Mustang 14 days apart starting when TSSM populations started to increase were compared for their control ability. Control efficacy was not significantly different to the non-treated control but a reduction by up to 85% can warrant applications. It will be necessary to establish threshold levels based on economic losses to better justify insecticide applications.

STEVENS, W. BART*, ROBERT G. EVANS, JAY D. JABRO and WILLIAM M. IVERSEN, USDA, Agricultural Research Service, 1500 North Central Avenue, Sidney, MT 59270. **High-frequency overhead irrigation for sugarbeet under two different cropping systems.**

Furrow irrigation has been utilized for sugarbeet in the MonDak (eastern Montana and western North Dakota) region, as well as neighboring states of Wyoming and Idaho, for close to a century; however, overhead sprinkler irrigation systems are being installed at an increasing rate in these areas. Our objective in this study was to compare high-frequency (HF) sprinkler irrigation in sugarbeet cropping systems to conventional practices on a sandy loam soil type. Irrigation frequency was varied based on either 30 mm (HF) or 60 mm (low-frequency, LF) cumulative ETc replacements. Irrigation treatments were evaluated from 2005 to 2011 within two cropping systems: 1) strip-till-sugarbeet, potato, malt barley (ST-SB/P/B) and 2) conventional-till-sugarbeet, malt barley, potato (CT-SB/B/P). The effects of irrigation frequency and cropping system were independent of each other but often the effects of each varied by year. Yield was generally not affected by irrigation frequency with the exception of a trend (P = 0.0736) for slightly greater root yield with HF (28.4 tons acre^{-1}) than with LF (27.4 tons acre^{-1}) irrigation. Sugar loss to molasses (SLM) was approximately 10% higher with HF than with LF irrigation in two of seven years. Sucrose yield was similar for the two cropping systems in most years but was 19.3% greater with CT-SB/B/P than with ST-SB/P/B in 2009. Root sucrose concentration was approximately 3.5% greater with ST-SB/P/B than with CT-SB/B/P in 2010 and 2011 but this did not lead to significant difference in sucrose yield. SLM was from 7.1% to 16.5% greater with CT-SB/B/P than with ST-SB/P/B in five of seven years.

WILSON, ROBERT G.[1]*, ANDREW R. KNISS[2], GUSTAVO M. SBATELLA[3], ALICE LEJOSNE[4]. [1]University of Nebraska, Panhandle Research & Extension Center, 4502 Avenue I, Scottsbluff, NE 69361, [2]University of Wyoming, Department of Plant Science, 1000 E. University Avenue, Laramie, WY 82071, [3]University of Wyoming, Powell Research & Extension Center,747 Road 9, Powell, WY 82435, [4]Lille Catholic University (ISA), 83 Boulevard Vauban, 59000 Lille, France. **Exploring the potential for clomazone for weed control in sugarbeet.**

Several weeds have developed resistance to glyphosate in states in the high plains of the USA. To sustain effective weed control in sugarbeets grown in these states there is a need to explore herbicides with different modes of action that also have efficacy on glyphosate-resistant weeds. Experiments were initiated in 2014 at Scottsbluff and Mitchell, NE and Lingle, WY to determine the potential of clomazone for selective weed control in sugarbeets. Clomazone was applied either 7 days before planting (DBP) or preemergence after planting (AP) at rates of 0.035, 0.070, 0.141 and 0.281 lb ai/acre. Glyphosate was applied to all plots after weed evaluations to reduce crop-weed competition. Sugarbeet injury 30 DAP increased as clomazone rate increased and from herbicide application made after planting. Sugarbeet plants quickly recovered from early season injury and by 50 DAP crop injury ranged from 0 to 33% as clomazone rate increased from 0.035 to 0.281 lb/acre. Although clomazone caused early season visual injury and moderate stand reduction, root yields at the end of the season were similar to the nontreated. A clomazone rate of 0.141 lb/acre was required to provide 90% kochia control and a dose of 0.281 lb/acre was required to provide 90% or greater common lambsquarters, hairy nightshade, pigweed species and barnyardgrass suppression.

Section B & E Physiology, Biotechnology, Genetics & Germplasm Oral Presentations

EUJAYL, IMAD A.*, and CARL A. STRAUSBAUGH, USDA-ARS, Northwest Irrigation and Soils Research Laboratory, 3793 N. 3600 E. Kimberly, ID 83341. **Identification of differentially expressed genes induced by *Beet curly top virus* infection in sugarbeet.**

Resistance to *Beet curly top virus* (BCTV) trait is crucial in Western USA. There is sparse public knowledge of genes regulating resistance. This research focused on gene expression profiling of resistance to the three BCTV strains: Cal/Logan (Cal), Worland (Wor), and severe. Differential gene expression was studied via RNA-sequencing of a highly resistant doubled haploid line (KDH13-PI663862) compared to a highly susceptible line (K19-19). KDH13 was subjected to 7 treatments: infested with non-infectious leafhoppers, infections with leafhoppers population carrying a single, two, or three strains, and control leaf transcriptome, and K19-19 infected with the three strains. RNA was extracted from leaves of the 8 treatments (3 replications, 24 mRNA libraries), sequenced in a HiSeq2500 and analyzed using TopHat and Cufflinks software. All sequences were aligned to the RefBeet-1.2. Based on 28 pair-wise comparisons, differentially expressed (DE) genes were determined with an adjusted false-discovery-rate (*q-value*) lower than 0.05. For example, *DND1* gene, known to be involved in innate immune response to pathogens (6.8kb located on chromosome1), was

found down regulated (*q = 0.01*), in KDH13 when infected with the three strains compared to infestation with non-infections leafhoppers, but no response of *DND1* was observed in K19-19. Additionally, transcripts of *IDH1* gene were totally absent in K19-19 infected with the three strains. There was a pattern of some defense gene families, including *ERF* genes subunits that were up-regulated when KDH13 was infected with Wor only and down-regulated when its infected with both Cal and Wor, an evidence of strain-specific and strain interaction gene expression. This research is the first to reveal gene transcriptional profiles associated with resistance as well as susceptibility to BCTV.

HUBBELL, LEE A.[1]*, JAMES F. STEWART[1], BRIAN J. GROULX[1] and GREGORY M. CLARK[2], [1]Michigan Sugar Company, 1459 S. Valley Center Dr., Bay City, 48706 and [2]Michigan Sugar Company, 2600 S. Euclid Ave., Bay City, MI 48706. **Variety approval standards and grower production over recent years.**

Michigan Sugar Company's Research Department performs thorough official variety trials each growing season to obtain yield, sugar per ton, sugar per acre, insect tolerance and disease tolerance evaluations. The main objective for the official variety trial is to provide the best varieties for our growers. It is a challenge to produce the best varieties for an area considering problems of diseases and insects, the need for increased tons and a good sugar content and purity to help the factories be more efficient. Over the last decade, Michigan Sugar Company has made advances in tons per acre and some increase in sugar content. The average yield from 2000-2004 was 19.5 tons per acre and from 2010-2013 was 26.4 tons per acre. The estimated yield for 2014 is above the most recent average of 26.4 tons per acre. The variety approval requirements gives the seed companies direction for their breeding program. In 2008, Michigan Sugar Company started using varieties with the Roundup Ready trait; however, none of the varieties sold that year met our approval requirements. For the next few years most Roundup Ready varieties were low on sugar per ton or lacked the Cercospora tolerance we wanted. Michigan Sugar Company has made variety approval requirement changes during this period and twice those requirements were set five to six years in the future, helping the seed companies plan and produce what we need. The varieties being sold now and new varieties being tested for the future have made huge advances in production and in the tolerance traits that are beneficial to our growers.

KRAFT, THOMAS, Syngenta, Box 302, 261 23 Landskrona, Sweden. **The impact of the sugar beet genome sequence on sugar beet breeding.**

Recently the genome sequence of sugar beet (*Beta vulgaris* L.) was published and I will here present some examples how this information

can be used in sugar beet breeding. The most common use of the genome sequence related to breeding is the facilitation of the development of molecular markers. The genome sequence can be used as a framework for identifying suitable sequences for marker development in any region of the genome. Sequencing additional genotypes allows for the identification of a high number of polymorphisms, selection for these polymorphisms across the genome, and subsequent development of a high-density genotyping chip spanning the genome. Such chips can be used for studying the genetic structure of the breeding germplasm and other sources of genetic variation available for breeding (e.g. germplasm releases). The chips are also an efficient tool to be used in association mapping studies. These studies require a set of lines to be genotyped with a high number of markers and result in the identification of markers linked to important traits that can be used in marker-assisted selection. The genome sequence can also greatly simplify the fine-mapping of major genes and thus the development of tightly linked markers. Fine-mapping of a trait requires the availability of many polymorphic markers in the region surrounding the gene responsible for the trait variation. The genome sequence can be used to identify suitable sequences that will be re-sequenced in the parents of the fine-mapping population in order to identify polymorphisms for marker development. Once the trait has been fine-mapped and a smaller region of the genome identified, the genome sequence can be searched for potential candidate genes in the region that could be responsible for the trait variation. The genome sequence is also important for many types of genome studies, for example for interpretation of results from RNAseq experiments.

LONG, JORDAN*. MARCINEK, RAFAL and HARPER, STEPHEN, Germains Seed Technology, Hansa Road, Hardwick Industrial Estate, King's Lynn, Norfolk, PE30 4LG, UK. **Measuring seed and young plant vigor from the laboratory through to the field.**

A major factor determining the yield of sugar beet is the amount of solar radiation captured by the plants. It is therefore critical to ensure rapid, early establishment, to reduce the time from emergence to full canopy closure in order to maximize yield. Seed priming has a positive effect on seed quality causing faster and more uniform germination which in turn supports faster emergence and crop development. Routine measurements have been developed for germination, field emergence and yield; however measurements of emergence under controlled lab conditions and early plant growth in the field have been missing parts of the story until now.

We have previously shown the relationship between laboratory germination speed, as measured using imaging technologies (Icarus), and field emergence (Long, Webb & Harper 2011). However emergence is made up of more that just germination, it also involves growth of the seedlings. To better characterize speed of emergence and compare dif-

ferent treatments, a laboratory emergence test has been developed, that correlates with field emergence speed. The information from this test gives another level of understanding of the seed quality and allows testing of treatments under controlled conditions year round, instead of just in the spring. Being able to predict which treatments will give faster more uniform emergence in the field is a useful tool to more rapidly develop seed enhancements.

The other missing part has been the measurement of the growth of young plants following emergence. In theory faster emerging plants will have a head start and as the plants grow exponentially, small differences early on can lead to larger differences in the time taken to reach full canopy closure. A portable imaging tool has been developed to gather overhead pictures of plants in the field which are then analyzed with imaging software. This gives measurements of the projected leaf area of individual plants and allows large number of plants to be monitored. Images can be gathered at different times between the 2 to 8 leaf stages to follow leaf area development. Results have shown that the faster emergence does indeed lead to larger plants. In addition it gives us a tool to measure the effect of seed treatments designed to improve early plant growth following emergence.

McGRATH*, J. MITCHELL AND SAFA ALZOHAIRY1 USDA-ARS, Sugarbeet and Bean Research Unit, 1066 Bogue St., East Lansing, MI 48824-1325. 1 Plant Breeding, Genetics, and Biotechnology Program, Dept. of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing, MI. **Transcriptomes of seeds germinating at temperature extremes.**

Germination is crucial to developing healthy, vigorous, and productive field populations of sugar beets. Despite planting high-quality, technically-augmented seed for growers with very high germination (>92%), field emergence and persistence continues to hover at ~60% in Michigan. Previous research suggests this difference is the result of stress during germination in the field environment. For many years, the East Lansing USDA-ARS sugar beet program has focused on stress responses during germination. To date, we have identified some biochemical pathways that appear to influence seed germination and seedling vigor in ways that can improve emergence potential. However, we still do not understand the responses in a way that might allow us to increase genetic gains for traits related to emergence, seedling vigor and stand establishment, a goal for the 'one seed – one beet' concept. One way to identify additional genes involved is to examine expression of all genes during germination in different environments. In this case, East Lansing breeding materials were screened for germination at temperature extremes that could be expected under field conditions (e.g. 10 °C for early spring planted beets and ~40 °C for late summer planted beets). SP7322 (the pollinator parent of the high seedling vigor hybrid USH20) performed the best under cold temperature (60% germination

vs. the next best germination of 30%), while at 40 °C all tested materials germinated to >80%. The five best high temperature germinators were re-examined at 41 °C and 42 °C, and a sharp decline in germination was seen (>80% reduction) at 41 °C and no germination was seen at 42 °C, with the exception of 4% germination in Accession EL-A027008 (derived from PI 357361, selected for high germination, and intercrossed with nematode resistant breeding lines selected in the Imperial Valley, California). These two accessions were chosen for RNAseq transcriptome analyses with the interim result that candidate genes identified as temperature responders in other plants were expressed differentially in these two accessions. Further analyses will identify additional candidate genes and biochemical processes with the aim to develop genetic and physiological markers and germplasm with good performance under temperature stress as well as possibly identify the genes and mechanisms involved in temperature stress resistance.

RUSHING, DOUGLAS W. , Monsanto Company, 800 North Lindbergh Blvd, St. Louis, MO 63167. **Engaging in conversations about agriculture and biotechnology.**

Innovation is key to feeding a rapidly growing global population while also protecting the environment. However, better dialogue is needed to build understanding and consensus in addressing some of humanity's biggest challenges. The role of the farmer has never been more important. In the coming decades, agriculture's ability to meet the demands of our growing global population in an increasingly sustainable way will be vitally important. Farmers will have to grow more on existing farmland and effectively mitigate challenges from weather and threats – such as insects, weeds and resource scarcity. Innovation will be central to helping farmers do more with less, and manage the challenges that prevent food and crops from making it to harvest. The subject of biotechnology or genetically modified organisms (GMO's) is often one filled with controversy and misinformation. Much of this has been driven by the growing influence of social media. Research has shown that three segments of the social media world are driving the conversation about our food supply. New communication tools are required to reach these diverse and opinionated populations about agriculture and food production tools. This will involve listening, sharing common values, sharing agriculture's story, and engaging in a new form of conversation.

SAVARY, BRETT J.[1,2]*, JIANFENG (JAY) XU[1,2], JOSE C. TOVAR[1], NINGNING ZHANG[1], and HONG FANG[2], [1]Arkansas Biosciences Institute, [2]College of Agriculture and Technology, Arkansas State University, P.O. Box 639, Jonesboro, AR 72467. **Molecular and biochemical technologies for remodeling sugar beet root cell walls with thermostable enzymes.**

Sugar beets are targeted for expanded industrial sugar (sucrose) production beyond traditional growing regions to meet national needs for advanced biofuels, renewable chemical feedstocks, and for conversion to value-added biobased products. We are investigating biochemical and molecular technologies for remodeling the cell wall in sugar beet roots to provide economic and environmental benefits for sustainable beet-biomass processing. We are assembling a toolbox with thermostable glycohydrolases to evaluate effective action on beet pulp and demonstrate bioproduction systems. This presentation will summarize current progress to develop the naturally thermally-tolerant pectin methylesterase and thermostable *Geobacillus* endo-arabinanase. We also highlight application of "designer" glycopeptide technology for stabilizing proteins and efficient targeting to the cell wall. Our research program's goal is to establish the suitability for using these thermostable enzymes to rationally manipulate the structural and functional properties of cell walls and to engineer their direct expression in sugar beet tap-roots.

SMIGOCKI, ANN C.*, HAIYAN LI, SENTHILKUMAR PADMANABAN and USDA-ARS Molecular Plant Pathology Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705. **Characterization of a *Beta vulgaris* polygalacturonase-inhibiting protein (*PGIP*): a defense response gene.**

Polygalacturonase-inhibiting proteins (PGIPs) are plant cell wall proteins that inhibit pathogen and pest polygalacturonases (PGs). PGIPs are members of the leucine-rich repeat (LRR) protein family that play crucial roles in development, pathogen defense and recognition of beneficial microbes in plants. Two sugar beet *PGIP* genes were cloned from breeding line FC607. The full-length cDNA sequences were 1,152 (*FCPGIP1*) and 1,146 (*FCPGIP2*) bp and encoded a 384 and 382 amino acid peptide, respectively. FCPGIP1 and FCPGIP2 showed 74.8% sequence similarity and were most closely matched (47% similarity) to a subgroup of *M. truncatula* PGIP (GenBank accession # XP_003621816). FCPGIPs exhibited characteristics of other plant PGIPs, including the presence of an N-terminal signal peptide and a set of ten (FCPGIP1) or nine (FCPGIP2) LRR repeats. In 2 to 3-month old plants, RT-PCR analysis with gene-specific primers demonstrated that both *PGIP* genes were expressed constitutively, with maximum expression being observed in roots, followed by leaves then petioles and hypocotyls, all indicative of developmental gene regulation. A study of PGIP inhibitory effect on pathogens and pests is ongoing.

Section B & E Physiology, Biotechnology, Genetics & Germplasm Poster Presentations

O'BOYLE, PATRICK D[1]*., WERNER M. BEYER[2], JENS C. LEIN[2], AND MARGARET M. REKOSKE[1], [1]Betaseed Inc., 1325 Valley View Road, Shakopee, MN, 55379 and [2]KWS SAAT AG, Grimsehlstrasse 31, 37555, Einbeck. **Benefits of sugar beet root aphid resistance in North American sugar beet production.**

Sugar beet root aphid (SBRA, *Pemphigus betae*) is a devastating insect pest in many North American sugar beet production areas and can only be controlled using genetic resistance. SBRA pressure can cause reductions in sugar content (POL) and recoverable sugar per acre (RSA) and can cause storage losses. Proprietary trials in Minnesota in 2013 showed that while performance of both SBRA resistant and susceptible hybrids were similar in the absence of SBRA pressure, heavy SBRA infestation resulted in a 13% relative loss in RSA of susceptible hybrids. Official Variety Trial (OVT) results from the Red River Valley have also shown that SBRA resistant hybrids may have over 20% higher relative POL and approximately 2-fold higher relative RSA under high SBRA pressure. Proprietary trial hybrids in Michigan showed up to 1.2% lower POL in non-RA tolerant hybrids under only slight SBRA pressure, relative to resistant hybrids. A 2013 storage trial (Michigan Sugar OVT) revealed high correlations between SBRA ratings and external rot (79%) and internal rot (83%). Results from a Red River Valley yield trial in 2012 showed that sugar beets damaged by SBRA had approximately a 60% reduction in POL by 30 days after harvest (DAH) and an 80% reduction at 90 DAH relative to beets with minimal SBRA damage. Consequently, extractable sugar per ton in the same trial, had reductions at 30 and 90 DAH of approximately 80% and 89%. Although the direct cause of these losses is unknown, it is likely due in part to postharvest rots resulting from SBRA infestations. Due to a lack of biological, chemical, and cultural controls, genetic resistance provides the only option for producers to avoid preharvest and postharvest losses in sugar beets and for many years has allowed producers to grow successful crops despite SBRA pressure.

PANELLA, LEE[1]*, TRAVIS VAGHER[1], ANN FENWICK[2] AND LINDA E. HANSON[3], [1]USDA, Agricultural Research Service, 1701 Center Avenue, Fort Collins, CO 80526, [2]Beet Sugar Development Foundation, 800 Grant Street, Denver, CO 80203, and [3]USDA, ARS, 494 Plant and Soil Sciences Bldg. MSU, East Lansing, MI 48824-1325. **Development of a field inoculation method to screen for sugar beet seedling resistance to *Fusarium oxysporum* f. sp. *betae*.**

Fusarium yellows is an important disease in many sugarbeet production area in the U.S. and yield losses can be devastating. Also

seedling damping off caused by *Fusarium* can result in serious damage to the sugarbeet stand establishment. This can lead to a severe loss in yield. The objective of this research has been to develop the methodology for field screening of sugarbeet for *Fusarium* resistance at the seedling stage. *Fusarium oxysporum* f. sp. *betae* isolate, FOB220a (highly virulent), was used to prepare infested barley inoculum. Sterile barley inoculated with a liquid culture was incubated at room temperature until all barley grains were fully colonized. Ground, dried inoculum, added to the seed packets, was used to inoculate field experiments. Sterile barley was used as a control. The nursery consisted of one-row plots (75 cm spacing), 4 m long, at the ARS Research Farm, in Fort Collins, CO. Trials were planted in 2008 and 2010 using four public germplasms, which varied in their resistance to FOB220a – FC708, FC716, FC709-2, and FC702-2. In both years, seedling stands were counted every 7-10 days for six weeks post emergence. A final count was made 16 weeks post emergence in 2008. In 2008, there were significant differences between the inoculated and control plots, when averaged over the four lines and the four dates of seedling counts. When looking at each week, there were significant differences in all weeks except for the first seedling count ten days after planting. In 2010 there were significant differences among the four germplasms and the four evaluation dates. All of the inoculated lines lost seedlings over time, even though 3 of the 4 lines started within 10% of the control at the first counting date. There were clear differences between the lines at the last evaluation date.

RICHARDSON, KELLEY L., USDA-ARS, 1636 East Alisal St., Salinas, CA 93905. **Molecular characterization of wild *Beta* populations in the Imperial Valley, California.**

Populations of wild *Beta* species exist as weeds in commercial sugar beet fields in the Imperial Valley, California. Significant losses to sugar yield and quality result if these wild plants are not removed. In cases of extreme infestation, fields are abandoned without harvest. No selective chemicals are available to differentiate conventional sugar beet from wild relatives and hand removal is labor intensive and expensive. Planting sugar beet varieties with tolerance to glyphosate is a potential solution for infested fields, but risk of gene flow to adjacent wild relatives must be determined. Previous research identified these populations as either *Beta vulgaris* subspecies *maritima* or *Beta macrocarpa*. This distinction is critical because *B. v.* ssp. *maritima* will readily cross hybridize with cultivated sugar beet while *B. macrocarpa* rarely will. In April 2011, whole plants, mature seed, and leaf tissue for DNA extraction were collected from wild plants in 25 infested sugar beet fields throughout the Imperial Valley. Morphology of plants from collected seed grown in non-competitive conditions assigned taxonomy of these populations to *Beta macrocarpa*. In this study, we used molecular tools with the objective to determine genetic similarities and differences be-

tween and within wild *Beta* populations. DNA was extracted from collected leaf tissue and DNA of known *B. v.* ssp. *maritima* and *B. macrocarpa* accessions was included for comparison. Six simple sequence repeat (SSR) molecular markers were run and fluorophore-assisted fragment analysis assigned sizes to resulting PCR products. Marker data was evaluated for population structure. The K statistic divided the wild *Beta* populations into two subgroups suggesting gene flow occurred either amongst wild beet populations or between cultivated and wild beets at some point in their history. Phylogenetic analyses are underway to further clarify these relationships.

SIDDIQUI, HAMAD*, BRIAN H. BROWN,. and RAFAL MARCINEK. Germains Seed Technology, Hansa Road, Hardwick Industrial Estate, King's Lynn, Norfolk, PE30 4LG, UK. **Inducing systemic acquired resistance in sugar beet plants to enhance plant's reactions to environmental stresses and improve yield.**

The systemic acquired resistance (SAR) is a "whole-plant" resistance response that occurs following an earlier localized exposure to a pathogen. SAR is analogous to the innate immune system found in animals, and there is evidence that SAR in plants and innate immunity in animals may be evolutionarily conserved. Plants use pattern-recognition receptors to recognize conserved microbial signatures. Pathogen-(or microbe) associated molecular patterns (PAMPs/MAMPs) are typically conserved molecules ubiquitous across entire genera of pathogens that are essential for the normal life cycle of the organism (Boller and Felix, 2009). A broad array of structurally diverse PAMPs has been described originating from fungal, oomycete and bacterial pathogens. Most of these PAMPs are oligosaccharides, glycopeptides, and peptides. These elicitors can set off chain reactions that trigger different responses to not only pathogens, but also abiotic stresses such as drought, heat and cold. We have been investigating the effect of PAMP-containing seed applied formulations to improve stress tolerance, crop establishment, plant growth and ultimately yield of sugar beet. These formulations have been tested in the lab and in various field trials in Europe and the US.

TOVAR, JOSE C.[1], JIANFENG (JAY) XU[1,2], and BRETT J. SAVARY[1,2], [1]Arkansas Biosciences Institute, [2]College of Agriculture and Technology, Arkansas State University, P.O. Box 639, Jonesboro, AR 72467. **Can the enzyme TT-PME reduce water-binding to lower energy inputs in sugar beet pulp processing?**

We are investigating novel biotechnical application of the thermally-tolerant pectin methylesterase (TT-PME) in sugar beet processing. Removing water from wet pulp (cossettes) is necessary to stabilize for storage and to reduce weight for shipping, and drying pulp is a highly energy intensive process (consumes up to 25% of total beet processing

energy). Our current objective is to determine if this enzyme can be used to selectively manipulate cell wall structure to reduce pulp's water holding capacity. We hypothesize TT-PME can promote calcium crosslinking via homogalacturonan chains in beet tissue, resulting in more rigid and compact structure that will facilitate mechanical de-watering of pulp, which will lower energy inputs for drying treated pulp. Our results show indeed that TT-PME treatment promotes calcium cross-linking to significantly reduce water binding in pulp. This establishes the enzyme as a candidate for developing biotech sugar beets that will directly express the enzyme in tap roots to provide an improved quality output trait for pulp processing.

STEVE BARNES[1], KEVIN KOH[2], ANDREW SHARPE[2], SIGRID VANSTRAELEN[1] & GLENDA WILLEMS[1], [1]SESVanderHave,Tienen, Belgium and [2]NRC, Saskatoon, Canada. **Relationship between physical and genetic distances in sugar beet chromosomes.**

The order of genes or markers along chromosomes can be determined in two main ways. The most traditional is the study of genetic linkage - two genes that are located close to one another on a chromosome will be inherited together more often than with genes that are more distantly "linked" to them on the same chromosome. This allows the construction of genetic linkage maps, based on recombination frequency, often given in cM.

The availability of genome sequence information provides a second measure of linkage - physical distance in millions of base pairs (Mbp). Careful analyses show that there is no clear linear relationship between these measures of distance, although gene order is, of course, maintained. In general, centromeric regions have lower recombination levels (and hence more MBp per cM) than interstitial regions.

We will present the results of our analyses, based on extensive linkage mapping of a variety of types of genetic marker, and comparisons with their physical positions in the genetically anchored SESVanderHave genome assembly, relative to gene density, repeat content, and location relative to cytological features (rRNA, centromeres, telomeres etc). Comparative sequencing of a set of sugar beet lines also provides data on amount and types of polymorphism in different regions of the genome.

ZHANG, NINGNING[1], JIANFENG (JAY) XU[1,2], and BRETT J. SAVARY[1,2], [1]Arkansas Biosciences Institute, [2]College of Agriculture and Technology, Arkansas State University, P.O. Box 639, Jonesboro, AR 72467. **Recombinant expression of a thermostable endo-arabinase for isolating functional oligosaccharides from sugar beet pulp.**

Sugar beet pulp is a lignin-deficient plant fiber that is a rich source of structurally complex cell wall polysaccharides, particularly branched

arabinan. The goal of this project is to develop an efficient biochemical platform for generating functional oligosaccharides, specifically, feruloylated arabino-oligosaccharides (FAOs), from sugar beet pulp. FAOs may promote healthful colon functioning through prebiotic, anti-inflammatory, and mucosal immuno-modulatory activities, and enzyme treatment may improve FAO bioavailability in food and feed applications. We hypothesize root-expressed endo-arabinase can selectively cleave the arabinan chain in beet tissue to promote release of soluble FAOs. In this study, a thermostable endo-1,5-*a*-L-ABN from *Bacillus thermodenitrifican* TS-3 was expressed in yeast (*Pichia pastoris*) cells and functional enzyme was secreted into media. We present our characterization of the yeast-expressed enzyme in terms of molecular structure, specific activity, sensitivity to pH and temperature, and tolerance to high temperature. Continuing studies will investigate the enzyme's ability to generate FAOs for evaluating bioactivity in a colon epithelial cell model.

Section C - Entomology & Plant Pathology
Oral Presentations

BELLES, DAVID[1]* and PALLE PEDERSEN[2], [1]Syngenta, 4037 E. Karsten Dr., Chandler, AZ 85249 and [2]Syngenta, 317 330th Street, Stanton, MN 55018. **Pasteuria technology to manage sugar beet cyst nematode (*Heterodera schactii*)**.

Sugar beet cyst nematode (*Heterodera schactii*) causes significant stand and yield reductions in 39 countries worldwide. Managing *H. schactii* is difficult but important as *H. schactii* cannot be eradicated after it is introduced into a field. Historically, several management practices have been used to control this pest including tolerant cultivars, chemical control (nematicides), and the rotation with non-host crops. No single management tactic is effective but the use of multiple tactics can minimize yield loss. Integrated solution strategies combining tolerant cultivars with other control methods is important as tolerant varieties do not completely eliminate *H. schactii* feeding or reproduction. Also, the prudent use of tolerant cultivars are necessary as continual use may increase the likelihood that the *H. schactii* population will adapt to the sugar beets source of resistance allowing increased levels of *H. schactii* reproduction. Clariva Pn (*Pasteuria nishizawae*) seed treatment is a new offer from Syngenta that compliments the use of nematode tolerant cultivars to manage *H. schactii*. Pasteuria spp. are natural bacterial obligate parasites of nematodes with a unique mode of action. The Pasteuria spores (active ingredient) are highly effective and lethal to nematodes, without harming other organisms, plants and the environment. When delivered as a seed treatment, it provides enhanced convenience and effectiveness for growers. Pasteuria spores attach, penetrate and infect the nematode body, ulti-

mately leading to its death. The technology starts to work immediately and reduces the reproductive rate even before killing the nematode. Pasteuria strains are specific to a nematode species or genus. In small plot field trials with moderate- to high-levels of *H. schactii* in Idaho, Colorado, and Michigan Clariva Pn increased the sugar per acre versus an insecticide/fungicide check.

BOETEL, MARK A.[1]*, LARRY G. CAMPBELL[2], AND JEFFREY D. BRADSHAW[3], [1]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108, [2]USDA-ARS, Northern Crop Science Laboratory, 1307 18th Street N., Fargo, ND 58102, and [3]University of Nebraska, Panhandle Res. & Ext. Ctr., 4502 Avenue I, Scottsbluff, NE 69361. **Sugarbeet root aphid impacts on postharvest root storage.**

The sugarbeet root aphid (SBRA), *Pemphigus betae* Doane, is a serious insect pest of sugarbeet in several North American sugarbeet production areas; however, it is rarely an economic pest in the Red River Valley (RRV). In 2012 and 2013, all RRV factory districts were impacted by SBRA outbreaks, and several growers incurred significant yield losses. This research was carried out to determine the impact of SBRA damage on the postharvest storage quality of sugarbeet roots. Study sites included fields near Nielsville and Ada, MN in 2012 and 2013, respectively, and Scottsbluff, NE in 2013. Treatments consisted of 1) lightly infested, and 2) highly infested sugarbeet roots, and were replicated at least six times across each field in a paired design. In the second year, all roots were rated according to a 0 to 5 rating scale to quantify the SBRA infestations. Root samples were returned to the laboratory, washed, and stored at 5°C for up to 90 days after harvest (DAH). At 90 DAH, the postharvest respiration rate in roots that had been colonized by high SBRA infestations was 475% greater than those with light SBRA infestations. Also at 90 DAH, postharvest sucrose content in roots affected by high aphid infestations was 75% lower than in roots that had light SBRA infestations. Extractable sucrose levels per unit root weight were negligible in roots that had been colonized by high SBRA infestations. Harvesting two weeks earlier dramatically reduced postharvest losses in aphid-damaged roots. In addition to demonstrating the impacts of SBRA damage on postharvest respiration and storage losses, these findings provide important implications regarding whether such roots should be placed into long-term storage with healthy roots.

BOLTON, MELVIN D.[1]*, LUIGI FAINO[2], BART P. H. J. THOMMA[2] and GARY A. SECOR[3], [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, North Dakota, USA, [2]Laboratory of Phytopathology, Wageningen University, The Netherlands and [3]North Dakota State University, Department of Plant Pathology, Fargo, ND, USA. **Insight into sterol**

demethylation inhibitor (DMI) resistance in *Cercospora beticola* using RNA-Seq.

Cercospora leaf spot (CLS) is a devastating disease of sugarbeet caused by the fungus *Cercospora beticola*. Management measures include the application of sterol demethylation inhibitor (DMI) and quinone outside inhibitor fungicides. Understanding the molecular mechanism of fungicide resistance is critical for fungicide resistance management. We have shown previously that the gene encoding the DMI target enzyme, *CbCyp51*, is over-expressed in DMI-resistant isolates upon exposure to the DMI tetraconazole. However, no mutations in the *CbCyp51* gene or promoter were associated with resistance. Following the same experimental approach, we sequenced the entire transcriptome of a DMI-resistant and -sensitive isolate using next generation RNA-Seq technology to identify genes involved with DMI-resistance. We identified 104 genes commonly differentially expressed between the two isolates in response to tetraconazole, suggesting a core set of genes are triggered in response to the fungicide and/or associated cellular stress. A set of 110 genes were uniquely induced in the DMI-resistant isolate after exposure to tetraconazole. Pathway and sequence analysis of these 110 differentially expressed genes is being carried out to identify regions or mutations associated with DMI-resistance, which will be exploited for PCR-based detection analyses. Recent progress on this project will be discussed.

BORNEMANN, KATHRIN[1,2], NAZLI DIDE KUTLUK YILMAZ[3], MOHAMED F. R. KHAN[2] and MELVIN D. BOLTON[1]*, [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, North Dakota, USA and [2]North Dakota State University, Department of Plant Pathology, Fargo, ND, USA and [3]University of Ondokuz Mayis, Agriculture Faculty, Department of Plant Protection, Samsun, Turkey. **Sequence analysis of the *Beet necrotic yellow vein virus* P25 pathogenicity factor in Turkey and the Red River Valley of MN and ND.**

Turkey is one of the largest beet sugar producing countries in the world. Rhizomania is a devastating disease of sugar beet caused by *Beet necrotic yellow vein virus* (BNYVV) and is widely present in Turkey. In the past, disease management was obtained by using hybrids with resistance genes *Rz1* or *Rz2*. Recently, BNYVV strains with four RNA components were identified that are able to overcome *Rz1*-mediated resistance. All *Rz1*-resistant strains described so far possess an A67V amino acid exchange within the RNA3-encoded P25 pathogenicity factor. To identify the extent that the A67A mutation or other mutations occur in P25, 638 soil samples were collected throughout the country and analyzed for the presence of the virus. Positive samples were taken for a resistance test with *Rz1*, *Rz2*, and *Rz1+Rz2* resistant sugarbeet cultivars and virus titer was measured with ELISA. Samples were also analyzed for the composition of P25. One sample showed high virus titers over all treatments. P25 tetrad composition showed an ASHG

tetrad in susceptible plants and ACHG in *Rz2* and *Rz1+Rz2* resistant plants. Nine samples were identified carrying an additional RNA component with the P26 pathogenicity factor and ACHG tetrad composition as well as high virus titers. P26 has so far been identified in France, England, and Kazakhstan, and has only been associated with the SYHG tetrad. However, sequencing results showed a high variability of the P25 tetrad with newly identified compositions. The same strategy was applied to the sugarbeet growing area of the Red River Valley and southern Minnesota. In total, samples were collected from 604 locations. Of these, ~15% were positive for Rhizomania in the susceptible variety. Recent progress on this project will be discussed.

BRANTNER, JASON R. AND ASHOK K. CHANDA*, Univ. of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **Integrated management of Rhizoctonia on sugar beet with varietal resistance, seed treatment, and postemergence fungicides.**

Damping-off and crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2, have been prevalent throughout the sugar beet growing area of Minnesota and North Dakota. Current control options include early planting of partially resistant varieties and the use of in-furrow (IF) or postemergence (PE) fungicides. In this study, various seed treatments and azoxystrobin IF on a resistant and susceptible variety were tested as stand-alone treatments and with PE application of azoxystrobin for control of *Rhizoctonia*. Seed treatments included metconazole + rizolex (Metlock), penthiopyrad (Kabina), Metlock + Kabina, sedaxane and an untreated control. There were significant (P = 0.05) variety by at-planting treatment interactions for stand establishment and number of harvestable roots. On the resistant variety, seed treatments except Metlock resulted in higher stand than azoxystrobin IF, while on the susceptible variety, azoxystrobin IF resulted in stands as high as the most efficacious seed treatments. For both varieties, stand was significantly lower for seed treated with Metlock and the untreated control. There were no significant interactions for yield and recoverable sugar A^{-1} (RSA). The resistant variety was significantly higher than the susceptible variety for both yield (24.5 and 20.3 ton A^{-1}, respectively) and RSA (7747 and 6426 lb A^{-1}, respectively). Azoxystrobin IF and all seed treatments resulted in significantly (P = 0.05) higher yield and RSA than the untreated control. Yield for azoxystrobin IF, Kabina, sedaxane, Metlock + Kabina, Metlock, and the untreated control was 24.5, 23.9, 23.1, 23.0, 21.4, and 18.3 ton A^{-1}, respectively. Application of PE azoxystrobin did not significantly affect stand, yield or RSA. Overall, the best stand establishment and yield was obtained with the resistant variety combined with an effective seed treatment fungicide or azoxystrobin IF.

CAMPBELL, LARRY G., USDA, ARS, Northern Crop Science Laboratory, 1605 Albrecht Blvd. N., Fargo, ND 58102-2765. **Potential of host-plant resistance as an alternative control measure for sugarbeet root maggot (SBRM).**

Germplasm lines with SBRM resistance have been available since 1996. The SBRM feeding damage observed on these lines (F1015, F1016, and F1024) is similar to that observed on susceptible commercial hybrids combined with recommended registered insecticides. Two previous trials have indicated that hybrids with a SBRM resistant pollinator and an elite susceptible CMS line would provide a substantial reduction in losses due to root maggot feeding. Two resistant germplasm lines, F1015 and F1016, and a susceptible germplasm line, F1010, crossed with three susceptible CMS lines (L53cms, FC504cms, and SP69550-01) were evaluated at a site with heavy SBRM pressure in 2013 and 2014. The difference between the two-year average root yield of hybrids with F1015 and F1016 as pollinators (37.9 and 36.8 Mg ha^{-1}, respectively) was not significant but both exceeded the average root yield (30.2 Mg ha^{-1}) of the three hybrids with F1010 as the pollen parent. Pollinator X CMS-line interactions were not significant. Average SBRM damage ratings (0 = no scaring to 9 = more than 75% of root surface covered with feeding scars) for hybrids with F1015, F1016, and F1010 as pollinators were 4.3, 3.8, and 5.3, respectively. PI 179180, a line with red globe-shaped roots, was identified as SBRM by North Dakota State University in 1973. Two lines selected from a cross between PI 179180 and a susceptible California sugarbeet line, C564, have high levels of resistance and are being increased with the intent to release one or both as a unique source of SBRM resistance. In 2013 and 2014 evaluations, these lines had average damage ratings of 2.4 and 2.5, compared to ratings of 1.8, 6.2, and 6.0 for F1024 (resistant germplasm), F1010 (susceptible line), and Beta-1301 (commercial hybrid), respectively.

EBERT, MALAIKA K.[1,2]*, BART P. H. J. THOMMA[2] and MELVIN D. BOLTON[1], [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, North Dakota, USA and [2]Laboratory of Phytopathology, Wageningen University, The Netherlands. **The *Cercospora beticola* effector CbAve1 promotes virulence during sugar beet infection.**

Cercospora Leaf Spot (CLS), caused by the hemibiotrophic fungus *Cercospora beticola*, is the most destructive foliar disease of sugar beet worldwide. Fungal pathogens like *C. beticola* secrete effector proteins into the apoplast to promote their virulence during infection. To combat the effects of pathogen effectors, plants have developed resistance (R) proteins that are able to recognize specific effectors and trigger defense responses. It was shown recently that the tomato R protein Ve1 provides resistance against *Verticillium dahliae* race 1 strains that secrete the effector protein VdAve1 (Avirulence on Ve1 tomato). Genome sequencing revealed that a homolog of tomato *Ve1, BvVe1*, can be found

in *Beta vulgaris* genome. Likewise, the *C. beticola* genome harbors *CbAve1*, a homolog of *VdAve1*. We have shown previously using agroinfiltration in *Nicotiana benthamiana* that tomato Ve1 recognizes CbAve1, resulting in a hypersensitive response. To determine whether CbAve1 is a virulence factor during the infection of sugar beet plants, Δ*CbAve1* mutant strains were developed. Sugar beet variety 86RR66 was inoculated with either a *C. beticola* wild type or Δ*CbAve1* mutant strain. A higher amount of fungal biomass was found in leaf material inoculated with the wild type than in the leaf material infected with the Δ*CbAve1* mutant strains. This result shows that the deletion of *CbAve1* affects *C. beticola* virulence. A detailed overview of *CbAve1* and *BvVe1* will be presented.

HAFEZ, SAAD L. and MAHESH P. PUDASAINI, University of Idaho, Parma Research and Extension Center, 29603 U of I Lane, Parma, Idaho 83660. **Sugar beet cyst nematode management on sugar beet in Idaho using tolerant varieties and reduced rate of Telone II.**

Sugar beet cyst nematode can cause up to 80% sugar beet yield reduction if the nematode was not managed. Our objectives in this study were to determine the response of tolerant sugar beet varieties, in-row and broadcast application of Telone II at reduced rate, and a combination of tolerant beet varieties with low rate of Telone II on sugar beet yield and beet cyst nematode population. The experiments were carried out for two growing seasons in a completely randomized design with seven treatments each with five replications in silt loam field. Telone II @ 8, 12 or 16 gal/A was shanked to a depth of 12 inches. Temik 15G @ 20 lb/A at plant and 13 lb/A at post-plant was applied. Nematode tolerant and susceptible sugar beet varieties were sown for these trials. Beets were harvested and weights were taken from all experiments. The results demonstrated that sugar beet yield was significantly increased in all tolerant varieties by 47 to 65% as compared to susceptible variety. Final population of viable cysts was increased by four folds in susceptible variety while there were no increases in tolerant varieties. The beet yield was significantly increased in both in-row and broadcast application of Telone II as compared to untreated control and Temik. All the rates of Telone II in-row had significant higher beet yield (93-102% increases) as compared to broadcast applications (58-71% increases). In the combination study, sugar beet yield was increased by 102% in susceptible variety in fumigated plots as compared to non-fumigated plots. Tolerant varieties were increased by 8-50% in the fumigated plots as compared to non-fumigated plots. In conclusion, the total beet yield was significantly higher in tolerant sugar beet varieties in fumigated plots as compared to tolerant varieties in non-fumigated plots and susceptible varieties in fumigated plots.

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

Fungicide band applications have proven to be very effective in controlling Rhizoctonia crown and root rot when properly timed. Their use poses two problems for growers; 1.the proper timing relative to growth stage can differ year to year and 2. the proper application window can be only 1-3 days, too short a time for optimally treating large acreages. In 2011, 2012, 2013 and 2014 we compared seed treatments including Kabina (Summitomo Corp.) (2011-2014), Vibrance (Syngenta)(2014) and Metlock-Rhizolex (Valent) (2014) and in-furrow applications of Quadris (Syngenta) (2011-2014), Prixor (BASF) (2013-2014) or Vertisan (DuPont) (2011-2014) and with application of Quadris or Priaxor applied at the 4-6, 8-10 and 10-12 leaf stages in 2011 and 2012 and with applications at the 4-6 leaf and 10-12 leaf growth stages in 2013 and 2013. Azoxystrobin band applications alone at the 4-6 leaf stage provided optimal yield and disease control, with applications at the 8-10 and 10-12 leaf stages being less effective. The use of seed treatments alone were not effective in reducing disease severity or increasing yields but when combined with fungicide band applications at all timings, all seed treatment rates provided optimal disease control and yield increase. In-furrow treatments alone provided good disease control and high yields but disease control and yield were optimal when combined with fungicide band treatments. The use of penthiopyrad seed treatment or infurrow treatments combined with fungicide band applications provided optimal control and yield increases while allowing growers nearly 3 weeks to apply band applications compared to the 3-5 day period where azoxystrobin band application had to be done to achieve optimal disease control. In-furrow applications required 50-100 times more fungicide compared to seed treatment alone.

KHAN, MOHAMED F. R.[1]*and SAHAR ARABIAT[2], [1]Plant Pathology Department, North Dakota State University and University of Minnesota, Fargo, ND 58108, [2]Plant Pathology Department, North Dakota State University, Fargo, ND 58108. **Sensitivity of *Rhizoctonia solani* to fungicides in vitro and in vivo.**

Rhizoctonia solani Kühn, AG 2-2 causes damping-off, and crown and root rot of sugarbeet. Fungicides, especially azoxystrobin have been widely used over a decade to control *R. solani*. However, *R. solani* AG 1 was reported to have developed resistance to azoxystrobin. As such, it is necessary to determine the sensitivity of *R. solani* AG 2-2 to azoxystrobin and other fungicides labeled for controlling this pathogen. Sensitivity of *R. solani* to fungicides was determined using mycelium radial

growth assay, and in vivo study was conducted to determine the effectiveness of these fungicides at controlling *R. solani*. Mean baseline EC_{50} values for isolates collected before use of these fungicides in 1999 were 0.32, 0.17, 0.94, 49.78, and 97.13 for pyraclostrobin, penthiopyrad, prothioconazole, azoxystrobin, and trifloxystrobin, respectively. The mean EC_{50} values of the isolates collected in 2005 to 2012 was 0.86 µg/ml for pyraclostrobin, 0.21 µg/ml for penthiopyrad, 0.56 µg/ml for prothioconazole, 296.06 µg/ml for azoxystrobin, and 341.70 µg/ml for trifloxystrobin. There was no shift in sensitivity for *R. solani* isolates exposed to the different fungicides. Mean EC_{50} of *R. solani* isolates to azoxystrobin, trifloxystrobin, pyraclostrobin, and penthiopyrad increased with a change factor of 5.95, 3.52, 2.69, and 1.24, respectively. Frequency of isolates with EC_{50} values >10 µg/ml for azoxystrobin and trifloxystrobin increased in non-baseline isolates by 80% compared with baseline isolates which increased by 25%. All fungicides at labeled rates effectively controlled *R. solani* in vivo. The data indicated that *R. solani* was still sensitive to azoxystrobin although it was widely used in sugar beet production. Penthiopyrad showed low EC_{50} values, and showed no cross sensitivity with azoxystrobin, which makes it a good choice to be used with azoxystrobin in managing *R. solani* and for fungicide resistance management.

KUHN, PAUL J.*, DOUG RUPPAL, BILL GILBERT, RAM RAMALINGAM, DENNIS SIMMONS, REBECCA LARSON and TYLER RING, Syngenta, 410 Swing Road, Greensboro NC 27409. **Evaluation of Stadium™ fungicide applied to sugar beets post harvest to reduce decay and sucrose yield losses during storage.**

Loss of sucrose from healthy sugar beets in storage has been estimated at 0.2-0.5 lb per ton per day. Reduction in levels of extractable sugar is mainly due to respiration, but can be markedly increased due to infection and decay by fungi and bacteria. Rotting may also be accompanied by an undesirable increase in invert sugars. We report here on studies to evaluate the possible beneficial effects of Stadium fungicide applied post harvest for maintenance of quality and yield.

After harvest, beets were inoculated with various rot fungi, and then treated with Stadium fungicide at 0.96-2.5 floz/ton in 0.5 gal spray/ton, before placing under storage conditions that mimic those in commercial piles. After storage for various periods of time (40-85 days in ND; 130 days in ID), disease was assessed, and yield and sugar levels determined.

Based on disease incidence and severity, treatment with Stadium at all rates resulted in statistically significant reductions in decay caused by *Botrytis, Fusarium, Penicillium,* and *Rhizoctonia*. Although data on yield and sugar content are not yet available for all trials, the data in hand indicate that treatment with Stadium resulted in higher yields and reductions in loss of extractable sugar.

These early results are encouraging and, assuming that they are

substantiated in ongoing studies, consideration will be given to trials in commercial situations. Other activities will include optimization of application technology, and starting residue trials.

Stadium™ is a Trademark of a Syngenta Group Company.

RUSH, C. M.*, LI PAETZOLD and BECKY BRYAN, Texas A&M AgriLife Research, 2301 Experiment Station Road, Bushland, TX 79012. **High resolution melting analysis for rapid identification of BNYVV haplotypes.**

Over the last 5-10 years, resistance-breaking (RB) strains of BNYVV have appeared at increasing frequency in all major sugar beet production areas in the USA and around the world. However, no simple way to determine whether RB strains of BNYVV were present in a field or to determine the haplotype of RB strains causing rhizomania in resistant cultivars has been available. High Resolution Melting Point Analysis (HRM) is a realtime qPCR-based method of identifying genetic variation in nucleic acid sequences by analyzing melting dynamics of a PCR product. This technique was evaluated for its ability to differentiate known haplotypes of BNYVV. Primers were developed to amplify a section of the hyper variable region of BNYVV RNA 3, and a number of archived, sequenced samples, representing known haplotypes of wild type and RB strains of BNYVV were analyzed. HRM was able to clearly differentiate wild type BNYVV from RB and avirulent strains that originally had been isolated from symptomatic and asymptomatic field beets. HRM analysis provides a simple, inexpensive, highly sensitive and rapid method to identify haplotypes of RB BNYVV. It has significant potential to benefit breeders in developing cultivars with resistance to specific haplotypes of BNYVV, improve specificity of diagnostics and facilitate studies on BNYVV population genetics.

STEWART, JAMES F.[1]*, LEE A. HUBBELL[1], BRIAN GROULX[1], GREGORY M. CLARK[2] and STEVEN POINDEXTER[3]. [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Dr., Bay City, MI 48706, [2]Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706 and [3]Michigan State University Extension, 1 Tuscola Street, Suite 100, Saginaw, MI 48607. **Managing *Rhizoctonia solani* root and crown rot in sugarbeets with tolerant varieties and fungicide applications.**

Michigan sugarbeet growers lose approximately one to two tons per acre to Rhizoctonia root rot infections each year. In problem areas the yield loss is much worse. Rhizoctonia root rot is controlled with a combination of cultural practices, tolerant varieties and fungicide applications. Research trials have demonstrated that Quadris applied in-furrow at planting in a T-Band provides the best control of Rhizoctonia root rot in Michigan. Quadris foliar applications applied between the 4 to 8 leaf stage also gives good Rhizoctonia control. In Michigan

two Quadris applications are needed in areas where the disease level is high. Sugarbeet varieties with tolerance to Rhizoctonia are needed in approximately one third of the Michigan sugarbeet growing region. The presentation will examine yield losses in sugarbeets caused by Rhizoctonia and control measures including fungicide applications and the use of tolerant sugarbeet varieties.

STRAUSBAUGH, CARL A.[1]*, OLIVER NEHER[2], EUGENE REARICK[3], and IMAD A. EUJAYL[1], [1]USDA-ARS NWISRL, 3793 N. 3600 East, Kimberly, ID 83341, [2]Amalgamated Sugar Co., 1951 Saturn Way, Suite 100, Boise, ID 83709, and [3]Amalgamated Research LLC, 2531 Orchard Drive East, Twin Falls, ID 83301. **Influence of harvest timing, fungicides, and BNYVV on sugar beet storage.**

Root rots in sugar beet storage can lead to multi-million dollar losses because of reduced sucrose recovery. Thus, studies were conducted to establish better chemical control options and a better understanding of the fungi involved in storage rot. A water check and three fungicides (Mertect at 0.065 ml product/kg root, Propulse at 0.049 ml/kg, and Stadium 0.13 ml/kg) were investigated for their ability to control fungal rot on sugar beet roots held in long term storage during both the 2012 and 2013 storage seasons. At the end of September into October, roots were collected on five subsequent weeks, treated, and placed on top of a commercial indoor storage pile until early February. Both Propulse and Stadium performed well, by reducing fungal growth on roots versus the check by an average of 84 to 100% for roots collected the first three weeks both years. Both Propulse and Stadium performed well, by reducing root surface discoloration versus the check by an average of 75 to 100% with roots collected across all 5 weeks both years, except for 1 week in 2012 with Stadium. When compared to Mertect, both Propulse and Stadium reduced root surface discoloration by 50 to 100% and fungal growth by 46 to 67% when differences could be statistically proven. When compared to the check and Mertect, both Propulse and Stadium reduced sucrose loss by 14 to 46% when differences could be statistically proven. The predominant fungal pathogens were an *Athelia*-like sp., *Botrytis cinerea*, *Penicillium* spp., and *Phoma betae*. Propulse and Stadium should be considered further for root rot control in commercial sugar beet storage and on roots being held for seed production.

VARRELMANN MARK[1]* AND DACH, MARLENE[1], [1]Institute of Sugar Beet Research, Holtenser Landstrasse 77, 37079 Goettingen, Germany. **Development of a reverse genetic system for Beet soil borne mosaic virus (BSBMV).**

BSBMV belongs to the unassigned genus Benyvirus and possesses a similar vector, genome organization, particle morphology and host range like BNYVV. However, worldwide distribution and symptom for-

mation in sugar beet differ significantly. Moreover, BSBMV is not controlled by BNYVV resistance genes like *Rz1* in sugar beet. In the US, both viruses occur in mixed infections but information about interaction between species is limited. Here, the production of an infectious cDNA clone for agrobacterium mediated infection as well as fluorescence labeling of the recombinant virus is reported. Symptom formation and *Polymyxa betae* transmission is comparable to the wild-type virus. The recent development of a BNYVV infectious clone with a similar infection technique now allows studying BSBMV molecular biology, the proposed synergism with BNYVV host colonization strategy and occurrence of reassortants in mixed infections.

WEBB, KIMBERLY M.[1]* and FRANCISCO CALDERON[2], [1]USDA-ARS, Sugar Beet Research Unit, 1701 Centre Ave., Fort Collins, CO 80526 and [2]USDA-ARS, Central Great Plains Resources Management Research, 40335 County Rd. GG, Akron, CO, 80720. **Mid-infrared and Near-infrared detection of *Rhizoctonia solani* AG 2-2 IIIB on barley based artificial inoculum**

The amount of *Rhizoctonia solani* in the soil and how much is needed to cause disease in sugar beet (*Beta vulgaris* L.) is relatively unknown. This is mostly because of the usually low inoculum densities natually found in soil, and the low sensitivity of traditional serial dilution assays. We investigated the usefullness of using mid-infrared (MidIR) and near-infrared (NIR) spectroscopic properties to identify the artificial colonization of barley grains with *R. solani* AG 2-2 IIIB to detect *R. solani* populations in plant tissues and inoculants. The objectives of this study were to compare the ability of traditional plating assays to NIR and/or MidIR to identify *R. solani* from different sized fractions of colonized ground barley that is being used as an artifical inoculum from un-inoculated barley. NIR and MidIR were sensitive in resolving different barley particle sizes, with the <0.25 mm and 0.25-0.5 mm particles having different spectral properties relative to the more coarse particles. We found that barley colonized with *R. solani* had diffent MidIR spectral properties than un-inoculated samples for the larger fractions (0.5-1.0 mm, 1.0-2.0 mm and >2.0 mm) of the ground barley. This colonization was confirmed by traditional plating assays. Comparison with the spectra from pure fungal cultures and un-inoculated barley suggests that the colonized barley MidIR is different because of consumption of C substrates by the fungus, rather than by the presence of fungal bands in the colonized samples. MidIR was better than NIR in resolving colonized from control samples.

WEBB, KIMBERLY M.[1]*, ADAM HEUBERGER[2] and COREY BROECKLING[2], [1]USDA-ARS, Sugar Beet Research Unit, 1701 Centre Ave., Fort Collins, CO 80526 and [2]Colorado State University, Proteomics and Metabolomics Facility, 2021 Campus Delivery, Fort Collins, CO

80523. **Metabolomic differences in a susceptible and resistant *Beta vulgaris* germplasm during early responses to *Rhizoctonia solani* AG 2-2 IIIB.**

Sugar beet can be significantly impacted by Rhizoctonia crown and root rot caused by *Rhizoctonia solani* AG 2-2 IIIB. The molecular processes that mediate sugar beet resistance to *Rhizoctonia solani* are largely unknown and identifying the metabolites associated with *Rhizoctonia solani* infection may provide novel targets to utilize in breeding programs for enhanced resistance. The metabolic changes that occurred during susceptible and resistant *Rhizoctonia solani* interactions were compared with mock inoculated treatments and characterized using a non-targeted metabolomics workflow spanning primary and secondary metabolism products. Metabolites from infected and healthy, root and leaf tissue, were taken at 0, 3, 5, and 7days after infection (or mock inoculated) from two ssugar beet lines, FC709-2 (resistant) and 19941023 (susceptible check) and extracted with methanol:water (80:20) and detected using non-targeted reversed-phase UPLC-MS and GC-MS workflows. Non-targeted UPLC-MS analysis of sugar beet roots detected more than 900 compounds, of which 143 were annotated, including glycerolipids, primary metabolites, dipeptides, phenolics and conjugates, fatty acids, flavonoids, and terpenoids. Metabolites detected by GC-MS include carbohydrates, organic acids, sugar alcohols, phenolics, amino acids, nucleosides, fatty acids, sterols and terpenoids. Statistical interrogation of the datasets revealed clear distinction between tissue type and genotype, and more subtle changes in response to inoculation that was dependent on genotype. Notable among the *Rhizoctonia solani* infected tissues, was the accumulation of the phytoalexin betavulgarin in the susceptible line (19941023) at day seven after inoculation.

WENNINGER, ERIK J.[1]*, SUSAN Y. EMMERT[2], KELLY TINDALL[3], HONGJIAN DING[4], MARK A. BOETEL[5] AND SANFORD D. EIGENBRODE[2], [1]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Kimberly Research & Extension Center, Kimberly, ID 83341-5082, [2]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339, [3]Twin Falls County Cooperative Extension, 246 3rd Ave. East, Twin Falls, ID 83301; current address: DuPont Pioneer, 2223 Old Troy Rd., Union City, TN 38261, [4]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339; current address: Food and Drug Administration, Jefferson, AR 72079, and [5]Department of Entomology, North Dakota State University, NDSU Dept. 7650, P.O. Box 6050, Fargo, ND 58108-6050. **Aggregation behavior and a putative sex pheromone in the sugar beet root maggot fly, *Tetanops myopaeformis*.**

Field observations showed that male-biased aggregations of sugar beet root maggot flies, *Tetanops myopaeformis* (Röder), occur on utility poles near sugar beet fields; this contrasts with the approximately

equal sex ratio for flies observed within beet fields. Peak observation of mating pairs on utility poles coincided with peak diurnal abundance of flies. Volatiles released by individual male and female *T. myopaeformis* flies were sampled from 08:00h to 24:00h in the laboratory using solid phase microextraction (SPME) and analyzed by gas chromatography / mass spectrometry (GC-MS). Ten compounds were uniquely detected from males. Three of these compounds (2-undecanol, 2-decanol, and sec-nonyl acetate) were only detected between 12:00h and 16:00h. Another seven compounds (i.e., 6,10-dimethyl-5,9¬ undecadiene-2-one, dodecanal, tetradecane, pentadecane, and three unknowns) were also uniquely detected from males; however, these did not exhibit temporal trends in release during the sampling period. Both males and females produced 2-nonanol, but males produced substantially higher (ca. 80-fold) concentrations of this compound than females, with the greatest production again occurring during sample periods beginning at 12:00h. The temporal synchrony among male aggregation behavior, peak mating rates, and release of certain volatile compounds by males suggests that *T. myopaeformis* flies exhibit lekking behavior and produce a pheromone. Field assays using synthetic blends of the putative pheromone (comprising nine volatiles sampled from males) showed evidence of female attraction, especially at the highest dose tested.

WINTERMANTEL, WILLIAM M.*, LAURA L. HLADKY, AND ARTURO A. CORTEZ, USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905. **Emergence and competitiveness of new *Beet curly top virus* variants in sugarbeet production regions of the western United States.**

Curly top disease, caused by various strains of *Beet curly top virus* (BCTV), causes significant economic losses for sugarbeet throughout the western United States. Since the mid-1990s two strains of BCTV, known as 'mild' and 'severe', have been the predominant forms causing disease on sugarbeet and other crops; however, changes in severity and infectivity on melon in California led to the identification of new variant strains that differ in prevalence and severity among crop host plants. Samples of sugarbeet and other crops exhibiting curly top symptoms were collected from locations in California and Idaho from 2012-2014. DNA from these plants was extracted from symptomatic leaf tissue and evaluated to identify known strains using a series of strain-specific primers that differentiate traditional and recently identified emerging variants of BCTV, with further confirmation by DNA sequencing. Results confirmed an increasing prevalence of a new BCTV variant in sugarbeet and melon samples from California in 2013, and from sugarbeet samples in Idaho in 2014. The predominant new variant appears to be a recombinant virus formed by exchange of DNA between the traditional mild and severe strains, but with pathogenicity on sugarbeet that resembles the severe strain in sugarbeet. Continuing studies are evaluating competitiveness of three new variant BCTV

strains in sugarbeet and other host plants through inoculation of both viruses in single and mixed infections, with subsequent evaluation of symptom severity in single infections and relative titer of each strain using quantitative strain-specific PCR. Continued field evalutions combined with laboratory studies will determine the effect of emerging variants on current sugarbeet varieties and potential to impact production.

Section C - Entomology & Plant Pathology
Poster Presentations

HANSON, LINDA E.[2]*, CHIARA DE LUCCHI[1], LUCA SELLA[1], MARCO DEBIAGGI[3], J. MITCH MCGRATH[2], LEE PANELLA[4], and PIERGIORGIO STEVENATO[1], [1]Università degli Studi di Padova, Legnaro (Padova), Italy, [2]USDA-ARS Sugarbeet & Bean Research, East Lansing, MI 48824; [3]Massalombarda, Italy, [4]USDA-ARS Sugarbeet Research, Fort Collins, CO 80526. **Variable disease susceptibility and root rot response in sugar beet lines from Italy and the United States to isolates of *Fusarium oxysporum* f. sp. *betae*.**

The soil-borne fungus *Fusarium oxysporum* may cause severe yield losses in cultivated sugar beet worldwide, and causes both Fusarium yellows and Fusarium root rot diseases. Fusarium yellows was first reported in Colorado by Stewart in 1931, with foliar symptoms of wilting and interveinal yellowing and root symptoms of vascular discoloration. Fusarium root rot was first reported in Texas in 1989 and is characterized by a black rot in the root, as well as vascular discoloration and foliar symptoms similar to Fusarium yellows. In work from Texas it was reported that the different symptoms were caused by different *formae speciales*, *Fusarium oxysporum* f.sp. *betae* and *F. oxysporum* f.sp. *radicis-betae*, and that different isolates caused different responses on the same sugar beet variety. Recent work in Europe indicated some varieties had root rot associated with Fusarium infection in the field. To investigate this, in the current study, we tested US sugar beet germplasm and a collection of sugar beet lines from University of Padova (Italy) with different *Fusarium oxysporum* isolates (all classified as *F. oxysporum* f.sp. *betae*, from two of the three *F. oxysporum* genetic groups). One-month-old seedlings were inoculated and foliar symptoms were evaluated weekly for 6 weeks on a rating system from 0 to 5, where 0 was no symptoms and 5 was dead plants. Plants were successively harvested and the roots examined. We observed severe root rot in the susceptible Italian lines inoculated with isolates that had never shown root rot in US sugar beet cultivars, but only internal vascular discoloration. These same isolates caused no external root symptoms in the USDA germplasm. Our results indicate that Fusarium root rot is induced not only from different *Fusarium oxysporum* isolates that infect plants, but also due to different host factors.

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

Dry rot canker (DRC) is a root disease of sugar beet that was first identified from Utah in 1921, and since that time has been identified from California, Colorado, Minnesota, Montana, Nebraska, North Dakota, and Wyoming. Until recently, the disease was thought to be caused by a strain of *Rhizoctonia solani*, causal agent of the universally familiar Rhizoctonia root and crown rot (RRCR) disease. DRC has now been proven by sequence analysis of the internal transcribed spacer region to be initiated by a binucleate species of *Rhizoctonia*, anastomosis group (AG) F. Foliar symptoms of DRC are similar to those of RRCR, consisting of yellowing and wilting. However, root symptoms are distinct and serve as the major method for distinguishing between the two diseases. Lesions on roots are dry, sunken, and circular to oblong in shape. Beneath surface lesions is a brown spongy material that penetrates deeply into taproots and is sharply demarcated from healthy tissue. The root lesions additionally produced a distinctive series of concentric circles. Further biological and molecular analyses of isolates infesting more than a dozen fields throughout western Nebraska suggest that DRC is a distinct disease caused by a pathogen unmistakably divergent from *R. solani*. Historically, this disease has been considered to be very rare in occurrence however our continuing investigations are revealing a more prevalent presence in sugar beet production than previously thought.

HARVESON, ROBERT, M., University of Nebraska, Panhandle Research and Extension Center, 4502 Ave I, Scottsbluff, NE 69361. **Evaluation of alternative fungicides to azoxystrobin for managing Rhizoctonia root and crown rot in Nebraska.**

In Nebraska, Rhizoctonia root and crown rot, caused by *Rhizoctonia solani*, is generally considered to be the most commonly occurring and damaging sugar beet disease in Nebraska. Previous studies have demonstrated that applications of azoxystrobin based on soil temperatures exceeding 65°F will effectively reduce disease and improve yield parameters. However, the almost exclusive use of Quadris (azoxystrobin) for more than a decade raises concern for resistance development by the pathogen to this fungicide and other members of the strobilurin class. We then began a study in 2012 to evaluate the performance of alternative fungicides currently registered for Rhizoctonia root rot in sugar beets (Priaxor, Proline, and Headline) and compare their performance to Quadris utilizing both in-furrow treatments at planting and foliar applications based on soil temperatures. The study consisted of 9 treatments and data collected included multiple disease counts during the season, and sucrose and root yield determinations at harvest. The treatments consisted of 1) untreated control, 2-5) appli-

cations of each fungicide applied in-furrow at planting, 6-9) applications of each fungicide made using both in-furrow and foliar applications after 4 inch soil temperatures averaged 65° F for three consecutive days. Our results indicated that Quadris, Priaxor, and Proline all performed similarly, significantly reducing disease incidence and increasing sugar yields compared with untreated inoculated controls. Headline was not effective in improving yields or reducing disease compared to the untreated inoculated controls. We further determined that better results were obtained with the combination of in-furrow and foliar applications later in the season than the in-furrow alone.

MARTIN, FRANK N.*, CLIFF HOGAN and JULIA SCHRANDT. USDA-ARS, 1636 East Alisal St, Salinas, CA, 93905. **Establishment of a culture collection of *Polymyxa betae* and development of tools for investigating the pathogen's biology.**

Rhizomania can be a serious disease in commercial sugar beet fields and cause significant losses in production. This disease is caused by *Beet necrotic yellow vein virus* (BNYVV) that is transmitted to sugar beet roots by the fungal obligate pathogen, *Polymyxa betae*. As an obligate pathogen *P. betae* can be difficult to work with and as a result, there is still much to be learned about the fungal vector. In order to begin investigations on the biology and ecology of *P. betae* a culture collection of isolates was established. Soil samples were collected from multiple locations within California where sugar beet has been grown and cultures of *P. betae* purified. Single cystosori cultures were then established and DNA extracted from infected roots for analysis. The same approach was used to generate a *P. betae* culture collection from sugar beet production regions across the USA with 12 cultures representing 8 additional states purified to single cystosori accessions. Several published real time PCR assays for *P. betae* were evaluated but found to not have the level of specificity required so a new TaqMan assay was developed targeting the rDNA. This assay is highly specific and has been multiplexed with a plant internal control amplification to allow for accurate quantification of the pathogen in host tissue.

MARTIN, FRANK N.[1]*, CAROL WINDELS[2], LINDA HANSON[3], JASON BRANTNER[2], [1]USDA-ARS, 1636 East Alisal St, Salinas, CA, 93905, [2]University of Minnesota, Northwest Research & Outreach Center, 2900 University Ave, Crookston, MN 56716, [3]USDA-ARS, 494 Plant & Soil Science Building, East Lansing, MI 48824-1325. **Phylogenetic analysis and population structure of *Rhizoctonia solani* AG2-2 isolates recovered from sugar beet.**

Rhizoctonia solani AG 2-2 (intraspecific groups IIIB and IV) is an economically important root pathogen on sugar beet in many production areas throughout the world. The pathogen not only reduces stand and harvestable yield, but also can make beets more susceptible to stor-

age rots prior to processing. Disease management strategies that focus on crop rotation may have an important impact on maintaining populations of the pathogen in soil and plant debris since the intraspecific groups of *R. solani* AG 2-2 may respond differently to crops commonly grown in rotation with sugar beet. The separation of AG 2-2 intraspecific groups IIIB and IV is generally done using differential growth at 35°C, however this grouping is not always reflective of host range, pathogen virulence or culture morphology. To clarify the phylogenetic relationships in AG 2-2 intraspecific groups, four nuclear loci were sequenced (3,098 bp) for 70+ AG 2-2 isolates from the USA and other regions of the world. The analysis clearly indicates that the intraspecific groupings of IIIB and IV are not reflective of evolutionary relationships among AG 2-2 isolates. Genomic sequence data of a IIIB isolate was used to design an array of 48 SSR markers to examine the population structure of AG 2-2 isolates from sugar beet. These are currently being validated using a wider range of isolates and based upon the results obtained, 9-12 SSR markers will be selected for analysis of field populations.

METZGER, MICHAEL S.[1,2]*, GARY A. SECOR[2] and VIVIANA RIVERA-VARAS[2], [1]Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075 and [2]Dept. of Plant Pathology, North Dakota State University, P.O. Box 6050, Fargo, ND 58108-6050. **Characterization of a new bacterial disease of sugarbeet in the Red River Valley production area of North Dakota and Minnesota**

A previously uncharacterized disease of sugarbeet roots was observed late in the growing season in commercial fields reared in the Red River Valley of Minnesota and North Dakota during 2012-2014. The primary symptoms are a soft, watery decay of the interior of the root with limited) exterior symptoms. Other notable symptoms include black coloration of interior rot margins, blackened petioles and areas of frothing on exposed crowns. The disease was observed in multiple fields with an incidence of 1-5% and was primarily observed in Syngenta varieties. The rot caused severe problems during long-term postharvest storage complications during factory processing due to the accumulation of invert sugars and reduced quality. The preliminary cause of the disease has been identified as Pectobacterium (Erwinia) spp. The source of inoculum, mechanism of infection and factors affecting disease development are not yet known and are part of ongoing research to further characterize this potentially problematic disease.

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ID, 83347. **The Amalgamated Sugar Company Beet Curly Top Virus nursery - a philosophy of transparency and improvement.**

Sugar beet growing regions in Idaho, Montana and Wyoming can face significant losses caused by infections with Beet Curly Top Virus (BCTV). The virus is vectored by the beet leafhopper (*Circulifer tenellus*) and only genetic tolerance in conjunction with insecticide applications provides a measure of control. Disease nurseries are an important tool to survey and evaluate genetic tolerance. However, factors such as agronomical and environmental conditions can influence the outcome. In 2013, The Amalgamated Sugar Company (TASCO) Ag Research Department established a preliminary BCTV nursery (Nampa, ID) with the goal to support the ongoing breeding efforts and to provide a second location to the existing Beet Sugar Development Foundation (BSDF) nursery (Kimberly, ID). The TASCO nursery was conducted based on the latest BSDF BCTV nursery protocol (established in a collaborative effort between BSDF, TASCO, USDA-ARS and seed companies) with certain adjustments. This presentation will give insight to the thought process behind these adjustments, the philosophy behind the need for transparency and improvement, as well as the day-to-day problems associated with establishing, conducting and evaluating the BCTV nursery.

REKOSKE, M. M.[1], MECHELKE, W.[2] and BEYER, W. M.[2] [1]Betaseed, Inc. 1325 Valley View Road, Shakopee, MN 55379 and [2]KWS SAAT AG, Grimsehlstrasse 31, 37555 Einbeck, Germany. **Field performance advantage of sugar beet hybrids with Rz1+Rz2 genes in Minnesota.**

Beet necrotic yellow vein virus, BNYVV when vectored by the fungus *Polymyxa beta* causes the disease rhizomania of sugar beet. Rhizomania was first identified in the US in 1984 in the Imperial Valley of CA, and today is found in all major US beet growing areas including Minnesota (1996). The disease results in sugar yield loss (SY lbs/acre) greater than 20% under moderate levels of infection, and significant postharvest storage losses in terms of extractable sugar. Several major genes have been identified that confer tolerance to the disease. Rz1 and Rz2 are two which have been extensively used in commercial hybrids. Worldwide BNYVV exists as either a four stranded (Type A, B) or five stranded (Type P) member of the Benyvirus genus. Type A has variation on RNA3 in the P25 coding region and two motifs (ACHG and VCHG) have been identified in Minnesota and elsewhere. Both variants have been found to break the Rz1-resistance of some rhizomania resistant cultivars. Potential yield trial sites in Minnesota were investigated through soil assay via GH bait test for BNYVV type (RT-PCR), sequenced for motif on RNA 3 and virus concentration levels (ELISA). Hybrids with Rz1, Rz2 and with Rz1+Rz2 were evaluated under conditions BNYVV Type A ACHG, BNYVV Type A VCHG, and slightly infected soil (ELISA < 0.1) to infected (ELISA > 1.0). Hybrids having both Rz1+Rz2 genes exhibited greater field tolerance based on

virus content and on relative SY than hybrids with either Rz1 or Rz2 alone. The use of Rz1+Rz2 hybrids is an effective means to optimize sugar beet performance with multiple strains of BNYVV found in the upper Midwest.

RUSSART, NATHAN[1]*, MARK BOETEL[2], ROBERT FOOTIT[3] AND IAN MACRAE[1], [1]Dept. of Entomology, University of Minnesota, NWROC, 2900 University Ave, Crookston, MN 56716, [2]Dept. of Entomology, NDSU Dept. 7650, P.O. Box 6050, Fargo, N.D. 58108-6050 and [3]Agriculture and Agrifood Canada, Ottawa, ON K1A 0C6. **Seasonal Occurrence of Sugarbeet Root Aphid, *Pemphigus betae* Doane, in the Red River Valley of Minnesota and North Dakota.**

The Sugarbeet Root Aphid (SBRA) is an occasional insect pest of sugarbeet in the Red River Valley of Minnesota and North Dakota. Late-season drought conditions in 2011 and 2012 facilitated the development of yield-impacting populations of SBRA. These aphids are known to overwinter as eggs on narrow-leaf cottonwood, *Populus augustifolia*, in more westerly growing areas; however, that host is not present in the Red River Valley, which calls into question what the pest may be using as a primary/overwintering host in the region. Typically, female nymphs (stem mothers) hatch from eggs and form galls on leaf petioles in the spring. Inside the gall, the stem mothers feed and parthenogenically produce live daughters. Remaining in the gall until mid-summer, aphids within galls produce a winged generation which exits galls and disperses to neighboring secondary host plants, where they deposit daughters in the soil. The resulting aphid colonies remain, feeding on the summer hosts (e.g., sugarbeet) through the summer. At the end of summer, another winged generation is formed which disperses back to the overwintering host. A series of suction traps, originally constructed to monitor the aphid vectors of viral diseases in potatoes, coincidentally monitored SBRA flight activity in 2012 and 2013. In 2014, similar traps were specifically placed in sugarbeet fields to monitor SBRA flight. Results of HYSPLIT wind analyses and the annual flight activity of SBRA in the Red River Valley of MN and ND will be presented and discussed.

VARRELMANN, MARK[1]*, MARTIN A. BECKER[1], CHRIST, DANIELA S.[1] and [1]Institute of Sugar Beet Research, Holtenser Landstrasse 77, 37079 Goettingen, Germany. **Impact of self-propelled harvesters with different defoliation and microtopping techniques on sugar beet storage stability.**

During harvest, sugar beets receive injuries from defoliation or topping, tap root breakage and bruising. As wounds represent entry sites for pathogens and saprophytic microorganisms, harvesting technique might pose a significant influence on the development of storage rot and white sugar yield losses. To detect possible effects of eight different

self-propelled harvesters on injuries and root rot formation, sugar beets were sampled from a harvester demonstration field trial in Poland. Before storage, sugar beets were rated for topping/defoliation quality and injuries. Storage at 8°C was conducted in climate containers for 5 and 12 weeks. Freshly harvested and stored beets were analyzed for sucrose, invert sugar and melassogenic substances. Stored beets will be rated for root rot development. Results will demonstrate, if there are interactions between harvest injuries caused by different techniques and storability.

WINTERMANTEL, WILLIAM M.[1]*, KIMBERLY M. WEBB[2], NAVNEET KAUR[1], JESSICA PRENNI[3], CAROLYN BROCCARDO[3], LISA WOLFE3, LAURA HLADKY1, PAUL COVEY2, AND ART CORTEZ1, [1]USDA-ARS, Salinas, CA 93905, [2]USDA-ARS, Ft. Collins, CO 80526, and [3]Proteomics and Metabolomics Facility, Colorado State University, Ft. Collins, CO 80523. ***Beet necrotic yellow vein virus*** **infection results in alteration in expression of metabolic, photosynthetic, and putative defense proteins in sugarbeet.**

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV), is one of the most economically important diseases affecting sugarbeet, and is widely distributed in most sugarbeet growing areas of the world. Control is achieved almost exclusively through planting of resistant varieties. Following the introduction of *Rz*1 varieties in the 1990s, new pathotypes that break resistance appeared. Previous studies demonstrated that a relatively small number of differences in sugarbeet protein expression were associated with BNYVV infection as well as resistance to infection. Further studies have now examined protein extracts from near isogenic lines grown in virus-specific soils under standardized growth chamber conditions using SCX fractionation, followed by reverse phase liquid chromatography and mass spectrometry (LC-MS-MS) and subsequent separation on a reverse phase nanospray column. Peptide spectra were examined for protein identity using a Uniprot *Amaranthaceae* database, and statistically significant differences in protein expression among resistant and susceptible sugarbeet were determined. A subset of representative genes encoding differentially expressed proteins and representing all treatments were identified through reverse genetics, and molecular probes designed to these sequences were used to examine RNA levels for validation of protein expression data. All transcript (RNA) levels examined matched results of protein expression analysis. Proteins exhibiting significantly different expression between BNYVV infection of resistant and susceptible near isogenic sugarbeet lines were associated with several protein classes including but not limited to metabolism, photosynthesis, and stimulus response.

Sections D & F
Chemistry & Instrumentation/Factory Operations
Oral Presentations

ANDERSON, BOYD A.[1]* LOUIS H. KNIEPER[2] and HENRY W. COX[3], [1]Hydrite Chemical Company, 300 N. Patrick Blvd, Brookfield, WI 53045 and [2]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284 and [3]Advanced Oxidation Technology, 4730 Wallace Lane, Fredericksburg, VA 22408. **Southern Minnesota Beet Sugar odor control, lessons learned towards a more balanced approach.**

Regulatory limits in the State of Minnesota currently restrict hydrogen sulfide levels to 30 ppb at the property line. Each result over 30 ppb constitutes a violation and each violation carries potential fines.

Three years ago, the Southern Minnesota Beet Sugar Cooperative (SMBSC) began detecting H_2S measurements above 30 ppb at their monitoring stations. As result, SMBSC began searching for cost-effective treatment approaches for H2S. Four of SMBSC's six ponds have the potential to mingle with their condenser pond and thus require the use of food grade chemicals for treatment. The following three food grade products were used: 1. Hydrite Chemical's Hydritreat HS line of products. 2. Peracetic acid (PAA). 3. Hydrogen peroxide.

Bench scale testing of pond water with Hydritreat HS resulted in reduction of sulfide from 10.5 mg/l to 0.5 mg/l. Hydritreat HS also proved successful in the pond; however, due to poor chemical dispersal, it became cost prohibitive. In looking for a more cost effective treatment, SMBSC began experimenting with a PAA/H_2O_2. This treatment was effective at controlling H_2S, however unintended consequences of this approach limited the growth of bacteria in the ponds resulting in high COD readings and the cost of treatment was still high.

After reviewing these results, SMBSC and Hydrite Chemical have decided to move forward with testing an engineered treatment dispensing system using Hydtritreat HS products. A proposed chemical distribution system is expected to improve contact between the treatment chemistry and the targeted sulfide to reduce cost and maintain pond biology.

CARLSON, JEFFREY L.*, LOUIS H. KNIEPER and VIDYASAGARA SUNKAVALLI, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, P.O. Box 500, Renville, MN 56284. **Environmentally-focused R&D opportunities for the beet sugar industry.**

Environmental regulations continue to grow in scope requiring increased monitoring and reporting along with tighter discharge requirements and very low tolerance for violations. Specific end-of-pipe, and process-based changes, were looked at to see if they hold promise to meet the known near- and medium-term impending regulations. End-

of-pipe and fuel-switching solutions are attractive in that they are in use and have known costs. However, these solutions are usually increase costs without providing any added return. The process-based changes could reduce costs and/or increase sugar production, but may require more time to implement with uncertain outcomes. Potentially applicable technologies identified include reverse osmosis, ammonia stripping, ion exclusion, waste-stream management and reuse, and alkaline diffusion. The histories of these technologies in the industry are reviewed, and further research required to make them viable options for control pollution is discussed.

KNIEPER, LOUIS H.*, JEFFREY L. CARLSON and VIDYASAGARA SUNKAVALLI, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, P.O. Box 500, Renville, MN 56284. **Environmental regulatory agenda – current survival and future trends.**

Energy and water intensive industries like beet sugar production are faced with increased pressures from current and proposed regulations directing the management of Air, Water and Waste management practices. Expanding governmental agencies seek to grab authority by layering the regulatory burden placed on all impacts of industrial operation and encroach into operational parameters. The authors examine some recent changes and challenges to the Clean Water Act, Clean Air Act, Resource Conservation and Recovery Act and several state or local regulations. The methods of creating change and the current practice by environmental protection groups to sue and settle with regulators is described. Impacts of change and uncertainty on costs of operation are evaluated with specific examples from Minnesota. Future trends are forecasted and economic and operational impacts on sugar beet factories are evaluated.

DIRINGER, TIM AND BJARNE CHRISTIAN NIELSEN Vestergade 35, 6500 Vojens, Denmark. **Higher efficiency of the centrifugal station due to optimized spray water control, based on the results of inline colour measurement.**

Sugar colour is one of the important criteria to evaluate the quality and the price of the sugar on the market.

Raw sugar as well as refined sugar is traded with quality criteria, which have to be fulfilled by the sugar industry.
The standards for colour measurement in the sugar industry are given by the ICUMSA.

Many sugar factories are producing sugar of lower colour (higher quality) than necessary. This requires extra costs and extra energy and will increase the sugar losses in molasses as well as the total energy costs in the sugar production.

Neltec Denmark A/S has installed various inline colour measurements in cane sugar factories as well as in beet sugar factories world-

wide, to optimize the sugar colour in real time without any time delays and also to reduce production costs and increase the capacity of the sugar factories.

The paper shows an example of potential cost savings in the sugar house by using optimized control of spray water times based on the results of the inline colour measurement of crystal sugar behind the centrifugals.

FOOTE, GEREK, Segment Sales Representative, GEA PHE Systems, 100 GEA Drive, York , PA 17406. **Efficeincy gains through heat transfer.**

Today's sugar plants' objectives are far different from what they began as just a few years ago. With decreased margins, today's plants must find ways to cut costs and find innovative ways to increase profit margins. Unfortunately, these costs are often accomplished by cutting maintenance budgets and shortening man power lists. One costly area in the maintenance budget is the plate heat exchangers. Many plants still spend tens of thousands of dollars on maintaining efficient heat transfer. However, this cost in itself is inefficient.

GRECH, JASON M.[1]*, SAMI FAOUR[2], JOHN FORTE2 and CARL SCHOENFELDER[3], [1]BetaTec Hop Products Ltd, Stanford Park, Stanford Bridge, Worcestershire, WR6 6SG, England, [2]BetaTec Hop Products Inc. 5185 MacArthur Blvd. N.W., Washington, DC 20016 and [3]Hydrite Chemical Co. 300 N. Patrick Blvd. Brookfield, WI 53045. **Bacterial metabolite control using natural hop beta acids.**

Bacterial infection during the production of sugar is a significant issue. Bacteria consume sugar, leading to yield loss and the production of metabolites. Classically lactic acid is the metabolite that is associated with infection but other compounds can also be produced e.g. nitrite and dextran. Nitrite generally has little adverse effect; high nitrites have been reported to produce higher ash levels by reaction with sulphites, although their presence is a general indication of infection. However in Europe a recent regulatory change, tightening the amount of nitrite allowed in animal feed (molasses), has made it difficult for some producers to conform, making control of nitrite a significant issue. Hop beta acids have been proven to be very effective at controlling nitrite formation by treating the early stages of extraction e.g. the mixer in a tower system. Dextran can also cause serious processing issues. It can be produced in the beets during storage and also by bacteria in the extraction system. Although external sources are very difficult to manage dextran formed in the factory can, potentially, be controlled. *Leuconostoc*, the main dextran producing bacteria, are mesophilic and generally grow in the cooler areas of the extraction and can be treated using a similar dosing strategy as nitrite bacteria.

HAFEMANN, HARTMUT[1]* and HANS J. SCHMIDT[2], [1]BMA Braunschweigische Maschinenbauanstalt AG, Am Alten Bahnhof 5, 38122 Braunschweig, Germany and [2]BMA America Inc., 3127 Wild Meadow Ln, Aurora, IL 60504. **Experience in relocating a fluidized-bed steam dryer.**

German sugar factories have been successfully practicing the drying of beet pulp with superheated steam for more than 20 years. Nevertheless, the restructuring of the European sugar industry led to the closure of a number of factories even those with modern technologies. In this context BMA received an order for re-assembly of a fluidized-bed steam dryer at the Uelzen factory of Nordzucker. In addition the order included an increase of the evaporation capacity. The measures to optimize the performance were (1) redesign of fan components, (2) installation of the patented BMA rotary weir, (3) implementation of a plug-protection-sensoring system, (4) overhaul of the airlock. Details of the measures, the difficulties and required repairs during the assembly and the results of operation will be reported.

HATCH, ROBERT O.[1]* and Jay S. Crieglow[2], David R. Smith[3], and Ron Kawlewski[4], Blake Klinger[5]. [1]Organic Defoamer Group, P.O. Box 4883, Jackson, WY 83001, [2]Spreckels Sugar, 395 W. Keystone, Brawley, CA 92227 and [3]Southern Minnesota Beet Sugar Cooperative, 83550 county road 21, Renville, MN 56284. **Update on *"Propylene Glycolate", or 1,2-Propanediol, Sodium Salt* used as a top coat seal to protect thick juice from degradation in storage tanks.**

At the 2013 ASSBT meeting in Anaheim, California we reported on initial results from the experimentation of a "Floating Caustic formulation"; "propylene glycolate"; or 1,2-propane-diol, sodium salt, to seal and protect the top of Ellipsoidal Thick Juice Storage Tanks. This paper will: Review the Chemistry of "propylene glycolate", Review the past two years of plant application, with the Chemistry and Quality of the thick juice stored. The need for the original formulation, and application, to be improved to address some possible "imperfections". Laboratory results will be discussed regarding new formulations and the need to try and replicate real world storage conditions in a "laboratory" setting. Laboratory results will be from beet sugar plants in very hot as well as very cold climates.

HEMPELMANN, REINHOLD* AND SCHULZE, THOMAS, BMA Braunschweigische Maschinenbauanstalt AG, Am Alten Bahnhof 5, 38122 Braunschweig, Germany. **Low draft extraction towers - energy and loss aspects.**

As far as energy consumption and sugar yield is concerned the extraction plant is one of the most important process steps in the sugar factory. For new factories as well as replacements of existing installations, Tower extraction has become the state-of-the-art technology. For

more than 15 years the "Tower 2000" concept has proven its capability for (1) high sugar yields, (2) low raw juice drafts, (3) low infection risk, (4) high reliability and (5) low maintenance and repair costs. Two new extraction systems in the US sugar industry were installed to operate with low raw juice draft. The influence on the process capacity in juice purification and evaporation, the energy consumption and the sugar yield will be shown. Further developments and its limits will be discussed.

HONARVAR, MASOUD[2]* AND BAHRAMI, MOHAMMAD ERFAN[1]
[1]Ph.D Student of Food Science and Technology, Islamic Azad University, Science and Research Branch of Tehran and [2]*Assistant Professor of Food Science and Technology, Islamic Azad University, Science and Research Branch of Tehran. **The Possibility of Using Digital Image Processing System for Evaluation of Raw Cane Sugars Quality Characteristic.**

Assessment of quality characteristics of agricultural and food products has been associated with many problems. The purpose of this study was the predict of raw cane sugars quality with digital image processing technique. The characteristics of raw cane sugars such as Ash, Sucrose, Invert, color Solution, pH, Starch , Dextran, Moisture and Refractive Index in 11 different Iranian and imported raw sugars sample were determined. Then the picture of samples was taken by scanner and different Morphological characteristics such as area mean and area median of crystals, Perimeter Mean and Peri,etre Median of Crystals, Mean and Median of crystal Square property and number of crystals in 0.5 g were identified using Matlab software. Result Showed that was the good correlation between morphological and Physicochemical properties of raw cane sugars. For example, the very good relationship between area mean and some quality parameter like ash (R=0.81), Sucrose(R=-0.87) and Dextran(R=0.85) was found. Also relation between Perimeter mean and ash(R=0.76), Sucrose (R=-0.83) and Dextran(R=0.84) was identified. Good correlation between area median and perimeter median with some properties like ash, Sucrose, Dextran and Moisture was found. Number of crystals and Sucrose(R=0.92), ash(R=-0.90), Dextran(R=-0.94) and RI(R=0.62) had very good relationship too. The results showed that image processing system can be used as an efficient way to predict the quality characteristics of raw cane sugars.

HUMBERT, BILL, American Crystal Sugar Co., 1201 Hwy 75 S, Crookston, MN 56716. **Performance Results after Spindle Flight rebuilt by Putsch® Technicians.**

Proper equipment performance is crucial in sugar factories, as any process interruption or equipment deterioration causes costly delays and operation inefficiency. With campaign durations of up to 270 days,

ACSC always looks to improve with new equipment and maintenance procedures to achieve optimal equipment performance. Pulp presses are exposed to wear and abrasion and demand regular maintenance. The clearance between pulp press screw flighting and screens affects the moisture content of pressed pulp. Over time, the flighting wears and the clearance increases, increasing pressed pulp moisture and drying cost. In order to restore original performance, flighting should be re-welded to regain original size. In the past, Stord and Babbini pulp presses were manually rebuilt by a contractor using a hard surfacing procedure to maintain the original clearance between screens and rotating spindle flights. Often the new hard surface material was welded over an existing hard surface base. As a result, ACSC experienced many sectional breakages at high pressure sections of several presses since welding over an already hard surfaced section made the weld extremely brittle and prone to failure. Sections of hard surface material broke off and ended up in pellet mills causing extensive damage to rollers and dies often requiring the replacement of these components. The Putsch® Flightbuilding group out of Asheville, NC however used a different standard procedure and rebuilt lost flight material on the leading edges using the original flight base material and then applied a hard surface layer on the flight-face and top to achieve original thickness and clearances to screens. This procedure did not cause excessive hardness and breakouts, yet the press performed as original without hard surfacing material breaking off. Improved performance results were verified by excellent press pulp moisture values. In fact, the 2 presses (#1 and #3) with rebuilt flights outperformed press #2 with completely new spindles in terms of press pulp moisture.

KAHRE, SCOTT M., The Amalgamated Sugar Company LLC, 138 W. Karcher Rd., Nampa, ID 83687. **Design and operation of an improved tailings separation and chip recovery system.**

At The Amalgamated Sugar Company LLC's Nampa factory, the process of receiving, conveying, and washing sugar beets produces large quantities of beet tails, chips, skins, and other organic matter. This material becomes suspended in the beet flume water, and must be separated prior to de-silting and recycling the water. The historical separation method utilized inefficient, labor-intensive rotary screens, and produced only low-value tailings for cattle feed and, at times, macerated chips to be included in pulp. A new process was designed and installed in order to greatly reduce the organic solids carry-over to the de-silting ponds, improve the quality of the tailings product, and isolate a chip fraction that could be returned to the slicers and processed along with whole beets. This endeavor was highly successful in that the organic loading to the flume water ponds was greatly reduced, which improved their settling performance and reduced odors during summer pond cleaning. Tailings quality was more consistent, leading to higher demand among cattle feeders. Lastly, the system recovered and re-

turned chips to the slicers in a quantity equivalent to 1.2% of the factory slice rate. This effectively reduced "shrink" in storage, as these chips were previously considered a loss between the receiving station and the cossette belt. This additional beet recovery yielded a simple payback period of less than three years.

KOCHERGIN,VADIM*, WILLIAM JACOB, SCOTT BRANDON, KEITH VINECKE and TIM PRYOR Amalgamated research LLC, 2531 Orchard Dr. E., Twin Falls, Idaho, USA. **Ion Exchange Decolorization Applications Using Fractal Shallow Bed Equipment.**

Decolorization applications with ion exchange resins have been tested in the beet sugar industry in the past with various levels of success. Very few installations are in operation, mainly where the targets for sugar color are extremely high, and the opportunities exist for effluent discharge. Most information about decolorization of sugar solutions comes from sugar refining industry, where syrups at high brix are treated. Use of conventional large and inefficient decolorization equipment requires high capital and operating expenses. Innovative approaches to both process and equipment design are needed to improve the feasibility of ion exchange decolorization for beet sugar applications. Shallow ion exchange bed systems with ARi fractal fluid distributors have been proven efficient in thin juice softening and molasses chromatography applications. Compact design and high throughput along with low energy and effluent use are among the important features of this innovative equipment. Results of the studies on decolorization of thick juice and 30 Bx chromatographic resins will be presented. Although ion exchange resins are used as separation media, decolorization mechanism is based on adsorption rather than on ion exchange. This leads to slower kinetics and results in limitations to bed height requirements. Juice or syrup viscosity plays significant role in both expected throughput and resin color loading. Results from thin juice decolorization study will be discussed. A combination of shallow bed equipment and uniform fluid distribution allows the process to be carried out at unusually high flow rates (up to 50 bed volumes/hour). Removal of 50% of color from thin juice opens an opportunity to obtain two consecutive white strikes in a conventional beet factory.

LARSEN, KASPER GEHL[1] and JENSEN, ARNE SLOTH[1], [1]EnerDry A/S, Kongevejen 157, 2830 Virum, Denmark. **Latest development of steamdrying of pulp.**

The development of steamdrying of beet pulp continues by improved design and better integration in the factory. This has been implemented on new installations in Europe and Japan, where EnerDry has supplied 4 dryers with a total capacity of 171 t/h evaporation capacity. More dryers are under construction.

Over the last 40 years the energy consumption in the factories has

been reduced from 300 to 180 kWh/ton beet in the factory itself. To that comes the energy needed for the pulp drying, which is 90 kWh/ton beet making a total of 270 kWh per ton beet. To bring this further down steamdrying of the pulp is necessary. The steamdrying can always be integrated in an existing sugar factory and it is never necessary to make changes in the boiler house, but the power production is usually affected. Ways to have a good power production are illustrated by examples of how new steamdrying has been integrated in existing sugar factories in Europe and Japan the last few years, and the new installations are briefly described.

LEPAGE, JAMES[1]*, PATRICK KINCAID[1] and JAN SEETZ[2], AkzoNobel Functional Chemicals, [1]USA: 525 West Van Buren St, Chicago, IL 60607, [2]Europe: Stationsstraat 77, P.O. Box 247, 3800 AE Amersfoort, The Netherlands. **Removal of calcium based scales in sugar juice evaporators using EDTA.**

Sugar scale is a complex mixture of various components that forms on evaporator heat exchangers during the concentration of sugar juice. To ensure efficient mill operation this scale requires periodic removal by mechanical cleaning or with chemical treatments with NaOH and / or acid. Mechanical cleaning is highly labor intensive and comes with safety concerns, while chemical treatments may not always be effective especially on calcium (Ca) based scales. Additionally acid cleaning can be corrosive to equipment.

Chelating agents like EDTA have been known for 60 + years to dissolve numerous organic and inorganic metal ion based scales. We have determined that EDTA at high pH readily dissolves Ca sulphate, oxalate, carbonate and many other scale types typically found in sugar juice evaporators. In contrast, the dissolution of HAP (hydroxyapatite) based Ca scale is best done with a solution of EDTA at a pH < 10. Besides pH, the concentration of the EDTA solution and temperature will also impact the extent of scale removal. Since each evaporator may have a different scale composition – the optimal application and use of EDTA requires a knowledge of the scale(s) present in each evaporator. Examples of the application of EDTA to remove a range of scales found in cane sugar juice evaporators will be presented as with possible application to sugar beet juice scale. Successful cleaning typically requires just ~ 3 hours of boiling with EDTA. Monitoring of pH and free EDTA content using a simple titration procedure during the cleaning is critical to ensuring the proper amount of EDTA is used.

MAURICE, TODD,[1]* AUGUSTINE, GLENN,[1] RON KAWLEWSKI[1] AND RANDY DRAKE[2], [1]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284 and [2]Hydro Solutions, P.O. Box 221016, Louisville, KY 40252. **The importance of micro-nutrients in an Anaerobic wastewater system.**

We found our wastewater to be lacking in some of the micro-nutrients necessary to obtain maximum performance from the Anaerobic Digester. Although we have less than 1 year worth of data, preliminary results have shown that the addition of micro-nutrients to supplement some trace elements that are deficient in the influent wastewater feed to the Anaerobic system seem to improve the overall performance and efficiency of the system. Further sampling, testing, and data collection will be ongoing moving forward to confirm initial observations.

MCKEE, MARIANNE L.*, RONNIE TRICHE, and CHARLEY RICHARD, Sugar Processing Research Institute, Inc., 1100 Robert E. Lee Blvd, New Orleans, LA 70124. **Color and Ash – Is there a relationship between them?**

Many questions surround color and ash and a possible relationship between these two components of sugar. Color and ash content of beet and cane sugars including beet, juice, and extract campaign beet sugars as well as raw and refined cane sugars were studied. The appropriate ICUMSA method of determination for color and ash was used for each type of sugar. For beet sugars ash ranged from 0.004% to 0.015% while color ranged from 20 IU to 32 IU. For the refined cane sugars tested, color ranged from 18 IU to 58 IU while ash ranged from 0.007% to 0.011%. Raw cane sugars ranged from 800 IU to 3335 IU with ash values of 0.173% to 0.317%. These sugars were washed using a high brix white sugar solution to remove the syrup surface layer similar to the affination step in the cane refinery. The samples were dried and then tested for ash and color again after washing. Color and ash removed by washing is believed to be contained in the syrup surface layer. These components in the syrup layer are believed to be involved in reactions that promote color increase during storage of sugar. This presentation will show the differences in ash and color in the whole sugar sample as well as in the syrup layer for the various types of sugars studied.

MILLER, KENNETH C* and LEV DRAGO, Perry Videx, LLC, 25 Mt. Laurel Road, Hainesport, NJ 08036 USA. **Using return on investment to compare purchase of new or used equipment.**

Installing used equipment offers a competitive option for sugar factories and refineries. The paper begins with an overview on return on investment decisions. It is followed by a methodology for comparing costs and return on investment from new or used purchases. It then presents a simplified hypothetical case study of installing used or new equipment in a beet sugar factory, applying the methodology the analyze the results. This paper details the range of issues that are necessarily attached to capital projects, including engineering, warranty, and profitability.

MOHR, STEPHAN[1]*, ROBERT M. ZIMMERMAN[2] and MICHAEL HUENERLAGE[3], [1]Pfeifer & Langen, Aachener Str. 1042a, D-50858 Cologne, [2]The Western Sugar Cooperative, 7555 East Hampden Avenue, Suite 600, Denver, CO 80231, [3]Eberhardt GmbH, Am Bauhof 21, D-32657 Lemgo. **Lime kiln conversion from coke to natural gas operation – A project outline and experiences of three campaigns operation.**

In 2012 in Germany, two existing vertical shaft lime kilns were converted from coke to natural gas operations. This paper deals with the technical realization and the conclusions drawn from the completed projects. The initiative was triggered by observations **on emission** values made by German Authorities and the conversion from coke to natural gas of the existing lime kilns promised to be a very effective option. The technology used for the conversion is called GDS, Gas Distribution System. It was invented by John B. Jones in the USA. However, the GDS technology had to be adapted not only to the dimensions of the existing lime kilns but also to the strict German standards for gas firing systems. The adapted technology now features an automated start-up procedure by using pilot burners for ignition and an online kiln gas analysis system to control the combustion process. The paper presents (1) the decision process associated with the adoption of the new technology, (2) the challenges of a tight project schedule, (3) the necessary steps of the conversion, (4) the problems occurring during the first campaign, (5) the impacts on the beet factory (i.e. on the CO2 balance and exhaust gas temperature), (6) the experiences of three campaigns of operation, (7) the details of the technology used and (8) additional benefits that would justify a conversion from coke to natural gas operation on existing lime kilns

RHOTEN, CHRISTOPHER D., Consultant, 318 Millbrae Loop, Hendersonville, NC 28791. **A summarized review of procedures for the optimization of pre-liming.**

In conventional classical juice purification, the optimization of the pre-liming process step results in the maximum and relatively complete precipitation of certain insoluble impurities. Such optimization is essential to the maximum overall efficiency of juice purification, satisfactory 1st carbonation sludge filtration characteristics and the highest purity of thin juice produced relative to beet quality. Changes in beet quality as a result of storage time and/or storage conditions, primarily related to variation in the alkalinity and buffering capacity of the raw juice, result in the necessary modification of operating parameters. Such changes in juice quality lead to requirements for timely, judicious and correct adjustment of related pH/alkalinity operating parameters. As material throughput varies as a result of a change in raw juice flow rate, the ideal temperature for pre-liming along with the back-mixing characteristics within the pre-limer are affected due to the resulting change in juice residence time and thus, a coincidental change

in the effective performance of the pre-liming operation. Even with temperature adjustment, other compensating measures relative to prelimer pH profile and/or final pre-liming pH/alkalinity are also likely to be required. The purpose herein is to summarize a series of steps and procedures for the routine optimization of the coagulation and precipitation of insoluble nonsugar constituents in beet raw juice in pre-liming over the course of a beet processing campaign. This is essentially an ongoing three-step process that requires each step to be optimized and maintained at near optimum conditions to facilitate the optimization of the interrelated, subsequent steps.

RHOTEN, CHRISTOPHER D., Consultant, 318 Millbrae Loop, Hendersonville, NC 28791. **Linear growth rate based adaptive batch crystallization control.**

Supersaturation based batch pan control seeks to control the growth rate of the crystals via control of sucrose concentration in the mother liquor within the metastable zone for orderly crystal growth. However, in practice, this approach results in a rather complex computational and programming problem. In order to accurately measure and control supersaturation, a number of reliable, representative and relatively accurate process inputs are required. Among the more important inputs are the purity and temperature of the boiling mass as well as the concentration of the mother liquor. Given that the ultimate goal of the batch crystallization process is to manage crystal growth at a maximum rate while assuring orderly crystal growth without the formation of secondary grain. It follows then, that the direct measurement and management of crystal growth rate, made possible through the use of the simultaneous measurements of mother liquor and massecuite concentration, it is possible to manage crystal growth rate directly without resorting to a relatively complex calculation for supersaturation. Via measurement of the actual crystal growth rate by differential concentration measurement and using a calculated ideal growth rate algorithm for liquor feed management for the direct control of mother liquor concentration, all related crystallization parameters are automatically accounted for within the growth rate control algorithm and may essentially be ignored as process inputs to the crystallization control program. Such an approach to batch pan control utilizing a single mass crystal growth rate algorithm results in a relatively simple and effective control solution. This paper describes the development, installation and operating results of such a control solution.

SCHMITZ, LISA, M.*, DAVID R. GROOM, and BEVERLY J. JACOBSON, American Crystal Sugar Company, 1700 North 11th Street, Moorhead, MN 56560. **Closing the unaccountable sugar loss gap; identifying nonsugars present and estimating loss via various metabolic pathways of micro-organisms.**

During the past campaign (2013-2014), some American Crystal Sugar factories experienced periods of high unaccountable sucrose losses with consequent lower recovery. Lactic acid had typically been used to monitor the level of microbial activity in the beet end; it failed to indicate excessive microbial activity in the process. Additional chemical species were investigated to explain the losses. Beet end juices and condensates were analyzed for volatile fatty acids and ethanol among other chemical species. Lactic and acetic acid concentrations levels did not indicate an infection. However, ethanol concentration was higher than expected indicating microbial, possibly yeast activity. Microbial assays verified yeast and mold infections in the diffusers and ancillary equipment. The unaccountable losses increased rapidly due to the consumption per mass of the higher organisms. The invert accumulation was negligible due to the rapid consumption by the yeast. With metabolites identified, the missing sucrose was largely accounted for.

SUHR, MARK R.*, DR. VADIM KOCHERGIN, DR. MIKE INKSON. Sugar Knowledge International, Ltd. 410 Campbell Ln, Hutchinson, MN 55350, Amalgamated Research, LLC 2531 Orchard Dr., Twin Falls, ID. 83301, Sugar Knowledge International Ltd. Connect House, Clarence Court, Rushmore Hill, Orpington BR6 7LZ, ENGLAND. **The Economic Possibility of Two White Sugar Strikes in a Beet Sugar Factory**

The quality of the sugar beet has continued to improve and the factories having the possibility of installing more technologically advanced equipment could now produce two sugar "strikes" that meet the requirements for classification as white sugar. With the use of the SugarsTM program, the feasibility of producing two consecutive sugar crystallization steps of acceptable white sugar quality was examined and the consequential effect on energy, non-sugar recycle and sugar loss to molasses was developed. The use of a decolorizing step was introduced into the model at different process locations to determine the impact on white sugar quality, energy, extraction and equipment sizing. In addition the quality of the thin juice was varied over historical and optimized values to further develop the operating requirements to consistently produce two consecutive strikes of white sugar. A table presenting the results and operational impacts is included. These results allowed for the development of the capital sizing and equipment changes necessary to achieve the goal of two white strikes, either blended as a single grade of white sugar or segregated as two different grades of white sugar. Estimated capital costs and operational improvements were tabulated to show the economic feasibility.

VARAEE, M. HONARVAR[1] , M.[2], Akhavan Sepahi, A.[3] [1,2]Department of Food Science and Technology, College of Food Science and Technology, Science and Research Branch, Islamic Azad University, P.O. Box 1477893855, Hesarak, Ashrafi Isfahani Highway, Poonak, Tehran, Iran. [3]North Tehran Branch, Islamic Azad University, P.O. Box 1667934783, N.O 25, 10 Bostan, Street Southern Mokran, Square Heravi, Pastaran, Tehran, Iran. **Refining of filter press mud by *Aneurinibacillus migulanus*.**

Press mud, a byproduct from sugar factories, which may contribute to environmental pollution. The decrease of organic matter in the mud by the application of *A.migulanus* which was isolated and identified from filter cake is considered to reduce organic matter, improve concentration of calcium carbonate and change of color and electrical conductivity. The activities of *A. migulanus* on two pH 7.5 and 9, four dilutions Control, 25, 50 and 75% in two time 2 and 4 weeks is evaluated. The results showed that the amount of organic matter is decreased and the purity of calcium carbonate is increased In fact under normal pH and without the addition of water, carbonaceous pollutants were reduced by 33% after 4 weeks of storage at 37 °C. This beneficial application of commonly-existing microorganisms not only makes it possible to reduce environmental pollution significantly, but also to increase calcium carbonate content by 4%. Pale green color of filter cake converted to yellow and light grey. Lighter color showed that concentration of carbonate calcium are increased and have a high quality. The electrical conductivity increased 24% in pH 9 which are considered that muds with higher sanity are not reasonable for fertilizer. Key words: Press mud, Filter cake, Organic matter, Carbonate calcium

Sections D & F
Chemistry & Instrumentation/Factory Operations
Poster Presentations

BOUCHE, CATHERINE, ITECA SOCADEI, Europôle de l'Arbois, 13592 Aix-en-Provence, France. **On-line crystal growth monitoring and sugar color measurement using image processing techniques.**

There are two strategic locations that must be closely monitored during the crystallization process to improve and stabilize the sugar quality: the sugar boiling stage and the centrifuges outputs. In this study, a pan microscope coupled to a high resolution digital camera is mounted in front of a sight glass on a batch pan to follow the crystal growth. Before seeding it checks the syrup quality to detect and measure the contaminants, the air bubbles and the super coarse crystals. At the seeding stage, it makes sure that the good volume enters the pan as requested. During the boiling, the camera follows the crystal growth and its dedicated software calculates the Coefficient of Variation (CV)

and the Mean Aperture (MA) in real time, while monitoring the number of crystals and the number of fines. It can trigger alarms on non conformity (false grains or bad crystal size). At the centrifuges outputs, an on-line colorimeter equipped with a high resolution digital camera measures the sugar color using reflectance techniques. Correlated with the laboratory, the colorimeter delivers on-line color measurements in Icumsa Units, used to optimize the washing time of the centrifugals. Real-time image treatment provides additional tools to detect contaminants (brown lumps of sugar for instance) and trigger alarms or deviate out of specification objects to avoid contaminating the dryer. Video recording increases traceability and optimize the maintenance of the centrifugals (i.e., the operator can precisely point which washing nozzle or discharge scrapper has to be replaced).

The poster shows that image processing techniques are essential to keep sugar quality constant and within predefined limits, while providing fast payback and increasing production at lower costs.

HONARVAR, MASOUD[1]*, AGHAEI, MAJID[1], MARYAM MIZANI[1], and MOHSEN BAZRAFSHAN[2], [1]Islamic Azad University, Science and Research Branch, Tehran, IRAN, 1477893855 and [2]Fars Agricultural and Natural Resource Research Center, Zarqan, Fars, IRAN, 7341653112.

Some chemical properties affecting technological quality of two sugar beet (*Beta vulgaris* L.) cultivars during harvest and post-harvest in farms.

In autumn, sugar beet fields should be harvested quickly, and be made ready for planting the next crop. If rainfall occurs during this period, storage duration of roots harvested in the field is longer, and sugar beet quality is affected. In this study, the effect of storage time (at harvest time, and at four subsequent one week intervals) on some chemical properties of two sugar cultivars (ROSIRE from FLORIMOND DESPREZ and ISELLA from KWS) was studied using factorial experiment with randomized complete block design. Sugar content (SC), dry matter (DM), sodium (Na), potassium (K), amino-N (N), white sugar content (WSC), and molasses sugar (MS) were measured. The results obtained showed that storage time had a significant effect on SC, DM, Na, K, N, WSC, and MS for two cultivars. With increase in the period of root storage up to two weeks, SC, DM, WSC, Na, K, and N increased significantly due to moisture loss and dehydration. However, storage period of up to three and four weeks decreased these variables due to decrease in temperature, rainfall occurrence, and increase in the relative humidity, and thus increase in the amount of moisture in roots. In general, sugar beet storage causes dehydration of their roots, and reduces their technological quality. Therefore, it is necessary to harvest sugar beet according to a scheduled program, and the carrying capacity of the factory.

SCHUELER, JOHN, MICHAEL NELSON, AND KATHLEEN L. SWANSON, US Peroxide LLC, 900 Circle 75 Parkway Ste. 1330, Atlanta, GA 30339. SUNKAVALLI, SAGAR, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. **Hydrogen peroxide dosing for sulfide oxidation and supplemental dissolved oxygen in stabilization ponds at SMBSC in Renville, Minn.**

Hydrogen peroxide (H_2O_2) dosing was conducted within four stabilization ponds throughout the summer of 2014 in order to control hydrogen sulfide (H_2S) emissions. The Southern Minnesota Beet Sugar Cooperative (SMBSC) facility is subject to a perimeter ambient air quality standard for H_2S concentration to not exceed 30 parts per billion on a 30- minute average. Hydrogen peroxide oxidizes sulfides and provides residual oxygen.The first approach used in the ponds that contained process water with high chemical oxygen demand was to feed 50% hydrogen peroxide directly into 40 – 100 feet long nozzles floated or sunk in areas where high concentration of H_2S was observed. The second approach utilized flexible PVC tubing extending to two ends of the ponds with distribution arms and open nozzles every few feet for an even distribution of the product. The peroxide was delivered to the ponds using a chemical metering system attached to a bulk storage supply. This system allowed 50% hydrogen peroxide to be applied at varying concentrations. Residual peroxide levels were measurable at several areas of the pond using this application method. SMBSC additionally used peracetic acid and a catalyzed hydrogen peroxide blend for H_2S mitigation. However, 50% hydrogen peroxide made up the majority of the chemicals used from June – October 2014. Overall SMBSC observed significantly less H_2S generation.